LEAN SIX SIGMA AND ITS EFFECT ON ABSORPTIVE CAPACITY, INNOVATION PERFORMANCE AND SUSTAINABLE COMPETITIVE ADVANTAGE

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KUALA LUMPUR

2019

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THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

**FACULTY OF ECONOMICS AND ADMINISTRATION
UNIVERSITY OF MALAYA
KUALA LUMPUR**

2019

UNIVERSITY OF MALAYA

ORIGINAL LITERARY WORK DECLARATION

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LEAN SIX SIGMA AND ITS EFFECT ON ABSORPTIVE CAPACITY, INNOVATION PERFORMANCE AND SUSTAINABLE COMPETITIVE ADVANTAGE

ABSTRACT

The very nature of businesses in the current epoch is at a state of hyper competition. As globalization and technology takes over the essence of every aspect, managing business requires a strategic approach. Quality management, which philosophy revolves around the principles of continuous improvement, is an approach that could harvest relevant strategies in accordance to business cycles. Lean Six Sigma is a process improvement methodology which falls under the umbrella of quality management, touted as the latest management philosophy of the 21st century by scholars and practitioners alike. Although the profundity of Lean Six Sigma is prevalent to a certain extent, there are still companies that are unsuccessful with the application of the philosophy, particularly failing to appropriate its functions. Correspondingly, gaps in scholarly literatures displayed the lack of clarity which justifies how Lean Six Sigma could bring about far reaching prospects in terms of innovation and sustainability in competitive advantage in firms that embrace it which are very much a current necessity. The purpose of this study is to explore the possibility of Lean Six Sigma functioning as a source of dynamic capability through the concept of absorptive capacity. The study intends to delineate the relationship between the idiosyncrasies of Lean Six Sigma and components of absorptive capacity, which exemplifies dynamic capabilities. These capabilities are ideal cornerstones which enable firms to realize far reaching performance outcomes such as innovation and sustenance of competitive advantage. Using a Partial Least Square based Structural Equation Modeling (PLS-SEM), this study ran a quantitative analysis to test the theoretical framework drawing on a sample of 125 manufacturing organizations in Peninsular Malaysia. From

19 hypotheses studied, 11 explained significant findings. The results of the analysis elucidated Lean's Social Practice (LSP), Six Sigma's Role Structure (RS) and Structured Improvement Procedure (SIP) positively influences Potential Absorptive Capacity (PACAP) which resembles an exploration trait for an organization. Meanwhile, LSP, RS and Focus on Metrics (FOM) positively influences Realized Absorptive Capacity (RACAP) which resembles an exploitation trait. However, Lean's Technical Practice (LTP) was found to be non-significant towards both PACAP and RACAP. PACAP also positively influence RACAP and sustainable competitive advantage (SCA). Whereas RACAP positively predicts innovation performance (IP) which subsequently influences SCA. The analysis revealed Lean Six Sigma allows for exploration and exploitation activities alike through PACAP and RACAP respectively, leading to ambidextrous characteristics. These capabilities in turn influence IP and SCA in firms, justifying the path towards overarching performance outcomes through the application of Lean Six Sigma. Finally, the study outlines some of the limitations of the study and makes several managerial, theoretical and policy implication which firms and government institutions in Malaysia could capitalize from. Additionally, avenues for future research were also identified and recommended. In short, this study enlightened how Lean Six Sigma, or its idiosyncrasies could be maneuvered towards achieving far reaching outcomes such as innovation and sustainability in competitive advantage in organizations by empirically asserting its disposition as source of dynamic capability.

Keywords: *Lean Six Sigma, Potential Absorptive Capacity, Realized Absorptive Capacity, Innovation Performance and Sustainable Competitive Advantage*.

LEAN SIX SIGMA DAN KESAN TERHADAP KAPASITI PENYERAPAN, PRESTASI INOVASI DAN KELEBIHAN DAYA SAING YANG MAMPAN

ABSTRAK

Perniagaan di zaman sekarang berada didalam persaingan yang sangat sengit. Oleh sebab globalisasi dan teknologi mengambil alih intipati setiap aspek, pengurusan perniagaan memerlukan pendekatan yang strategik. Pengurusan kualiti, falsafah yang berputar di sekitar prinsip-prinsip peningkatan berterusan, merupakan pendekatan yang menekankan strategi yang relevan dan sesuai dengan kitaran perniagaan. *Lean Six Sigma* adalah metodologi perubahan proses yang tergolong di bawah subjek pengurusan kualiti, yang dianggap sebagai falsafah pengurusan terkini bagi abad ke-21 oleh sarjana dan pengamal. Walaupun kelebihan *Lean Six Sigma* berleluasa sehingga tahap tertentu, masih terdapat syarikat-syarikat yang tidak berjaya menerapkan falsafah ini, khususnya gagal dalam menyesuaikan fungsinya. Sejajar dengan itu, jurang dalam literatur menunjukkan kekurangan penjelasan yang membuktikan bagaimana *Lean Six Sigma* dapat membawa prospek yang jauh dari segi inovasi dan kelestarian bagi kelebihan daya saing di kalangan firma yang melaksanakannya. Oleh itu, tujuan kajian ini adalah untuk meneroka fungsi *Lean Six Sigma* sebagai sumber keupayaan dinamik melalui konsep kapasiti penyerapan. Kajian ini bertujuan untuk menggambarkan hubungan antara *Lean Six Sigma* dan komponen kapasiti penyerapan, yang menggambarkan keupayaan dinamik. Keupayaan ini merupakan teras utama yang membolehkan firma merealisasikan pencapaian prestasi seperti inovasi dan kelebihan daya saing. Menggunakan *Structural Equation Modeling* (PLS-SEM), kajian ini menjalankan analisis kuantitatif untuk menguji rangka penyelidikan daripada sampel 125 organisasi sektor pembuatan di Semenanjung Malaysia. Daripada 19 hipotesis yang dikaji, 11 daripadanya didapati adalah penemuan penting. Keputusan analisis menerangkan Amalan Sosial Lean (LSP), Struktur Peranan Six Sigma (RS) dan Prosedur Penambahbaikan Berstruktur (SIP) mempengaruhi secara positif terhadap Kapasiti Penyerapan Potensi (PACAP) yang menyerupai sifat eksplorasi untuk organisasi. Sementara itu, LSP, RS dan Fokus pada Metrik (FOM) berpengaruh secara positif terhadap Kapasiti Penyerapan Sedar (RACAP) yang menyerupai ciri eksploitasi. Walau bagaimanapun, Amalan Teknikal Lean (LTP) didapati tidak signifikan terhadap kedua-dua PACAP dan RACAP. PACAP juga secara positif mempengaruhi RACAP dan kelebihan daya saing yang mampan (SCA). Sedangkan RACAP secara positif meramalkan prestasi inovasi (IP) yang seterusnya mempengaruhi SCA. Analisis mendedahkan bahawa *Lean Six Sigma* membolehkan aktiviti penerokaan dan eksploitasi melalui PACAP dan RACAP, yang membawa kepada ciri-ciri '*ambidextrous*'. Keupayaan ini seterusnya mempengaruhi IP dan SCA di firma, menerusi pelaksanaan *Lean Six Sigma*. Akhirnya, kajian ini menggariskan beberapa batasan penyelidikan dan memberi beberapa implikasi terhadap pengurusan, teori dan dasar untuk manfaat firma dan institusi kerajaan di Malaysia. Di samping itu, kemungkinan penyelidikan masa depan juga dikenal pasti dan disyorkan. Kesimpulannya, penyelidikan ini menyedarkan bagaimana *Lean Six Sigma* dapat mendorong ke arah pencapaian yang berprospek seperti inovasi dan kelestarian dalam kelebihan daya saing dalam organisasi melalui bukti empirikal. Ini menegaskan kedudukannya sebagai sumber keupayaan dinamik.

Kata Kunci: *Lean Six Sigma, Kapasiti Penyerapan Potensi, Kapasiti Penyerapan Sedar, Prestasi Innovasi, Kelebihan Daya Saing Mapan.*

ACKNOWLEDGEMENTS

"*Take the first step in faith. You don't have to see the whole staircase, just take the first step*" - Dr. Martin Luther King Jr.

Life is a mysterious unfolding of events. It is different for every one of us. Adventurous, mischievous yet meaningful eventually. This piece of effort is a cornerstone of my lifework. In hindsight, the journey is implausible without the presence of some and the guidance of few. My parents, Rajamah and Jagantheran, are cardinal figures to my progress in life from whom I'm learning indefinitely. My wife, Vijayalatchumy, along with my siblings and friends, a patient support, for time is of essence and at length when I'm in research mode. At times, the research voyage can be precarious. Mine, was navigated through the support of three conscientious commanders. I am grateful to Prof. Datin Sri Dr. Suhaiza Hanim Dato Mohamad Zailani for her zealous direction and undivided sharing of knowledge pertaining to the subject matter of the study, Dr. Kuppusamy Singaravelloo, for his meticulous and diligent observation on the research progress along with Associate Prof. Dr. Santha Ramu, for being a compassionate audient during critical moments. I would also like to take this opportunity to extend my gratitude to the Directors of MBizM group of companies, Dr. Satnam Singh and Harbans Singh for their empathy and encouragement in the line of my profession and this research, which bodes profoundly to the nature of this study as well. My warmest appreciation to the Malaysia Productivity Corporation's (MPC), Dr. Rahmat Ismail, Director of Quality and Excellence Development Division (QED) for extending their support to this research. Finally, my sincere thanks and genuine appreciation to all that have been a part of this research endevour, both directly and indirectly.

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ACAP	:	Absorptive Capacity
DMAIC	:	Methodological phases in Lean Six Sigma stands for Define, Measure, Analyze, Improve and Control
FOM	:	Focus on Metrics
IP	:	Innovation Performance
LSP	:	Lean Social Practice
LTP	:	Lean Technical Practice
PACAP	:	Potential Absorptive Capacity
RACAP	:	Realized Absorptive Capacity
RS	:	Role Structure
SCA	:	Sustainable Competitive Advantage
SIP	:	Structured Improvement Procedure

CHAPTER 1: INTRODUCTION

1.1 Introduction

Management is a vital aspect in businesses and organization alike. Organizations are technically comprised of a network of routines. The composition of routines involve a set of interdependent operational and administrative routines which has a capability to evolve on the basis of performance feedbacks (Nelson & Winter, 1982). Organizational routines therefore are aspects that reflects capability of organizations which encompasses dynamic processes (Pentland & Feldman, 2005) managing which would determine the level of an organization's capability.

However, an undeniable fact of the business cycle is the increasing rapidity of change which requires strategic management (Frankenhoff & Granger, 1971). Adaptation to market demand warrant firms to make decisive changes to its routines which prescribe the manner in which organization works. The competition and changes in market compels firms to be able to recognize the fluctuation and be innovative in order to stay competitive. Seemingly this made quality as a source of survival and competitiveness of organization (Lande, Shrivastava, & Seth, 2016). The need to adapt to such a changing environment and the challenge on sustaining competitive advantage has prompted firms to ingest the notions stemming from quality management and business process improvement. Ehigie and McAndrew (2005) regard quality as the predominant factor infusing differentiation and competitive advantage in global marketplace.

Correspondingly, quality management and business process improvement had grown to become a deterministic aspect in strategic management as part of an integrated management philosophy (Powell, 1995). Quality management principles advocate continuous improvement philosophy which serve as dynamic capabilities subject to a proper infrastructure that promote changes in firms' operational capabilities (Anand, Ward, Tatikonda & Schilling, 2009).

Lean Six Sigma is the latest generation of improvement methodology which has a profound reach globally ever since the new millennium (Bakar, Subari & Daril, 2015; Snee, 2010). Lean Six Sigma is in fact a hybrid methodology involving two different schools of thought which are Lean and Six Sigma (Corbett, 2011; Sunder, 2013). Lean is the extension of Toyota Production System (TPS) which emphasis is to eliminate waste or non-value adding activities within processes. Six Sigma on the other hand was created by Motorola but made popular by General Electric (GE) whose focus is on reducing variation in processes through a structured approach (Pepper & Spedding, 2010). Together, Lean Six Sigma is known as "a methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed and invested capital" (George, 2002).

Since its emergence, the merit of Lean Six Sigma's management philosophy had been addressed globally by famed organizations embracing it. DuPont is one of the Fortune 500 companies that is renowned to have embraced Lean Six Sigma which boast its sustainable business growth model. In 2004, the organization reported a completion of 2500 projects targeted to increase growth which accounted to a massive $1.5 billion in increased revenue from those projects (Harry & Linsenmann, 2006). PolyOne Corporation deployed Lean Six Sigma as their major strategy to combat the 2008 economic downturn with a five year goal to have 20% full time associates on the initiatives. The resulting effects are a tenfold increase in the company's enterprise value since the launch in which they also surpassed the target by achieving 40% of full time associates on Lean Six Sigma initiatives (Barry, 2012). Lockheed Martin's Naval Electronics and Surveillance Systems plant generated $5 million in savings namely in its white collar processes in the second year of Lean Six Sigma application (George &

George, 2003). Xerox celebrates its Lean Six Sigma success with increasing profits, reducing costs, enriched business velocity and increased customer satisfaction ever since kicking off the integrated (Lean and Six Sigma) initiative in mid-2002 (Fornari & Maszle, 2004; O'Rourke, 2005). In Malaysia, Sime Darby group reported its benefits in FY2015 amounting to RM360.4 million from its Lean Six Sigma blueprint which began since 2013 (*Sime Darby Berhad*, 2015). The prevalence of Lean Six Sigma is expansive as it reaches out to manufacturing and services industry equally ranging from banks, education, healthcare, government administration and even military (Antony, Krishan, Cullen & Kumar, 2012; George & George, 2003; Zhang, Irfan, Khattak, Zhu & Hassan, 2012). In fact, the effectiveness of Lean Six Sigma are of such a magnitude that it is claimed to even combat economic recessionary period by functioning as a survival tool (Chaurasia, Garg & Agarwal, 2016).

However it must be voiced that many have the conception of Lean Six Sigma being just an improvement tool that deals with cutting cost and making changes in the process (Byrne, Lubowe & Blitz, 2007b). Byrne, Lubowe and Blitz (2007a) states that Lean Six Sigma has the vigour to reach beyond operational excellence and tap into the realm of innovation to sustain competitive advantage. Evidence of multinational giants that experienced turnaround through Lean Six Sigma ingenuities are prevalent. Caterpillar's stagnant revenue growth prompted it to embark on Lean Six Sigma initiatives which innovated its management. The company reported phenomenal success and a surge in revenue by 80 percent through the novelties in management and products alike. POSCO a Korean-based steel maker faced fierce competition when it was privatized in 2000. Through Lean Six Sigma, it became a premier provider of innovative steel products and services, establishing itself as the regional low-cost provider. UK-based gas and electricity company ScottishPower was losing market share in 2001. Lean Six Sigma helped to invent new ways of targeting their customers and providing innovative services in complex circumstances by radically overhauling its customer service and sales operations. In four years ScottishPower increased its customer base by 1.9 million with an average of 40,000 new customers per month (Antony, 2014; Byrne et al., 2007a; George, 2002; Lee, 2010; Salah, Rahim & Carretero, 2010).

Arnheiter and Maleyeff (2005) points out that organizations implementing Lean or Six Sigma management alone in time may face a point of diminishing returns and both principles could instead complement each other's strength towards achieving competitive advantage. Hence, many Lean companies are looking to add Six Sigma meanwhile many Six Sigma companies are learning to merge Lean management together (Arnheiter & Maleyeff, 2005; Snee, 2010). For instance, Boeing, who is a prominent Lean organization and GE, unarguably a leader in Six Sigma philosophy had teamed up to coach each other on their respective expertise as a means of knowledge and capability assimilation (Salah et al., 2010). Thus Lean Six Sigma is viewed as a synergized management system to leverage innovation and competitive advantage (Sheridan, 2000).

Although there are many studies exist on examining the link between Lean Six Sigma and organization outcomes such as operational, organizational, financial, culture, knowledge, learning and the likes, research on far reaching outcomes like innovation and sustained competitive advantage are scarce, received very little attention and still debatable which needs further insight (Yusr, Othman & Mokhtar, 2012). More importantly how does Lean Six Sigma bring about these far reaching outcomes need a rigorous discourse. With minimal evidence available in scholarly works, researchers have consented that studies scrutinizing the link between Lean Six Sigma and innovation are almost non-existent (Antony, Setijono & Dahlgaard, 2016; Hoerl and Gardner, 2010; Xu, Sikdar & Gardner, 2006). Whereas Byrne et al. (2007b) argues Lean Six Sigma can potentially foster habits that drives continuous innovation throughout the organization. Given this situation, this study intends to delineate how Lean Six Sigma could act as a source of dynamic capability in imparting the ability to learn new external knowledge and exploit them to enhance firm's innovation performance and sustain competitive advantage. This study proposes that the reconceptualized theory of absorptive capacity by Zahra and George (2002) is a useful domain in explaining this phenomenon which in turn leads to far reaching performance outcomes.

1.2 Background of the Study

1.2.1 Lean Six Sigma in Malaysia

Malaysia have been on the effort to empower innovation capabilities lately through agencies such as Malaysia Productivity Corporation (MPC), Malaysia External Trade Development Corporation (MATRADE), Ministry of Science Technology & Innovation (MOSTI), Malaysian Global Innovation & Creativity Centre (MaGIC) and the likes. Malaysia is embarking upon a new phase of development towards realizing its aspiration of becoming a developed nation by 2020 wherein there's a need to develop more innovation driven enterprises (MATRADE, 2013). The challenges the nation face towards achieving the 2020 vision amongst many are decelerated productivity growth in recent years, with Malaysian firms facing new competition from their East Asian peers (OECD, 2016). As such, studies on the grounds of productivity and organizational performance such as Lean Six Sigma could assist in the nation's initiatives to progress.

Lean principles in Malaysia are in fact pervasive given its "Look East Policy" and the permeation of Lean based production system since 1980s (Abdullah & Keenoy, 1995; Agus & Shukri Hajinoor, 2012; Furuoka, 2007; Saravanamuttu, 1988). In line to that, there is no doubt the studies in Lean are abundant in the Malaysian context. However Six Sigma on the other hand is still relatively new to Malaysia. A recent study by Ang (2015) shows the study of Six Sigma in Malaysia is limited with mostly attributed to best practice and critical success factor studies. However, the study on "Lean Six Sigma", the hybrid of both, in Malaysia is scarcely being deliberated.

There are nine studies registered in Malaysia under the "Lean Six Sigma" term (the hybrid methodology). Majority of the research are focused on the aspect of critical success factors (Abu Bakar et al., 2015; Fadly Habidin & Mohd Yusof, 2013; Jayaraman, Leam Kee & Lin Soh, 2012; Jeyaraman & Kee Teo, 2010). There is one conceptual study on the application of Lean Six Sigma in scrap management (Shing, Nadarajan & Chandren, 2014), one literature review (Ahmed, Manaf & Islam, 2013) and three empirical based investigation (Anuar, 2015; Habidin, Mohd Yusof and Mohd Fuzi, 2016; Zamri, Hibadullah, Fuzi, Desa & Habidin, 2013).

In 2010, Jeyaraman and Kee Teo (2010) came up with a conceptual framework on Critical Success Factors (CSFs) of Lean Six Sigma. In 2012, the authors used the framework to study its impact on operational and organizational performance in six multinational electronic manufacturing service (EMS) companies in Malaysia. In an extended version of this study, Jayaraman et al. (2012) did a multiple regression analysis which explained management engagement and commitment, established LSS dashboard, a frequent communication among all value streams of organizations and a supportive organizational culture are the most critical success factors in implementing the companies' Lean Six Sigma programs. However, they found organizational culture and belief did not moderate the success factors and performance outcomes (Jayaraman et al., 2012).

Fadly Habidin and Mohd Yusof (2013) explored the CSF for the automotive industry in Malaysia. Using structural equation modelling (SEM) technique, they designed and validated a CSF model for the industry drawing upon a sample of 252 Malaysian automotive organizations. The authors found leadership and customer focus as the two primary success factors for Lean Six Sigma implementation in the Malaysian automotive industry. Abu Bakar, Subari and Mohd Daril (2015) more recently made an effort to review the latest articles since 2010, dedicated and in particular to Lean Six Sigma hybrid methodology to congregate a comprehensive CSF list through an Affinity diagram. They identified five significant CSFs based on total and highest frequency scores from the list of articles being; organizational infrastructure and project management, management commitment and leadership, Lean Six Sigma competency, training and education and linking Lean Six Sigma to business strategy.

Ahmed, Manaf & Islam (2013) presented a summarized literature review on the importance and application of Lean Six Sigma in the healthcare services. Shing et al. (2014) learned how Lean Six Sigma could improve scrap management by a systematic management of scrap generation rate simultaneously improving throughput rate through waste reduction. Anuar (2015) assessed the implementation level of Lean Six Sigma in a Malaysian government-owned company. Through Kotter's 8-step change management model, the author investigated as to why the Lean Six Sigma program was unable to change the organization despite two years of training and implementation. Using descriptive statistics and t-test analysis, it was revealed that the distinction between steps one to four and five to eight of the Kotter's model was significantly different, therefore concluding the company's Lean Six Sigma program lacked alignment between performance and reward system.

Given the rise of "Green" concepts as of late, it was perceived to be important by Zamri et al. (2013) study the relationship between the relationship between environmentally sustainable production technique, Lean Six Sigma and its impact to financial performance in particular to Malaysian automotive industry. Using SEM, they devised a framework for Green Lean Six Sigma (GLSS) which involve five important measurements to be tested to identify its relationship with financial performance of automotive industry in Malaysia. Habidin et al. (2016) developed a model which study the association between

Lean Six Sigma strategic control system (SCS) and organizational performance (OP) within the Malaysian automotive suppliers. The results from 252 automotive suppliers demonstrated that even though Lean Six Sigma is related to OP, SCS does not mediate the relationship between Lean Six Sigma and OP. However, the authors claim OP seems to be improving when SCS is coupled with Lean Six Sigma.

1.2.2 Lean Six Sigma Research Issue in Malaysia

As portrayed in the discussion above, Lean Six Sigma studies in Malaysia are scarce which explains the relative infancy of this philosophy in a country which is striving forward to innovation and knowledge-based economy which calls for new management and organizational principles in the new global market (Mustapha & Abdullah, 2004). As Ang (2015) highlighted, the study of such management system is very limited in Malaysia be it even Southeast Asia and mostly focused in the western continent such as United States and Europe.

To date, there happens to be a lack of research being done in Malaysia on how Lean Six Sigma could be a driver towards innovation and sustainable competitive advantage with exception to Yusr et al. (2012) who studied Six Sigma's relationship with absorptive capacity and innovation. Although the study shed some important acumens of these relationship, there happens to be no detailed discussion and insights into how the latest management philosophy of Lean Six Sigma would impart dynamic capabilities which in turn instils innovation and sustainability in competitive advantage alike as this would be imperative in the advancement of Malaysia towards an innovation and knowledge based economy.

1.3 Problem Statement

Most studies had articulated on the relevance of knowledge and learning orientation on concepts of Lean and Six Sigma (Anand, Ward, & Tatikonda, 2010; Ang, 2015; Arumugam, Antony & Kumar, 2013; Choo, Linderman & Schroeder, 2007b; Sony & Naik, 2012; Tyagi, Cai, Yang & Chambers, 2015). The quintessence of continuous improvement philosophies like Lean Six Sigma lies in the notion of dynamic capabilities, which is the firm's ability to integrate, build and reconfigure internal and external competences (Teece & Pisano, 1994; Teece, Pisano & Shuen, 1997). Being dynamically capable, organization systematically generates and modifies its operational routines in pursuit of improved effectiveness (Zollo & Winter, 1999). One such concept which impel the traits of dynamic capability is absorptive capacity. The current hypercompetitive and turbulent environment have made absorptive capacity as one of the most sought after capabilities in generating sustainable competitive advantage (Fosfuri & Tribó, 2008; Gutiérrez, Bustinza & Molina, 2012; Lenox & King, 2004; Tu, Vonderembse, Ragu-Nathan & Sharkey, 2006; Zahra & George, 2002). Absorptive capacity refers to the ability of firm to recognize, create and utilize knowledge in order to gain and sustain competitive advantage (Cohen & Levinthal, 1990; Zahra & George, 2002). Lane, Koka and Pathak (2006) refers it as a construct that has emerged increasingly in organizational research in recent decades. Scholars consented absorptive capacity as one of the most studied aspects in the knowledge management domain in recent years (Fosfuri & Tribó, 2008; Gutiérrez et al., 2012; Jansen,Van Den Bosch & Volberda, 2005; Lane et al., 2006; Lichtenthaler, 2009; Todorova & Durisin, 2007; Tu et al., 2006).

However, very rarely have there been studies which focus on concepts of absorptive capacity from the perspective of Lean Six Sigma. With an eclectic range of theories being applied to understand and describe the underpinnings of Six Sigma, McAdam and Hazlett (2010) compiled peer-reviewed studies to explain the dynamics of Six Sigma from an absorptive capacity perspective from its multidimensional view of acquisition, assimilation, transformation and exploitation of Six Sigma as a new external knowledge. Their research uses absorptive capacity as a mean to structure literatures and conceptualized Six Sigma as new external knowledge or technology to be adopted. Therefore the questions raised accordingly were on how it fits into the organization in terms of a new knowledge. This study merely articulates the characteristics an organization should have or adopt to capture the Six Sigma knowledge. However it does not show how does the application of Six Sigma relates to the multidimensional aspects of absorptive capacity which in turn affects the organizations' competencies. Yusr et al. (2012) assessed the relationship between Six Sigma and innovation in 65 manufacturing companies in Malaysia. They found the relationship to be completely mediated by absorptive capacity which they conceptualized as a single dimension construct. Although the multidimensional aspect of absorptive capacity was addressed, the research analysis did not distinguish the components inherent in the concept.

Shah, Chandrasekaran and Linderman (2008) seek to explain the associative and predictive implementation of both Lean practice and Six Sigma and their impact on firm performance through a survey of 2511 manufacturing plants in the United States. Using a joint distribution frequency, the results showed that manufacturing plants using extensive Lean practice also utilized Six Sigma expansively. Using logistic regression, it was found that quality management, continuous improvement, process capability, pull system, error proofing and SPC significantly impact Six Sigma implementation. Finally using hierarchical regression analysis enlightened that Six Sigma implementers had a strong moderated relationship on Lean practicing plants with their three out of four operational measures as compared to non-implementers. Under the notion of absorptive capacity, the authors justified that prior related knowledge on quality or process improvement, denoting to Lean practice, would generate the drive and intensity of accommodating subsequent or new related practice, such as Six Sigma. Here, the authors articulate on how Six Sigma absorbed into a firm with Lean being a prior related knowledge but does not explain how both improvement method operationalize absorptive capacity in the firms.

McFadden, Lee and Gowen III (2015) augmented similar notions through their study on the path towards improving patient safety by usage of quality initiatives, Lean, Six Sigma and goal specificity mediated by patient responsiveness in the healthcare settings. They elucidated that initial practice of Lean corresponds to absorptive capacity capability when Six Sigma is subsequently smoothened into hospital improvement initiatives. This study's concept is as similar to that of preceding where it does not delineate how Lean and Six Sigma triggers absorptive capacity.

Gutiérrez et al. (2012) studied the upshots of Six Sigma teamwork and process management on absorptive capacity and how does that relate to learning orientation within organizations. The study conducted in Europe which generated a total of 58 firms of multiple industries were analyzed using EQS-SEM wherein the results showed a positive relationship between teamwork and process management on absorptive capacity. This then successfully impacted an organization's learning orientation thus validating the research framework of the authors. In this research, the authors opted for classification of absorptive capacity as per Zahra and George (2002). However the investigation that followed suit in the research did not segregate the multidimensional aspect of absorptive capacity. In the study, the authors explained they were not able to identify the positive effect whether it was in lieu of potential absorptive capacity or realized absorptive capacity. They explained that this could be a subject for future research. Correspondingly, this proves to be one of the motivation for this current study from a theoretical perspective as Lean Six Sigma induces the facet of dynamic capability of firms.

The connection between Lean Six Sigma implementation and the theory of absorptive capacity seems to be in a piecemeal or nebulous manner. Instead the theory could be explicated in a more in depth and analytical fashion through its multidimensional characteristics (potential and realized absorptive capacity). There is no detailed discussion on the phenomenon how Lean Six Sigma affects potential and realized absorptive capacity and how these lead to innovation performance and sustainable competitive advantage.

The link between Lean Six Sigma, potential versus realized absorptive capacity, innovation and competitive advantage has not been clearly explained in extant literatures. Arnheiter and Maleyeff (2005) statement that Lean Six Sigma could realize the attainment of competitive advantage remains an anecdotal statement as to date. There has been little study that verify this discussion in detail which explains this phenomenon from the perspective of not Lean or Six Sigma, but Lean Six Sigma. Central to this curiosity is how Lean Six Sigma acts as a source of dynamic capability enabling different developmental path towards the components of absorptive capacity (potential vs. realized) which differentially influence the creation and sustenance of competitive advantage.

In addition to this, the process management literature (i.e. process improvement) centers a debate on the extent philosophies like Lean and Six Sigma inducing innovation. Benner and Tushman (2003) contends that process improvement techniques provide inconsistent results to organizational outcomes with incremental innovation and change. They believe in order to possess dynamic capabilities, organizations require exploitation traits along with variance increasing exploratory traits which subsumes ambidextrous capability. Parast (2011) on the other hand argues that Six Sigma programs cater a dual focus on exploitation and exploration, however it may impede radical innovation targeting new customers. Choo, Linderman and Schroeder (2007a) discoursed on loose coupling approach between methodological elements of process improvement and contextual elements which renders different learning outcome and abilities therefore influencing ambidexterity of organization capability.

Hoerl and Gardner (2010) discussed how Lean Six Sigma associates to creativity in stimulating innovation. They suggest Lean Six Sigma is favorable to incremental innovation but not breakthrough innovation. They suggested Lean Six Sigma should be assimilated with other methods or approaches. Azis and Osada (2010) substantiated Six Sigma has positive impact in changing management system with its linkage being critical in strengthening innovation especially in disseminating commitment and sustaining spirit within the organization. Antony et al. (2016) submits that Lean Six Sigma does foster innovation in the context of process innovation, incremental innovation or innovation capability. Through the feedbacks from interview conducted with 10 UK-based companies, the authors also believe Lean Six Sigma have potential on radical innovation. They went on to suggest that future research should reflect on ambidextrous characteristics of Lean Six Sigma that explains the balance between exploitative and exploration. Corresponding to Antony et al.'s (2016) study, there are questions that remain open to date such as what are the explorative and exploitative elements influenced by Lean Six Sigma, and how do these elements bring about organizational outcomes.

Looking from the Malaysian business and economic perspective, according to The Global Competitiveness Report, Malaysia's progress is at a stalled transition between efficiency-driven (stage 2) to innovation-driven (stage 3) economy for the past 5 years (2012-2017) and dropped in ranking from 18th spot to 25th in the global competitiveness index. Malaysia's competitiveness in terms of management practices have been on a downward trend since 2015 in which it stands at 15th position as of 2017, down by six notches from the preceding year. This descending trend seems to be in parallel to Malaysia's overall business efficiency where it stands at 19th place in 2017 which is a fall by five spots from 2016 and nine spots from the year before (MPC, 2017b). Although ranked quite highly among ASEAN countries there seems to be a gap in the ability to translate management practices into business efficiency, hence excelling in innovation and sustaining competitive advantage is an uncertain facet.

Efforts are needed to bridge the gap between business efficiency and productivity performance. One of the key challenge is to improve organizational capabilities to inspire innovation (MPC, 2016). More is needed than creativity as the insight must be put into action to make a difference such as altered business processes within the organization, changes in the products and services and etcetera (MATRADE, 2013). With regards to being competitive and innovation capacity, MOSTI reports one of the key challenges Malaysian firms need to address rather systematically and urgently is the weak dissemination and weak attention to absorptive capacities (Olsson, 2012).

Given the stance as the latest improvement philosophy, it is meaningful to scrutinize Lean Six Sigma in this perspective which is a potent approach to impart dynamic capabilities in firms. The ability to transpire palpable outcome does not arrive by only embracing Lean Six Sigma instead, the theoretical underpinnings that drives it need to be understood. In this context, it necessary to understand how Lean Six Sigma imparts absorptive capacity which is composed of different components, and how do those consequently influence innovation and competitive advantage. As evidence shows, not all companies that have embraced Lean Six Sigma had been successful (Jeyaraman & Kee Teo, 2010). As a result, there are not much clarification to companies in Malaysia that explain how Lean Six Sigma imparts dynamism to its capabilities which subsequently leads to innovation performance and sustained competitive advantage. Therefore there is a need to learn how these paths unfold.

1.4 Research Questions

The aforementioned problems identified through literature led to some vital questions which warrant investigations. Lean Six Sigma is renowned as a philosophy which imparts dynamism to the capability of an organization. Firms need to understand the idiosyncrasies of Lean Six Sigma and the intricacies towards capabilities that are dynamic. Absorptive capacity is conceptualized as a dynamic capability which is composed of two distinct component (Zahra & George, 2002), therefore:

1) What are the practices of Lean Six Sigma (Lean Technical Practice (LTP), Lean Social Practice (LSP), Role Structure (RS), Structured Improvement Procedure (SIP), and Focus on Metrics (FOM)) that have positive effect on the components of absorptive capacity, Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP)?

According to theoretical argument, Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) are said to be co-existing at all times and should complement each other (Zahra & George, 2002). However, the question of whether these two components exist in such a manner under the context of Lean Six Sigma is still unwarranted for. It could be that both components exist under the context of Lean Six Sigma but not positively related. Therefore it is necessary to inquire:

2) What is the relationship between Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) under the context of Lean Six Sigma application?

Given that Potential Absorptive Capacity (PACAP) is said to arise or emerge first before Realized Absorptive Capacity (RACAP):

3) Does Potential Absorptive Capacity (PACAP) mediates the relationship between the practices of Lean Six Sigma (LTP, LSP, RS, SIP, FOM) and Realized Absorptive Capacity (RACAP)?

Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) are theorized as two separate components but plays a complementary role. Given its characteristics each component taps into differing organizational capabilities and hence organizational outcomes. Therefore:

4) What are the relationships between Potential Absorptive Capacity (PACAP), Realized Absorptive Capacity (RACAP), innovation performance and sustainable competitive advantage in the context of Lean Six Sigma?

1.5 Research Objectives

Corresponding to the research questions, the objectives of this study are as below;

1) To examine the positive effects of Lean Six Sigma's practices (LTP, LSP, RS, SIP, FOM) on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP).

2) To investigate the relationship of Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) under the context of Lean Six Sigma application.

3) To analyze the mediating role of Potential Absorptive Capacity (PACAP) between Lean Six Sigma practices (LTP, LSP, RS, SIP, FOM) and Realized Absorptive Capacity (RACAP).

4) To evaluate the relationship between Potential Absorptive Capacity (PACAP), Realized Absorptive Capacity (RACAP), innovation performance and sustainable competitive advantage in Lean Six Sigma firms.

1.6 Scope of the Study

The focus of this study will be on companies implementing Lean Six Sigma in particular to manufacturing industry. Further, the companies targeted are within Peninsular Malaysia to ensure consistency and reach throughout the research. To date, there are no indication as to the number of firms practicing Lean Six Sigma as there are no formal institutions which has such database. The reason to this is because the decision to adopt Lean Six Sigma is solely on the discretion of companies' top management. Companies may also choose to forsake the implementation of Lean Six Sigma in the near future if they opted to do so. As such, this makes it hard to keep track on the companies adopting Lean Six Sigma.

In Malaysia, the manufacturing sector remains a substantial contributor in terms of sales, employment and to the economy as a whole (Ang, 2015). Evidence of the sector's importance is reflected in terms of contribution to Malaysia's GDP, external trade and job creation namely (MPC, 2017a). Ang (2015) acknowledged the fact that manufacturing companies tend to have greater intensity of knowledge work given their emphasis on process improvement. In order to expand the reach of companies implementing Lean Six Sigma, selection of the companies was not narrowed to subsectors so as to allow for a larger inclusion of respondents based on Federation of Malaysian Manufacturers (FMM) database. Given the reasoning above, it would be rational to focus the study on manufacturing companies that adopted Lean Six Sigma as their process improvement initiative or management philosophy. In addition to that, it is noteworthy to state that this study follows an antecedent-outcome approach. This implies that this study will view the practices of Lean Six Sigma as antecedents which effect dynamic capabilities in the form of Potential and Realized Absorptive capacity. Under the context of Lean Six Sigma, how does Potential and Realized Absorptive capacity, two separate but coexisting and complementary components, relate to innovation performance and sustainable competitive advantage will be seen as the outcomes.

1.7 Significance of the Study

This study caters significance in several ways. The current business cycles and economic circumstance warrant firms to be adept to changes. Given that capability of organizations are entrenched in organizational routines (Winter, 2000; Winter, 2003), it is necessary for firms to learn and react accordingly to improve their conditions swiftly. The process improvement or quality management stream addresses this range of thought. Meaning to say, how firms could learn from external stimuli, market condition and business cycles and reconfigure its competencies to address the rapidly changing environment (Teece et al., 1997; Zollo & Winter, 1999; Zollo & Winter, 2002) is of essence to ensure sustainability.

Given Malaysia's aspiration to head towards vision 2020 by developing more innovation driven enterprises and a knowledge-based economy, this study improves the perception within Malaysian industry of Lean Six Sigma as a comprehensive management system or philosophy rather than being a mere tools and technique for process improvement. In addition to it, this study also shows how Lean Six Sigma is significant in part of innovating a company's performance to leverage competitive advantage. Besides, concerns of innovation and sustainability under the context of business process improvement in improving business efficiency are equally addressed in depth.

This study's results will illustrate how process improvement methodologies like Lean Six Sigma could be a driver in inducing capabilities in organization that are dynamic. As abovementioned, success stories shared a fact on how Lean Six Sigma enabled companies to digress away from the turbulence of trying economic times towards a favorable condition. This study describes how this can be achieved through Lean Six Sigma application and its idiosyncratic practices which enables dynamic characteristics of absorptive capacity. Lean Six Sigma enables companies to learn and extract external information which provides an opportunity for it to explore possibilities be it in terms of seeking resolution to internal issues or paving the way for exploring new market opportunities. In addition to that, the enriched information could pave the way for novel creation by exploiting them into operational use that spurs business efficiency through innovation. It was also corroborated that the application of Lean Six Sigma, appropriated constructively could impart ambidextrous characteristics in firms. This bridges the gap between business efficiency and productivity performance which happens to be one key challenge to improve organizational capability to inspire innovation according to MPC (2016).

Malaysian firms seeking to combat economic oscillation, pursue innovation and intend to sustain competitive advantage could learn and recognize the 'know-how' of achieving their objectives through the embodiment of Lean Six Sigma. With knowledge being the forefront of the application of this philosophy, this will drive the focus of the nation's economy towards realizing a knowledge and innovation driven economy moving forward.

1.8 Contribution of the Study

The essence of continuous improvement philosophy lies in the notion of dynamic capabilities. Although many studies have articulated on the relevance of knowledge and learning orientation on concepts of Lean and Six Sigma (Anand et al., 2010; Ang, 2015; Arumugam et al., 2013; Choo et al., 2007b; Sony & Naik, 2012; Tyagi et al., 2015), there's a dearth of studies done under the concept of absorptive capacity, which is a sought after capability in generating sustainable competitive advantage. For instance, Gutiérrez et al. (2012) who studied Six Sigma's teamwork and process management effect on absorptive capacity, although managed to identify significant influence of those traits unto the concept, they did not managed to define the multidimensional aspect of absorptive capacity. In other words, they could not clarify which of the components between potential and realized absorptive capacity accounts for the effects from those practices of Six Sigma. Additionally, the idea of how innovation could be triggered through process improvement endeavors like Lean Six Sigma had begun to take pace in recent scholarly works (Antony et al., 2016; Azis & Osada, 2010; Yusr & Othman, 2011). However, there happens to be a lack of explanation on how Lean Six Sigma brings about innovation and sustainability in competitive advantage, or what is the path towards these outcomes. One other key point of punctuation in the context of this study is the debate between exploration and exploitation characteristics process improvement philosophies caters (Benner & Tushman, 2003; Parast, 2011).

This study provides an overriding and comprehensive explanation as to how process improvement methodology of Lean Six Sigma would contribute to innovation performance and sustainability of competitive advantage of firms through two critical components of absorptive capacity. The results of this study corroborates the notion of Lean Six Sigma acting as a source of dynamic capability. This sums up the articulation by scholars that process improvement initiatives are potent facets of dynamic capability (Anand et al., 2009).

This study enriches extant published literatures by examining how Lean Six Sigma influences the dimensions of absorptive capacity and consequently how do those dimension impels innovation and sustained competitive advantage. From theoretical perspective, the study contributes by unfolding the dimensional aspect of absorptive capacity and its link with business process improvement (Lean Six Sigma) which affects business efficiency.

Besides, the study would enrich the debate between exploitation and exploration in the process management literature by extending valuable insights through the findings. Studies in the past had debated on how process improvement techniques are exploitative in nature (Anderson, Rungtusanatham & Schroeder, 1994; Benner & Tushman, 2003; Winter, 1994). This study have shed an important view of how Lean Six Sigma could cater exploration and exploitation traits alike paving the opportunity for an ambidextrous organization. It was discovered that Lean's social practice and Six Sigma's structured improvement procedure and role structure influences potential absorptive capacity, which is known to influence explorative capability through the ability to learn. This involves the process of acquiring and assimilating externally derived knowledge. Lean's social practice, Six Sigma's role structure and focus on metrics on the other hand influences realized absorptive capacity, which is regarded to influence the ability to exploit internal capabilities especially knowledge. This involves transforming and exploiting the knowledge of the firm.

As theorized by Zahra and George (2002) on how both potential and realized absorptive capacity effects sustainability of competitive advantage differently, it was also corroborated through this study's findings that Lean Six Sigma practices enables potential absorptive capacity which sustains competitive advantage through strategic flexibility in managing its resources given the ability to learn market conditions such as fluctuation, changing trends, customer necessities and the likes which allow them to align their business strategies and deploy necessary resources to fit the business needs through improvement projects. Another set of Lean Six Sigma practices as aforementioned enables realized absorptive capacity which triggers a 'bisociation' process which allows for innovation performance in the organization which in turn leads of sustained competitive advantages. From a practical perspective, managers and practitioners will be able to maneuver their decision makings in the implementation of Lean Six Sigma to balance exploration and exploitation traits according to the necessity of firms. Firms could use this study's framework as a general guideline to tap into the domain of exploration and exploitation practices through Lean Six Sigma projects.

The structured improvement procedure otherwise known as the DMAIC structure was realized to be an important practice amongst others. The DMAIC structure seems to be facilitating exploration and exploitation traits through the concept of absorptive capacity. This comes as a novel finding where research of past proposed the structured method relates to exploitative characteristics relative to explorative (Choo et al., 2007a). Potential absorptive capacity or exploration activities seem to take place primarily throughout the beginning of the phases. Project team members would scour or explore on the occurrence of the problem and requirements of customers. Then, they systematically move on to the process of exploring possible solutions that fits customer and market requirements. These activities chiefly takes effect during the Define, Measure, Analyze and partly in the Improve phases. Upon finalizing the solutions, implementation takes place in the form of exploitation. The implementation will be tracked, monitored and reviewed on periodical basis to ensure consistency and alignment with company strategy, customer and market requirement.

These exploitation activities takes place in the Improve and Control phases in the DMAIC structure. Given the sequential nature of potential and realized absorptive capacity (firms could not possibly exploit knowledge without acquiring them first), the structured improvement procedure was discovered to be mediated by potential absorptive capacity in influencing realized absorptive capacity. Hence, it can be said that exploration and exploitation activities flow in a systematic fashion through Lean Six Sigma's structured improvement procedure. This mediation effect holds true only for the structured improvement procedure amongst the other practices which distinctly influence the components of absorptive capacity. This findings supplement the research outcomes of Hwang et al. (2017) wherein structured improvement procedures influences both exploration and exploitation. More so, the findings of this study takes it one step further by clarifying how exploration and exploitation are being administered throughout the structured improvement procedure through the concept of absorptive capacity. This is marked as a novel finding of this study and an important contribution to the Lean Six Sigma or process improvement body of knowledge.

One other pivotal findings of this study is that focus on metrics drives exploitative learning. Locke and Latham (1990) elucidate that challenging goals will drive enhanced effort from project team members to achieve high or aggressive targets. Gutiérrez et al. (2012) claimed that setting of challenging goals will align employees' attention and motivation, therefore enabling the creation of knowledge and learning ability which develops absorptive capacity. However, it was not explained how it works between the components of absorptive capacity which this study is set out to do. Imposing challenging targets or goals do encourage learning ability and knowledge creation as posited but on varying modes among the components of absorptive capacity. It was initially perceived that focusing on metrics with high challenges and goals would trigger potential and realized absorptive capacity. However, it was discovered through the study's analysis, focus on metrics stimuluses a different type of learning capability, exploitative learning and rather negatively with explorative learning. It is conceived that a mechanistic structure with tightly coupled connections foster exploitative learning (Burns & Stalker, 1961; Hansen, Podolny and Pfeffer, 2001; Rowley, Behrens & Krackhardt, 2000; Weick & Westley, 1999). A strict focus on metrics was found to be essential towards realized absorptive capacity where rigorous efforts are placed in transformation and exploitation of knowledge to identify solutions to ensure target is met. Therefore, this findings add to the body of knowledge in explaining the scopes or features of process improvement methods which accounts for exploitation characteristics and most importantly could assist in explaining the arguments by some scholars that process improvement endeavors bring more of exploitation (March, 1991; Parast, 2011).

1.9 Definitions of Key Terms

Lean: A dynamic process of change driven by a systematic set of principles and best practices aimed at continuous improvement. The philosophy aims at producing products and services with reduced cost and fast to customer through waste elimination (Bhamu & Singh Sangwan, 2014; Liker, 1997; Womack, Jones & Roos, 1990).

Lean Technical Practice: Refers to the manifold of tools and techniques under the philosophy of Lean (Bortolotti et al., 2015; Gowen III, McFadden & Settaluri, 2012).

Lean Social Practice: Refers to the social side of Lean application or management (Hadid, Mansouri & Gallear, 2016; Shah & Ward. 2007).

Six Sigma: A systematic and structured management system to continuously improve organizational processes to achieve the strategic business goal of increasing bottom line benefits and enhancing customer satisfaction through a fact-based or data driven approach and through the collaboration of the organization's employees, customers and suppliers (Linderman, Schroeder, Zaheer & Choo, 2003; Pande & Holpp, 2002; Zu, Fredendall & Douglas, 2008).

Six Sigma Structured Improvement Procedure: A scientific and methodological problem solving procedure or cycle called DMAIC which stands for Define, Measure, Analyze, Improved and Control. The DMAIC is employed and adhered strictly in the Six Sigma regime (Pande & Holpp, 2002; Pyzdek, 2003).

Six Sigma Role Structure: A systematic employee structure designated for Six Sigma improvement specialist within a practicing organization which mainly consist of Black, Green and Yellow Belt resembling martial arts' expertise level (Pande & Holpp, 2002; Pyzdek, 2003; Zu et al., 2008).

Six Sigma Focus on Metrics: Refers to the practice of setting clear, challenging and high goals or targets compared to "easy to achieve" or fuzzy ones. Also refers to the use of metrics to monitor project progress (Linderman et al., 2003; Linderman, Schroeder & Choo, 2006; Zu et al., 2008).

Lean Six Sigma: A fusion between the philosophy of Lean and Six Sigma which becomes a methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed and invested capital (George, 2002).

Dynamic Capability: A learned pattern of collective activity through which the organization systematically generates and modifies its operational routines in pursuit of improved effectiveness (Zollo & Winter, 1999). It is also the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments (Teece et al., 1997).

Absorptive Capacity: A set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability (Zahra & George, 2002).

Potential Absorptive Capacity: The ability of a firm to be receptive to acquire and assimilate external knowledge (Lane & Lubatkin, 1998). Potential absorptive capacity reflects exploratory traits such as exploratory learning (Gebauer et al., 2012).

Realized Absorptive Capacity: The firm's capacity to leverage the knowledge that has been absorbed by transforming and exploiting them into operational benefits or utilization (Zahra & George, 2002). Realized absorptive capacity reflects exploitative characteristics such as exploitative learning (Gebauer et al., 2012).

Innovation Performance: Firms ability to introduce new products or services, encourage new ideas for development, develop new management approaches, adopt new improved methods (Cordero, 1990; Utterback & Abernathy, 1975).

Sustainable Competitive Advantage: Firms ability to implement value creating strategy not simultaneously being implemented by any competitors whom are unable to duplicate these strategies (Barney, 1991; Coyne, 1986; Porter, 1985).

1.10 Outline of Thesis

The thesis is organized in accordance to business research process. The thesis is mainly organized into seven chapters as follows.

Chapter 1: Introduction

The first chapter outline the introduction of the research which includes the background of the study, research problem, research questions, scope of the study, significance and contributions of the study. Besides it also provides the definition of key terms used in the research.

Chapter 2: Literature Review

The second chapter provides the literature reviews of the study. The chapter elucidates the content analysis that were carried out in order to identify gaps from the literatures of Lean Six Sigma. A synthesis and review of the studies in Lean Six Sigma were classified through the gaps identified in accordance to the nature of this study. The literature review also explains how every variables and their components are related through the context of this study.

Chapter 3: Research Framework and Hypotheses

The third chapter caters the research framework and the hypotheses development for the study. Underlying theories of this study were delineated which steered towards the development of theoretical framework. The hypotheses of the study followed suit thereafter.

Chapter 4: Research Methodology

The fourth chapter elucidates the research methodology of the study. The chapter outlines the research design utilized in the study which consisted of quantitative survey method. The survey settings, sampling procedure, operationalization of variables, measurement scales, questionnaire design and the methods employed in the study are explained in this chapter.

Chapter 5: Data Analysis and Findings

This chapter presents the findings garnered from the survey responses. Descriptive statistics were analyzed to understand the profile of the respondents. Response bias between early and late respondents were verified. This was followed by analysis of measurement model subsequently structural model.

Chapter 6: Discussion of Results

This chapter attempts to rationalize the findings from chapter five. The findings were discussed in accordance to the research questions and objectives in line to the hypotheses of the study. The chapter ends with a summary of the study's findings.

Chapter 7: Implications, Recommendations and Conclusion

This is the final chapter of the study. The chapter begins with a summary of the study and moves on to implications in terms of managerial, theoretical and policy. It also discusses on the limitation experienced and recommendations for future research. The chapter ends with conclusion of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview of the Chapter

This chapter provides an overview of quality management successively the evolution and concept of Lean Six Sigma. Thereafter a content analysis is done on the subject matter to learn the field in greater depth and length in order to identify research gaps. The theoretical research model is proposed in the subsequent chapter following an analysis of the literatures reviewed.

2.2 Background of Quality Management

Quality management and improvement over the years had pervaded the essence of science in management. Making management more methodical and systemic centric to ensure efficacy and innovation sustains to deliver the competitive edge a firm requires in this hypercompetitive epoch. Quality management systems had grown and developed in abundance as of late. The core of which is a comprehensive implementation throughout the organization and continuously improving through learning and re-learning.

The precedence began with the introduction of interchangeable parts in the 18th century by an inventor named Eli Whitney (Woodbury, 1960). Eli was also the inventor of cotton gin which revolutionized the cotton industry back then. Back in those days, each product produced are unique and a wholesome unit. Eli introduced ways that a part could be easily interchanged for another if one was damaged, broken or simply repaired rather than making a whole new unit altogether. For this to be realized, literally all the components of the product have to be identical in such way that any one of them could fit into another. This paved the way for mass production efforts which inspired the whole manufacturing industries (Woodbury, 1960).

This instigation led to many research on working processes and labor planning. Frederick Winslow Taylor introduced science into management through The Principles of Scientific Management (1911) by studying standardized work methods of labors and time studies (Grachev & Rakitsky, 2013). Complimenting Frederick's works, came Frank Gilbreth with Primer of Scientific Management (1912) and his studies on motion and invention on process charting where all the works in a process are identified and charted for better focus on respective work elements and illustration of value adding and non-value adding elements of the works (Carlson Dean, 1997; Gibson, Deem, Einstein and Humphreys, 2016). Lillian Moller Gilbreth between 1920s and 1930s fused psychology into the theory by experimenting how workers' attitude associates to the outcome of a process and the factors surrounding the administration of it. Lillian stressed the importance of individual point of view and how it affects the group's collective point of view in a workplace (Tadajewski, MacLaran & Graham, 2013). These cluster of research characterized how a work should be done to achieve optimization.

The status of quality improvement and management had been on the rise and evolutionary since the industrial revolution in yesteryears of 20th century. In 1924, an employee from the engineering department of Bell Telephone Laboratories (formerly known as Western Electric Co.), United States became increasingly involved in statistical problems which back then was viewed non-scientific coupled with a dearth of statistical shrewdness. Through investigations on inspection tasks, Walter Shewhart developed the Quality Control chart which later became renown as Statistical Quality Control wherein processes are emphasized to be made or brought under control that provides close variation or differences in the product thereby confirming to a certain standard of uniformity (Mahalanobis, 1948; Mauléon & Bergman, 2009). Quality measures were initially meant for inspection of products then to ways and methods of work and production thence, finally permeated to the entirety of management which was since transformed the way it was viewed to a scientific perspective.

Shewhart had two notable disciples W. Edwards Deming and Joseph M. Juran whom later began to change the interface of quality management into embracing it with the management paradigm making it a wholesome philosophy of management. Deming like Shewhart placed a great deal of importance on variation. However, Deming saw a larger perspective of quality management from the perspective of management as well. Deming proposed a management method with fourteen principles that acts as guidance for organizational leaders with an underlying system known as the System of Profound Knowledge (SoPK) (Anderson et al., 1994). Under the system he advocated on four fundamentals appreciation of a system; knowledge about variation; theory of knowledge and theory of psychology which drove the fourteen principles (Snee, 2008). This enlightened firms into how to go about their daily operations and managing workers that intuitively ensures a 'quality' management instead of managing quality.

Another disciple was Juran who was principally famous for the Juran Quality Trilogy where he stresses on the triangulation of quality planning, control and improvement that emphasizes on sustaining quality systematically and project by project. He also introduced the use of Pareto chart in quality that assist in explaining 80-20 rule of defect identification besides explicating that quality too has costs through Cost of Poor Quality (COPQ) and he even provided a quality control handbook in educating his principles (Juran & Gyrna, 1993; Juran, 1988; Juran & Riley, 1999). However, one of the characteristics derived by both disciples of Shewhart was the famous Plan, Do, Study, Act (PDSA) cycle in working things around continuously to strive till the very end (Landesberg, 1999). This marked an everlasting embracement of quality management as continuous improvement where the cyclical knowledge of advancing at every chance applicable became the very way of management. As it is seen here, most of the philosophies advocated earlier are becoming a singular management principle in terms of technicality (statistical controls) and management practices.

A considerable era of contribution in quality management can be seen after the 1950s. Right after the World War II, Japan was in need of transformation on many fronts undoubtedly its economy. The United States requested for the expertise of Deming and Juran to rejuvenate the Japanese quality and their science of working with their proficiency. This is where the Japanese absorption of the knowledge on quality began to intensify. Kaoru Ishikawa was then a part of Japanese Union of Scientists and Engineers (JUSE) of the quality control research group. Ishikawa was known as the father of Japanese quality and known for his contribution in delivering first quality control course for JUSE in 1949, inventing the Ishikawa diagram also known as the Fishbone diagram, displaying the importance of seven quality control tools (control chart, run chart, histogram, scatter diagram, Pareto chart, and flowchart), creation of the quality circle movement in 1962 (Watson, 2004). Ishikawa defines quality synonymously as other proponents to be comprehensive, continuously practiced and starts with the commitment from the top of the management.

Quality is an all rounding philosophy that every employee touches and should be responsible for. Quality as he advocated must be presented through customer's terms and provided to them to achieve the market objective as he stressed the market-in quality besides enrollment of employees in it and education importance that comes with it (Watson, 2004). Many would seem to match Ishikawa's development of total quality with that of Armand Feigenbaum's edition of Total Quality Control (Feigenbaum, 1956; Feigenbaum, 1961) which naturally became the modern management philosophy Total Quality Management (TQM). Feigenbaum was the first to use the term Total Quality Circle (TQC) following the Japanese company wide quality control (CWQC) (Martínez-Lorente, Dewhurst & Dale, 1998). Feigenbaum's contribution lies in his study on the relationship between quality improvement and macroeconomic impact of a nation in which he delineated the lag between initiation of quality effort and the benefits or economic effect thereafter (Watson, 2004; 2005). Feigenbaum's evaluation showed that Japan introduced quality in 1950s but its economy only flourished around 1970s whereas United States started around early 1980s and the economic success only followed at around 1990s. Likewise to earlier promoter of quality, he emphasized quality as being more than a method but an organization wide process, a way of ethics and managing and to be comprehended from a system's perspective.

Philip Crosby's *Quality is Free* (1979) became renowned throughout the management realm as Crosby emphasized much on defects being at zero or the concept of "Zero Defect" as these non-conformances entails unnecessary costs to the organization in spite of customer dissatisfaction. His view of quality is that it is meaningless to value it in terms of good, bad, low or high instead there are only two markers, one that confirms to a specified requirement and another that does not. Like Deming he propounded on his own 14 steps for managers or firms to attain long term success beginning with management commitment, employee involvement, training, awareness, focus on zero defect and the likes (Crosby, 2005). Following these gurus came many other succeeding proponents of the quality ecosphere. Nevertheless, Deming, Juran, Ishikawa, Feigenbaum and Crosby are regarded as the most important gurus of the quality management evolution (Martínez-Lorente et al., 1998). As the movement of quality was perceived to be of importance and being embraced into management, it was realized that process is what makes the difference in the end product or services in addition to management of an organization in general.

2.2.1 The Evolution of Lean

Lean is typically associated with the automobile company Toyota. This is in lieu of the fact that the essentials of Lean were derived from the basis of Toyota Production System (TPS) which the parent company used as reference in running their day to day operations in dealing with their strategic management.

The basis of TPS goes a long way back, in fact to the time of the founder, Kiichiro Toyoda's father, Sakichi Toyoda (1867–1930). A clear description on the evolution and history of Toyota can be learned from Liker (2004) *The Toyota Way* and (Wada & Yui, 2002) *Courage and Change: The Life of Kiichiro Toyoda*. As described in Liker (2004), Sakichi was the son of a carpenter who soon learnt to design and make looms for weaving cloth around the 1890s. From manual looms, he developed automatic looms that spontaneously stops when the thread breaks which requires human intervention on that instance to make changes or repairs. This was the foundation of *Jidoka*, which means automation with human touch. His son Kiichiro soon began in his father's step in inventing ways to eliminate disruptions. It is in these ways of working and thinking that the TPS' essence of consistently eliminating waste to increase productivity efficacy was born (Emiliani, 2006). The Toyoda family slowly ventured into the automobile industry by establishing Toyota Motor Company in 1937 having urged by the government to build trucks for the military (Womack et al., 1990). With practically fewer experience and little resource, Kiichiro made a trip to the United States to visit Ford's assembly plant in Michigan.

During that time, in the United States' automotive industry erupted with the magnitude of Ford Production System (FPS). Henry Ford's Model T assembly line or system made a name for itself remarkably where standard design and timely production delivery was essential in the application of FPS. The standard design of the product enabled a standard production system and Ford's appropriately fashioned assembly lines constituted a combination of labor and machinery in a measured arrangement and at an applicable speed which made the mass production a palpable achievement. Ford's idea created the podium for organization of mass production. Upon Kiichiro's visit in the United States, it was not more of Ford's plant that caught his attention but was the supermarkets' product replenishing system in the shelves that inspired him through which the Just-In-Time (JIT) idea, one of many ideas to follow, was born (Liker, 2004)

Other notable industrialists responsible for the evolution of TPS were Eiji Toyoda, Taiichi Ohno and Shiego Shingo whom are regarded for institutionalizing the TPS ceremoniously (Austenfeld Jr, 2006). As Ohno and Shingo explains the lack of formal training for managers compels them to work issues practically which explains the absence of direct connection between theoretical development of western management and Toyota's management system over the last 100 years in spite of Kiichiro Toyoda, Taiichi Ohno, and Shigeo Shingo being familiar with the Principles of Scientific Management (Emiliani, 2006). However the term Lean did not emerge until John Krafcik along with his mentors, Womack, Roos and Jones from Massachusetts Institute of Technology undertook a five million dollar five year study of the automotive industry that was published in 1990 as *The Machine that Changed the World* (Bendell, 2006). They soon advocated "Lean Thinking" philosophy underlining the universal application of Lean not just in manufacturing but in services, transactional process or management in general (Womack & Jones, 1996).

2.2.2 The Concept of Lean

Waste is an inherent feature in processes. In undertaking and executing tasks most of the time humans tend to be ignorant to the wastes that underlie their activity. The Japanese call waste as 'Muda'. However many articles had implied on this, not many has explicated the depth of the waste as Toyota backed which had two more dimensions to it, 'Mura' which means unevenness in the process such as unstandardized or disrupted practice and 'Muri' which means overburden in executing tasks that likely lead to wastes (Hines & Lethbridge, 2008; Ohno, 1988; Womack & Jones, 1996). Thus, elimination of waste became the prime motive in Lean. Every practice, every activity and functions that are likely to impede the flow of a process are specified as waste that are targeted for elimination. The disruption of flow is more likely to produce delays and in chain reaction effects all other process attached to it, which is in practical terms could be a silent disaster without even visibly apparent. The "doing more with less" notion of the Lean system came along through the hard times Toyota found itself to be. Toyota was facing insufficiency of capital, scarce resource and low volume that impeded its economy of scale (Liker, 2004).

Their lead to increase efficiency came through the naturalistic idea of customer-generated demand that drives the processes. In other words products and services are being produced at the request of customer just like observed in the United States' supermarkets. Therefore this eradicates inventory problems, process breakdowns and inefficiency, delay time or lagging of time amongst many others. So the change happened from the mindset of being a traditional push system and to embed the idea of a pull system (Cezar Lucato, Araujo Calarge, Loureiro Junior & Damasceno Calado, 2014; Womack & Jones, 1996). Deriving from this term, their focus of attention was driven to what customer wants (Womack & Jones, 1996) instead of what the firm wants to provide. This sets up the notion of value in the flow or the value stream in processes moving towards customer in the form of end product or service provision.

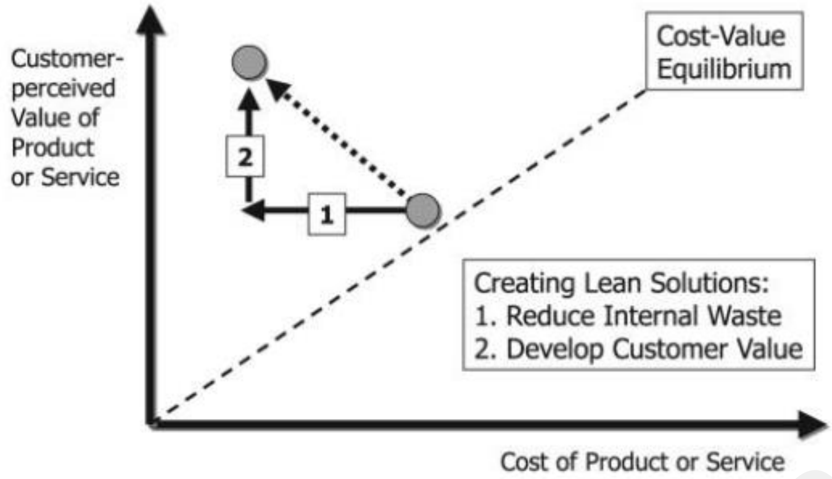


Figure 2.1: Relation of Value, Cost and Waste

Source: Hines, Holweg and Rich (2004)

As depicted in Figure 2.1 above TPS' motive of waste elimination was supplemented with the motivation of adding value to the process consequently to the customer. With this notion the company is set to add value to its products, processes, customers and organization as a whole and reduce waste which contributes to minimization of costs (Hines et al., 2004).

If observed in much depth, all the practices, techniques and tools utilized in TPS or Lean resides in the idea of identifying any problems that reflects waste, solving them in order to eradicate the wastages so that it smoothen and speeds the flow of the process, and ensuring such an event does not recur by tracking and ensuring it continuously. As Taicihi Ono (1988, p. ix) famously quoted:

> "*All we are doing is looking at a time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value added waste*".

Therefore, waste classification was defined to assist in detecting non-value adding steps in processes. Many would define this as the famous seven wastes as defect, waiting, inventory, motion, transportation, over processing, and overproduction. According to few there's an eighth type of waste, one more in the form of underutilized resources (Emiliani, 2006; Womack & Jones, 1996). With this came their method of working in eliminating wastes as put forth by Womack and Jones (1996) it starts with: specifying what creates value from the customers' perspective; identify all steps across the whole value stream; make those actions that create value flow; only make what is pulled by the customer just-in-time; strive for perfection by continually removing successive layers of waste. And Liker (2004) delimits to separate out repetitive process to learn how to apply TPS to the repetitive process after identifying customer value adding process, after which the process is mapped to identify value adding and non-value adding steps, infuse creativity the Toyota way and finally learn by doing it using the PDCA cycle. These steps are illustrated by Salah et al. (2010) as shown in Figure 2.2 below:

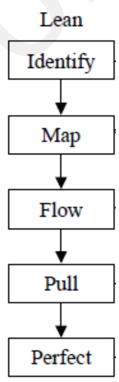


Figure 2.2: The Lean Flow

Source: Salah et al. (2010)

Feld (2000) and Singh, Garg and Sharma (2009) outlined the process as to firstly identify the value and need of customer from the viewpoint of customers' themselves, secondly through a value chain, define the activities that necessarily lower the wastes along the process, thirdly the process triggers only when customer initiates the demand, fourthly it should be pull oriented instead of push and lastly it is necessary to consistently perfect this flow to ensure impeccable quality delivered to customer.

Given the significance of it, the practices of Lean with their tools and techniques are abundant which Shah and Ward (2003) identified and reviewed across literatures. Practices that are regard as key reference in the Lean system as shown in Figure 2.3. According to Shah and Ward (2003; 2007) there exists a consensus within the literature of operations management and Lean production that generally the Lean practices could be bundled into four main categories which are notably just-in-time (JIT), total preventive maintenance (TPM), total quality management (TQM) and human resource management (HRM) that they claim to have been conceptually, theoretically, and empirically well established by many authors. Shah and Ward (2007) went on to address that Lean is not just a bundle of tools but instead an integrated socio-technical system. Hadid et al. (2016) stressed on this purview by investigating the interaction term between Lean's social practices and technical practices against the performance measures of financial and operations. They found that technical practices improve operational measures only but the interaction term improves both operations and financial performance altogether submitting support for the sociotechnical notion.

This support on social and technical aspect of Lean brings back to the ideology promoted by Toyota where it does not only focus on productivity efficiency by waste elimination but an equal respect for humanity as mentioned by Ohno (1988). Many practice in the industry level mainly focused on the technical portion of Lean that may have descended to their downfall as the proponents of Toyota argue, its more than just the Japanese method of working, it was a way of life with work being a part of it (Liker, 2004; Ohno, 1988; Womack & Jones, 1996).

Lean practice	Sources															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bottleneck removal (production smoothing)																
Cellular manufacturing									*			*	*	*	*	*
Competitive benchmarking																
Continuous improvement programs		*				*	*	*	*		*	*	*	*	*	*
Cross-functional work force	*		*		*	*			*		*	*	*	*	*	*
Cycle time reductions									*			*	*		*	*
Focused factory production									*		*	*	*	*	*	*
JIT/continuous flow production	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Lot size reductions	*	*		*	*	*	*	*	*	*	*	*	*		*	*
Maintenance optimization																
New process equipment/technologies									*			*			*	
Planning and scheduling strategies																
Preventive maintenance			*			*		*	*	*	*	*	*	*	*	*
Process capability measurements									*			*	*	*	*	
Pull system/kanban	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Quality management programs		*														
Quick changeover techniques	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Reengineered production process																
Safety improvement programs									*			*			*	
Self-directed work teams		*					*	*	*	*	*	*	*	*	*	
Total quality management		*				*	*	*	*		*	*	*	*	*	*

(1) Sugimori et al. (1977); Monden (1981); Pegels (1984); (2) Wantuck (1983); (3) Lee and Ebrahimpour (1984); (4) Suzaki (1985); (5) Finch and Cox (1986); (6) Voss and Robinson (1987); (7) Hay (1988); (8) Bicheno (1989); (9) Chan et al. (1990); (10) Piper and McLachlin (1990); (11) White (1993); (12) Shingo Prize Guidelines (1996); (13) Sakakibara et al. (1997); (14) Koufteros et al. (1998); (15) Flynn et al. (1999); (16) White et al. (1999).

Figure 2.3: Lean Practices and Their Appearance in Key References

Source: Shah and Ward (2003)

The emphasis that the motor vehicle giant puts on respecting or valuing its employees is something explicably undeniable as exemplified by the founder, Kiichiro's resignation following the adversity of Japanese economy that resulted in laying off its people. But then, those who remained were provided with justified wage package according to seniority and life time job assurance (Womack et al., 1990). Respect for people is usually eluded by many managers as they focus only on continuous improvement but it is that which lays a foundation for long term success and sustainability and which enables continuous improvement (Emiliani, 2006) or emphasized as 'Kaizen' which means change for better in Japanese (Chakraborty, Bhattacharya, Ghosh & Sarkar, 2013). Liker (2004) and Jeffrey and David (2005) provides an enriched view of the Toyota way known as the 4P model which delineates the four principles of Toyota. The Ps stands for Philosophy, Process, People and Partners and Problem Solving.

Philosophy refers to the long term view of the organization realized through short term goals regardless even if it results in dismal condition. Process is what matters in waste elimination besides producing a flow that only has value towards customers. People and partners are all those associated with the company be it the customer, employees or suppliers that in some ways related to the organization and finally problem-solving which implies to the continuous improvement through organizational learning (Mi Dahlgaard-Park, Mi Dahlgaard-Park & Dahlgaard, 2007). The Figure 2.4 below portrays the proportions of the 4P model and interrelationship of the 14 principles preserved by Toyota.

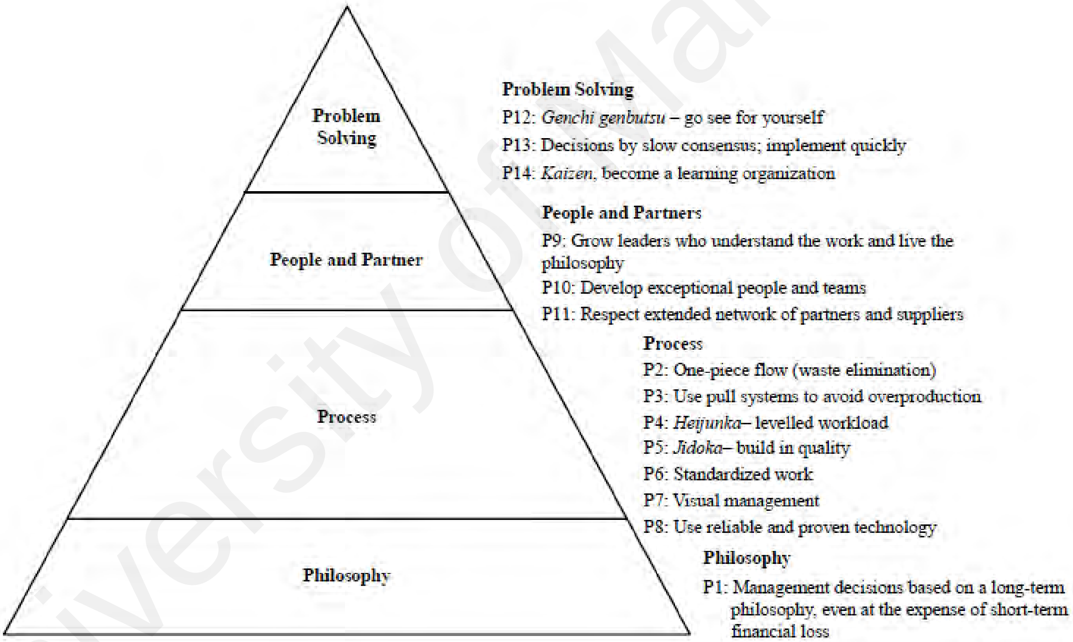


Figure 2.4: 4P Model of the Toyota Way

Source: Liker (2004)

As can be seen in Figure 2.4, a large part and ones that are pretty much visible comprises the technicality associated with the concept such as process and problem-solving to a certain extend. The humanistic part is mostly invisible that entice many to overlook on the importance of it.

Ensuing Toyota's DNA (Figure 2.5), the Lean philosophy involves the social and technical aspect where the balance of both, people who makes the basis of human aspect and continuous improvement which accounts for striving for perfection ensures a culture of longevity. As Emiliani (2006) revealed the simple logic behind this balance resides in the idea that authentic continuous improvement is impossible without the involvement of social practice or the respect for people.

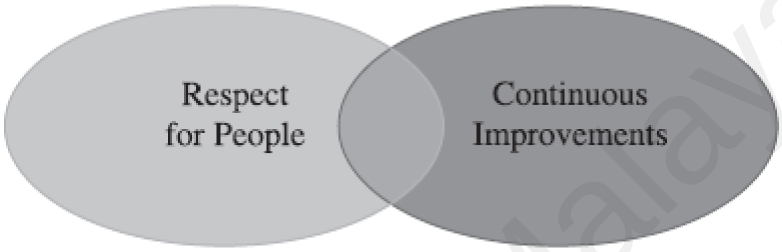


Figure 2.5: Toyota's DNA

Source: Mi Dahlgaard-Park et al. (2007)

2.2.3 The Evolution of Six Sigma

Bob Galvin, Bill Smith, Mikel J. Harry, Jack Germaine, Larry Bossidy, Jack Welch are amongst the names that resonates profoundly in the history and development of Six Sigma. As aforementioned, the noteworthy permeation of the concept kicked off through Motorola in the United States, during its years of tribulation, much similar to the Toyota's experience.

Motorola, started their march from battery eliminators and car radios advanced to a giant in the world of manufacturing (Holbrook, Cohen, Hounshell & Kleppe, 2000). Its progress however saw stagnation during the 1980s and 1990s where questions on what went wrong arose extensively to the top management (Pande, Neuman & Cavanagh, 2000). The concern over quality value of the company's products was boldly questioned by employees, who stressed it as the fundamental course for concern (Main, 1994). Bob Galvin at the helm of the company at the time took concern on it and went on to investigate the assertion which turned out to be factual and he made it imperative that the company increase its quality by ten folds, which as audacious at it seemed at the moment in time, it become their primary motive (Pyzdek & Keller, 2014). To begin with, he required a strict enforcer for change where he made his mind over Jack Germaine to spearhead the quality department of the company (Khoo, 2004). As much as both leaders could visualize on what they want to see as in change, they are in need of technical support and a methodology for change to be infused into the company's system instead of the already existing quality standards in the market. Bob wanted something definitive when it comes to assessing quality (Breyfogle III, 2003).

At the time, Bill Smith, a veteran engineer wrote a research report which revealed the product life rework correlation in which it realized a product with less or no rework has the tendency of perfected life span upon delivery to customer and better in performance (Hallam, Muesel & Flannery, 2010; Tennant, 2001). On another scene, Dr Mikel J. Harry came into the Motorola's backdrop as a doctoral intern where he went on to study the many possibilities of a pragmatic approach on quality system. Harry was in charge of Advanced Quantitative Research Laboratory (AQRL), an R&D arm of Motorola where together with Bill, he invented a logic-filter curriculum from which it evolved to what we know today as the Define, Measure, Analyze and Improve or the DMAIC methodology of Six Sigma (Ramberg, 2000). They articulated a quality system which would comprise a defect of not more than 3.4 out of a million opportunities which also translated into a yield of 99.9997 percent. For their efforts, findings, contributions and the eventual features of the methodology which we utilize today, Bill Smith is regarded as the "Father of Six Sigma" whereas Dr. Harry as the "Godfather of Six Sigma" (Cano, Moguerza & Redchuk, 2012; Maguire, 1999; Shekhawat, 2015) as the latter's contribution went on to inspire an evolution of how American businesses and organizations began to look at quality and business philosophy for continuous improvement. Between 1981 and 1992, Motorola reduced manufacturing defects using Six Sigma which yielded a colossal savings in manufacturing operations worth $ 1 billion (Howell, 2006). On aggregate, Six Sigma contributed USD 15 billion over the course of 11 years (Kwak & Anbari, 2004). Allied Signal (later came to be known as Honeywell after a merger) began their quest in Six Sigma in 1990s and nine years later yielded $600 million savings annually with comprehensive employee involvement and embedding the principles in their aircraft engine design fragment (Pande et al., 2000). The then CEO of Allied Signal, Larry Bossidy a former GE personnel convinced the then GE CEO Jack Welch on the supremacy of Six Sigma.

Although Six Sigma began its streak at Motorola, the global intensification came through the adoption of the concept by General Electrics (GE) when Jack Welch was at the helm as CEO. The difference of Jack Welch's application of the philosophy from Motorola's initiation is that he literally made the concept an engrained culture of his organization (Breyfogle III, 2003; Pande et al., 2000). Business conduct amongst everything else is based on Six Sigma which transitioned the company's purview on a continuous improvement path. Technically, GE was an all in all Six Sigma company regardless of manufacturing, services or even the management structure. His leadership trait via Six Sigma hails a great impact on its success whereby he etched the compensation incentive package in such a way where 60% bonus is based on financial accomplishment whereas 40% is based on Six Sigma achievements (Welch & Byrne, 2001). In 1998 GE invested USD 500 million in Six Sigma initiatives and in return capitalized over USD 750 million on that year and USD 1.5 billion in the subsequent year in savings alone (Bartlett & Wozny, 1999; Welch & Byrne, 2001). The company's overall operating margin improved by 4.1 % from 14.8% (1996) to 18.9% (2000) (Hendricks & Kelbaugh, 1998; Raisinghani, Ette, Pierce, Cannon & Daripaly, 2005).

2.2.4 The Concept of Six Sigma

Just as with Lean's interpretation of waste being inherent in processes, another feature that's seemingly inherent and almost inevitable is variation. Every task or activities executed are subject to variation as there are practically no similar things that are alike, not even people or processes (Berry, 2011). Peoples action are varied thus not one action may exactly resemble the preceding or subsequent ones. One of the central subsets in Deming's System of Profound Knowledge is knowledge about variation which he explicated through his red bead experiment (Gartner & Naughton, 1988). Deming explains that there are two types of causes in variation that exist, common and special. Common causes (also known as chance cause) are naturally in existence whereas special cause variation occurs out of unexpected or undesired focus (Deming, 1986). Therefore variations within process are always inborn thus almost impossible to eliminate. However, the whole notion in this context is not to alleviate variation but to minimize special cause variation as best as possible. Bergman and Kroslid (2000) explained comprehension of variation is the important aspect in implementing Six Sigma. Thus Six Sigma's idea of improving process revolves around this concept of reducing variation.

The word Sigma arrived from Greek which symbolizes variation which Greek statisticians used to measure variability (Pyzdek, 2003). In others words, it defines standard deviation from the mean which reflects the variation (McAdam & Lafferty, 2004). The motive of Six Sigma is to bring the process under six standard deviation of the mean. This implies that the deviation is very narrow therefore variation does not resemble a significant issue as most likely that exist would be common cause variation thus, the process is very much standardized. At sixth sigma level the concept articulates a defect range of 3.4 per million opportunities also referred commonly as defects per million opportunities, DPMO (Breyfogle III, 2003; Pande et al., 2000; Pyzdek, 2003). Although seemingly outlandish, the attainment of this level had been proven possible and to work as accomplished by the likes of Motorola and GE.

The innards of Six Sigma can be traced back as far as the 19^{th} century when German mathematician and physicist Johann Carl Friedrich Gauss (1777-1855) invented the Gaussian function, famously known as the normal distribution or 'Bell Curve' (Fendler & Muzaffar, 2008). The curve as named shaped like a bell depicts how probability is distributed or represented whereby it centers around the mean of the data. This helps to determine the normality of the distribution and a visual depiction of how the data is scattered. Breyfogle and Forrest (1999) describe how sigma quality level acts as an indicator in detecting the likelihood of defects that is derived from standard probability curve of a process. The process capability (Cp) defines at which level the sigma is positioned and the corresponding defects at that level. As McAdam and Lafferty (2004) submit process capability is defined as the allowable process spread over actual process spread as per the below equation.

$$C_p = \frac{[\text{Upper Specification Level (USL)} - \text{Lower Specification Level (LSL)}]}{\text{6 standard deviation}}$$

Equation 2.1

This implies, at a particular sigma level, obtained using the above equation, the plausible amount of defects that the process produces could be estimated.

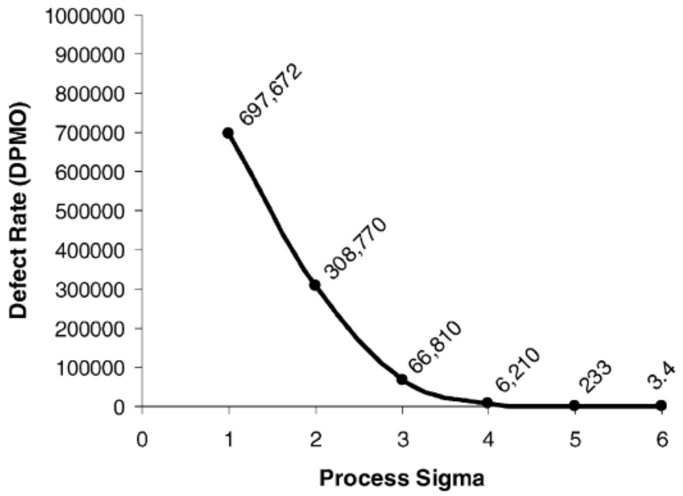
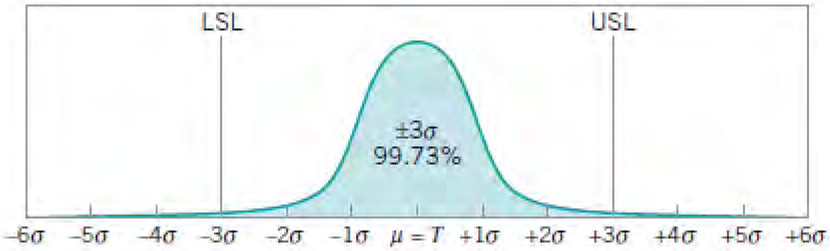


Figure 2.6: Defect rate (DPMO) versus Process Sigma Level

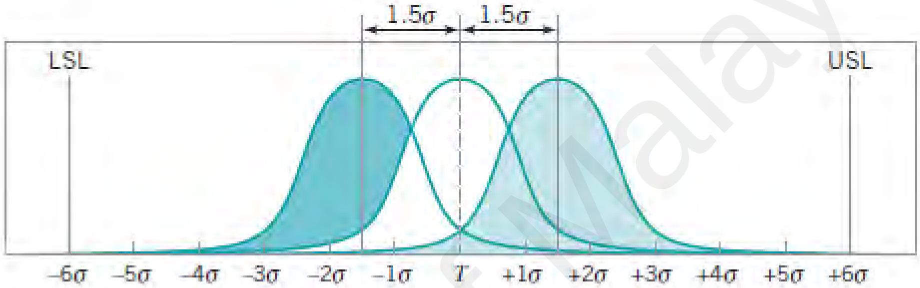
Source: Linderman et al. (2003)

Figure 2.6 above portrays the process sigma level and the corresponding defect yields at each point. The pattern speaks in decrement form wherein as sigma level rises the defect amount diminishes. Montgomery (2008) provides a clear demarcation on the concept of Six Sigma through the normal distribution curve as depicted below;



Spec. Limit	Percent Inside Specs	ppm Defective
±1 Sigma	68.27	317300
±2 Sigma	95.45	45500
±3 Sigma	99.73	2700
±4 Sigma	99.9937	63
±5 Sigma	99.999943	0.57
±6 Sigma	99.9999998	0.002

(*a*) Normal distribution centered at the target (*T*)



Spec. Limit	Percent inside specs	ppm Defective
±1 Sigma	30.23	697700
±2 Sigma	69.13	608700
±3 Sigma	93.32	66810
±4 Sigma	99.3790	6210
±5 Sigma	99.97670	233
±6 Sigma	99.999660	3.4

(*b*) Normal distribution with the mean shifted by ±1.5σ from the target

Figure 2.7: The Motorola Six-Sigma concept

Source: Montgomery (2008)

As explained by Montgomery, the concept of Six Sigma in mathematical terms is technically ± 3 sigma. Naturally under a 3 sigma level (Figure 2.7 (a)) the parts per million is at 2700 units. It means, for every million times a particular process is executed or the products or services produced, the probability that the process yields defect are 2700 times. Many would logically reckoned that the process sigma of 3 level is good enough given the fact the process yields at 99.73% of perfection. At this point for many, it is an

‘A’ condition where it is assumed to be at its best. But consider this situation carefully, at an average of 99% of goodness level (Breyfogle III, 2003);

• 20,000 lost articles of mail per hour

• Unsafe drinking water almost 15 minutes per day

• 5,000 incorrect surgical operations per week

• Short or long landing at most major airports each day

• 200,000 wrong drug prescriptions each year

• No electricity for almost 7 hours per month (Harry, 1987).

At a 99% linked process sigma level (approximately between 2 and 3 sigma), there’s roughly around 5,000 incorrect surgeries, 200,000 wrong drugs possibly being consumed, people tend to drink hazardous water every 15 minutes and every hour 20,000 mails are getting lost. Imagine the magnitude of troubles and tribulations such a process can bring especially to one that concerns health or even any process for that matter as it seems to have a chain reaction in affecting consumers or customers through certain ways. Given the inconsistency mentioned above one would hesitate on taking flights. Another example is the frustration of having blackouts every now and then, what more for the credibility of healthcare service. This simply justifies the need for closing down variation, it is simply how crucial it is for businesses to ensure safety and losses they could possible cause their customers.

However Motorola, through various experience and experiments came to a conclusion that process sigma level tends to shift with an average of 1.5 which requires adaptation to the normal distribution level as depicted in Figure 2.7(b). The notion on this theory lies in the law of thermodynamics in particular, entropy (Bothe, 2002). Bothe explains that entropy is increasing constantly in all systems, which makes the processes unstable upon being stabilized and this occurs as a natural phenomenon as per the second law of thermodynamics. This explains for the need to continually monitoring of the process through detecting these movements in control charts (Bothe, 2002). Adjusted to 1.5 shift in sigma level, a process at a 6 sigma level would yield defects of only around 3.4 for every million opportunity of the process which many advocates to achievement of perfection at this level (Linderman et al., 2003; Pande et al., 2000; Pyzdek, 2003; Zhang, Hill, Schroeder & Linderman, 2008). However it should be made aware that process sigma can elevate to any level respective to the level of performance.

The idea of variation narrowing could further be explained in viewpoint of specification limits.

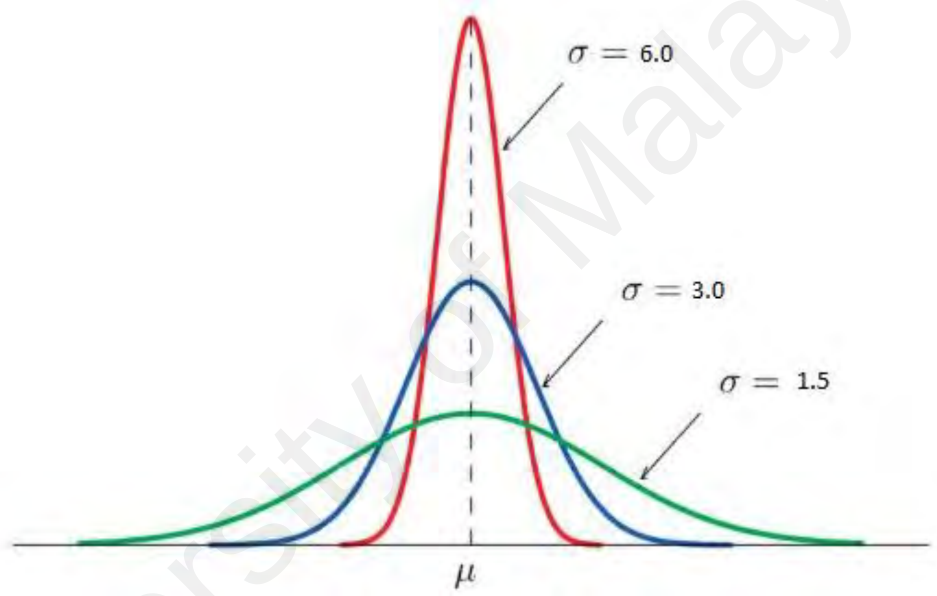


Figure 2.8: Differences in Process Sigma Level

Figuratively, the idea in Six Sigma is to reduce variation as repetitively mentioned. Depicted above in Figure 2.8 is a graphical idea on the concept. The interval between the lower and upper specification limit (LSL and USL) is known as "design bandwidth" (Denk, 2005). A lower sigma level will naturally possess a larger deviation from the mean of the process as likely inherit a large portion of defect which are technically the values outside the bandwidth that are unacceptable (Denk, 2005). Comparatively, as the process is being improved, the variation is being minimized which means, the defect rate reduces as the sigma level improves or moves higher represented by the move from 1.5 to 3.0 and subsequently to 6.0 sigma level. Notice that the curve is narrowing as it approaches a higher sigma level, characterized by smaller deviation from the mean of the process. Harry and Schroeder (2000) expounded that the process bandwidth narrows in relation to the design bandwidth which explains the phenomenon in detail.

Like the traditional PDCA cycle, Six Sigma follows on its own structured improvement method known as DMAIC which stands for Define, Measure, Analyze, Improve and Control phases in enduring process improvement (Breyfogle III, 2003; Pande et al., 2000). This is one of the distinctive characteristics of Six Sigma as compared to other quality or process management initiatives whereby the improvement process follows a strict methodology in the abovementioned format. In a Six Sigma project, the team members *Define (D)* the project problem and goal requirements, secondly *Measure (M)* the process to identify current process performance, third *Analyze (A)* and determine the root causes of the problem to scale down the vital-few factors of the process, *Improve (I)* the process by defect eradication and finally *Control (C)* the renewed process through statistical measures and continuous monitoring (Pyzdek, 2003). Snee (2007) explains that the DMAIC is comparable to the PDCA cycle as in Plan, to recognize an opportunity and plan a change; Do, by testing the change and carrying out a small scale study; Check, by reviewing the test, analyze the results and identify what is learned; and Act, take action based on what is learned in the study step, if the change did not work, go through the cycle again with a different plan and if successful, incorporate what is learned from the test into wider changes. What is learned will be used to plan new improvements to beginning the cycle again (Snee, 2007).

Each phase within the DMAIC structure is affixed with statistical tools to assist in going by the modus operandi in each stage. Bendell (2006) puts Six Sigma in this context as a package of impressive arsenal of statistical tools, with approximately 140 statistical tools and concepts embedded into the DMAIC phases. Although voluminous, some are vital at each phase as Snee and Hoerl (2005) identified eight key tools which are frequently applied throughout the DMAIC phases that acts as an integration mechanism. These are process mapping, cause-and-effect matrix, measurement system analysis, capability study, failure modes and effects analysis (FMEA), multi-vari study, design of experiments, and control plans.

Sometimes quality management tend to be viewed by some as being a more peripheral management thus, improvement efforts are sidelined or being dispatched on do-the-best basis or as and when necessary. The severity in advocating against such an attitude towards improvement have been advocated by early proponents in that it has to be specialized just as any other branches in an organization's activity. Juran and Godfrey (1999, p. 5.8) argues that there's no improvement that could be classified as general and that "*all improvement takes place project by project and in no other way*". Accordingly, Six Sigma tackles the improvement efforts on a project-by-project basis (Breyfogle III, 2003; Pyzdek, 2003). To be able to succeed in Six Sigma implementation, as the concept and proponents emphasized, it should be attached to the firms' goals and objectives, aligned orderly in making improvement count at each project undertaken. This is why the emphasis for project selection in accordance to cost-benefit analysis are typically considered along with the motives of the projects lined up (Antony & Banuelas, 2002; Pyzdek, 2003). Pande et al. (2000) elucidated three generic project selection criteria to be highlighted in determining project choice which are business benefits, feasibility of undertaking the project and the project's impact to the organization.

Another never-to-be-found criteria or one that is unique is the 'Belt-Structure' of improvement specialist that Six Sigma advocates. Six Sigma has a unique practice and training in assembling the specialist to run the projects in the format of a belt system (Harry & Schroeder, 2000). There are four different belt levels within the Six Sigma ideology that represents the level of improvement specialization inherent in the organization. These are Master Black Belt, Black Belt, Green Belt and Yellow Belt (Kwak & Anbari, 2004). Pyzdek (2003), Pande et al. (2000), Henderson and Evans (2000) and Harry and Schroeder (2000) outlined the function of each Belts' roles and responsibility. They explicate that the Master Black Belt is an enterprise level expert on a full time basis who has extensive experience as a Black Belt and one that connects the operational level specialists to the top management besides guiding the Black Belters. Master Black Belt often stands as an in-house consultant to the organization. The Black Belts are certified technical experts also on a full time basis that leads improvement projects and given the level of their expertise, manages high impact and cross functional projects and guides the Green Belters. Green Belts are the so called project originators who functions on a part-time basis with the mastery of the Six Sigma body of knowledge.

They would usually lead interdepartmental projects and connects other members to the projects. Finally the Yellow Belters are those who have first-hand knowledge about the program or a ground level awareness that contribute in membership of projects (Antony, Kumar & Madu, 2005). There is another level above all these pyramid known as Six Sigma Champions who typically facilitate the deployment or implementation of Six Sigma in the organization, who acts as a focal person amongst the top management hierarchy and to which generally the Master Black Belt tends to liaise with (Murugappan & Keeni, 2000). A full scale of the Belt system is as shown in Figure 2.9. The training and curriculum for each level are customized and tailored according to each belts capacity thereby infusing the specialization that each requires (Harry & Schroeder, 2000; Pyzdek, 2003). The intensity of trainings are of such magnitude in ensuring the specialist are genuinely up to the par for their improvement undertakings. As Pyzdek (2003) lays Black Belts are required to complete 200 hours of training subject to passing a written examination and completion of at least two major projects whereas Green Belts required to complete 40 hours of training course and completion of at least one project or participate in two successful projects annually.

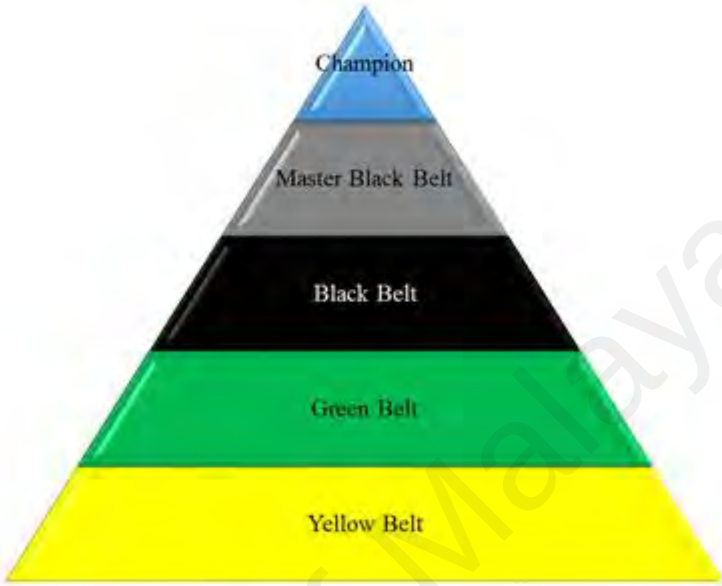


Figure 2.9: Belt System of Six Sigma

The advocacy of Six Sigma led to many definitions about the concept as there happens to be none in standard form. Corresponding to the uniqueness of the concept as discoursed above, many scholars and practitioners came about in their own standings in explaining or providing a definitional form for Six Sigma.

Harry and Schroeder (2000) define Six Sigma as a means to realize the philosophy and values that encompasses all key initiatives in the organization and enables a common understandable language within the organization. Schroeder, Linderman, Liedtke and Choo (2008, p. 540) articulated it as "*an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives*". Linderman et al. (2003, p. 195) put forth a similar augmentation of Six Sigma as "*an organized and systematic method for strategic process improvement and new product and* *service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates*". Being a focus on improvement, identifying and elimination of root causes of defects or mistakes as per the criteria critical to customers had been the focus in establishing Six Sigma as an improvement approach as per Wiklund and Wiklund (2002). In explaining what Six Sigma is in detail, Pyzdek (2003, p. 3) looks at it as a "*rigorous, focused and highly effective implementation of proven quality principles and techniques which aims for virtually error free business performance".* Pande et al. (2000, p. xi) on another end illuminated Six Sigma as being "*a comprehensive and flexible system for achieving, sustaining and maximizing business success that is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes*".

As technical the definitions on the concept of Six Sigma can be, some had given a broader perspective about it. Fursule, Bansod and Fursule (2012) demarcates Six Sigma as being both, a philosophy and a methodology that improves quality by analyzing data with statistics to find the root cause of quality problems and to implement controls. Meanwhile Antony and Coronado (2001, p. 119) suggested it to be "*a business improvement strategy used to improve business profitability, to drive out waste, to reduce cost of poor quality and to improve the effectiveness and efficiency of all operations so as to meet or even exceed customer's needs and expectations*". In addition to these definitions, Gamal Aboelmaged (2010) provides numerous other definitions used by authors in literatures as follows in Table 2.1.

Table 2.1: Examples of Six Sigma Definitions

Andersson et al. (2006)	Improvement program for reducing variation, which focuses on continuous and breakthrough improvements.
Antony (2002)	A business performance improvement strategy that aims to reduce the number of mistakes/defects – to as low as 3.4 occasions per million opportunities.
Banuelas and Antony (2002)	A philosophy that employs a well-structured continuous improvement methodology to reduce process variability and drive out waste within the business processes using statistical tools and techniques.
Behara et al. (1995)	The rating that signifies "best in class", with only 3.4 defects per million units or operations.
Bendell (2006)	A strategic, company-wide, approach ... focusing on variation reduction, projects have the potential of simultaneously reducing cost and increasing customer satisfaction.
Black and Revere (2006)	A quality movement, a methodology, and a measurement. As a quality movement, Six Sigma is a major player in both manufacturing and service industries throughout the world. As a methodology, it is used to evaluate the capability of a process to perform defect-free, where a defect is defined as anything that results in customer dissatisfaction.
Chakrabarty and Tan (2007)	A quality improvement program with a goal of reducing the number of defects to as low as 3.4 parts per million opportunities or 0.0003 per cent.
Kwak and Anbari (2006)	A business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer needs and expectations.

Source: Gamal Aboelmaged (2010)

In a far-reaching perspective, Six Sigma is to be viewed from categorized levels that is deployment of the concept from a strategic level and comprising the entire organization, a project level in tactical terms and operational level through the use of its method, tools and techniques (Breyfogle III, 2003; Gamal Aboelmaged, 2010; Pyzdek, 2003; Snee & Hoerl, 2005). As depicted in the Figure 2.10, Breyfogle III (2003) describes in detail the bottom line components associated with viewing Six Sigma from a broader perspective (satellite-level) and a more direct or detailed mode (30,000-foot level) which connects the overall business or organizational long term strategy with the means of reaching the goals in short term through projects aligned to the relevant metrics.

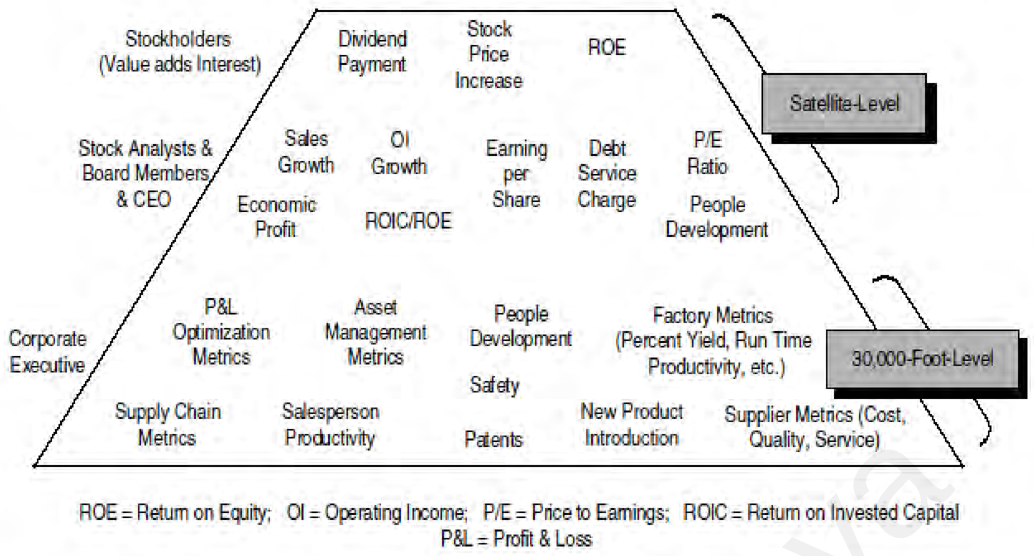


Figure 2.10: Satellite-level and 30,000-foot-level metrics
Source: Breyfogle III (2003)

2.2.5 The Evolution of Lean Six Sigma and its Concept

The nature of quality management as had been discussed is always on the rise and evolving. From Taylor's principle to Deming's management principle, to Juran's, Feignebaum and so on, the evolution of process improvement has indeed been improving. The use of Lean and Six Sigma had somewhat reached an impasse that further improvement were seen to be barricaded. Thus, practitioners were found to be improvising or innovating the concepts at either end to resolve this stalemate. It was claimed that the first signs of integration of both popular concepts of Lean and Six Sigma came about in the United States at 1986 (Chakravorty & Shah, 2012; Salah et al., 2010; Svensson, Antony, Ba-Essa, Bakhsh & Albliwi, 2015; Vinodh, Kumar & Vimal, 2014) however the term "Lean Six Sigma" was first uttered around the new millennium by Sheridan (2000) after which it was largely believed to become increasingly popular (Byrne et al., 2007b).

Yadav and Desai (2016) provided numerous views on the hybrid's explanation as shown in Table 2.2:

Table 2.2: Definitions of Lean Six Sigma

Author	Definitions
Andersson et al. (2014)	Lean Six Sigma is an integrated vital strategy that enables companies to meet and exceed customer expectations in a changing and competitive global environment
Assarlind et al. (2013)	Lean Six Sigma uses tools from both toolboxes to get the best from the two methodologies, increasing speed while also increasing accuracy
Besseris (2014)	Lean Six Sigma is modern business excellence initiative that offers a great wealth of continuous improvement tools and techniques to combat process instabilities and product malfunction
Corbett (2011)	Lean Six Sigma is a hybrid methodology that organizations adopt for sustaining high production rates and high quality, or reducing waste in their processes
Gibbons and Burgess (2010)	Lean Six Sigma provides the concepts, methods and tools for changing processes; hence, it acts as an effective leadership development tool in that it prepares leaders for their role, leading change
Habidin and Mohd Yusof (2013)	Lean Six Sigma focuses on operational excellence for continually seeking better improvement in customer satisfaction, saving in quality cost, process speed and in turn against competitive advantage
Hilton and Sohal (2012)	Lean Six Sigma is a philosophy comprising a number of organizational factors that are critical to the successful deployment in which the senior Six Sigma facilitators adopt the Six Sigma methodology referred to as define-measure-analyze-improve-control (DMAIC) phases, and within each phase, various statistical and lean tools are selected as appropriate
Nicoletti and Vergata (2013)	A systematic approach to improvement to improve performance as measured by quality, cost, delivery and customer satisfaction
Kumar and Antony (2008)	Lean Six Sigma is the latest managerial practice which helps in creating value by eliminating waste form the process, removing the causes of defect in the product
Ray and John (2011)	Lean Six Sigma is a well-structured methodology that aims to eliminate waste or non-value-adding activities and focuses on the reduction of variation in critical processes to achieve bottom-line benefits or customer satisfaction
Roth and Franchetti (2010)	Lean Six Sigma is highly esteemed for formulating quick-results improvement strategies that translate to tangible corporate-wide economic returns
Salah et al. (2010)	Lean Six Sigma can be described as a methodology that focuses on the elimination of waste and variation, following the DMAIC structure, to achieve customer satisfaction and better financial results for the business with regards to quality, delivery and cost

Table 2.2 continued

Author	Definitions
Thomas and Barton (2011)	Lean Six Sigma is a quality improvement technique that enables to achieve the benefits of waste reduction and responsive manufacturing offered by Lean with developing robust, error free and fault-tolerant production offered by Six Sigma
Snee (2010)	Lean Six Sigma is a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom-line results

Source: Yadav and Desai (2016)

Given the extensive descriptions or definitions, Lean Six Sigma can be considered as a philosophy of synthesis under quality management or process improvement that amalgamates the necessity of speed by eliminating waste and the emphasis of quality through the consistency it generates by minimizing variations in process.

2.2.6 Issues with Lean and Six Sigma

In parallel to the evolution of Lean from an automotive base, many job-shop based companies implemented Lean given the complications of the nature of this type of companies where the analysis, mapping and flow of products are tedious (Irani, 2001). Therefore many rendered the idea that it is meant for only 'manufacturing' purpose (Arnheiter & Maleyeff, 2005) which till now is questionable to some. This could mainly be deduced to the root cause of not understanding the philosophy of Lean appropriately. Sometimes the philosophy are even misunderstood as some believe that Lean is meant for a "*laying-off*" strategy or downsizing (Arnheiter & Maleyeff, 2005). As exemplified by Parker and Slaughter (1994) that Lean is more to a pro-company than it is to employees. This implies that workers should actually beware if this concept moves up the strategy table and into implementation because many jobs are on the course of being put to rest. Parker and Slaughter also went on to explain that some actions of the management does make them feel this way for instance flowing down problems to the hierarchy below avoiding accountability. There are also much attention given to tools of Lean for which the concept was highly popular (Shah & Ward, 2003; Shah & Ward, 2007). Lean consist of a bundle of best practices on how do to things in a more effective, efficient and simplistic manner that curbs rising cost. Spear (2004) explains that management tend to prioritize tools and techniques in the modus operandi that they forget about the underlying philosophy or the fundamental principles in managing these tools, techniques and practices. The issue that seem to bog Lean is that its flexibility, which may not be properly utilized especially when one is inexperienced. Another being the fact that Lean is more fluid in implementation where it encompasses every worker as it's the responsibility of the whole organization in general.

The need for Six Sigma stemmed from the weaknesses of other initiatives predominantly TQM. TQM was a wide ranging, all-encompassing philosophy however, to the extent that remained solely as a 'philosophy' that became the inherent weakness of itself (Pepper & Spedding, 2010). This could also be a point to consider in Six Sigma which through its eminence and the success of big companies may render a misconception as some puts it as simply a repackaging of a statistical and traditional quality practice (Catherwood, 2002). Although Six Sigma provides a direction, learning from the weakness of TQM, it is also in the jeopardy of overselling it by jumping into a bandwagon if it's used purely for commercial purposes (Arnheiter & Maleyeff, 2005). Arnheiter and Maleyeff (2005) explained that the goal of 3.4 DPMO is viewed by some as an absolute term which should be benchmarked. This is untrue as it depends on each firm's nature and requirement of processes. The term 3.4 DPMO is based on the experimentation and viability found in Motorola's case which is nevertheless hard to accomplish as the presence of low-hanging fruits are never-ending (Arnheiter & Maleyeff, 2005). The question of Six Sigma goals being high and outlandish had never skipped the minds of those who newly heard of the concept. There exist a grey shade in the context of goals as Locke and Latham (1990) argues challenging goals inevitably leads to higher or enhanced performance. Conversely quality gurus like Deming is against the notion of setting numerical goals which he perceives to achieve nothing, and setting difficult ones may lead to frustration, discouragement and demoralization and what matters most is the method that is being used to improve (Deming, 2000). Earley, Connolly and Ekegren (1989) stands in supplementary to this statement as they voiced that it may pose anxiety in achieving highly set goals. Linderman et al. (2003) study undertakes experimentation of this account by describing the possibility that the relationship between goals and performance maybe concavely related. Another concern that is presumable in the application of Six Sigma is the rigorous focus on statistical tools, data and structured method that for some instances may prove to be uninviting. Bendell (2006) explains this scenario as intensive focus on left-brain activity given the focus on statistical apparatus while contending with right-brain functions for creativity and innovation. In summary of the restrictions, Bendell's (2006) claim is that Six Sigma is more slanted towards complexity of technique and analysis meanwhile Lean is naïve of its simplicity.

2.2.7 Benefits of Fusion: Lean and Six Sigma

Michael George is the foremost reference when it comes to Lean Six Sigma. He gives an emphatic view on why the fusion is important for the future evolution of the process improvement or continuous improvement concepts. The reality of the fast paced environment of business had made it obligatory for businesses to search an avenue to improve and thus this needs to be fast. George puts forth three predominant reasons as to why the fusion is necessary;

i) Lean cannot maintain process under statistical control

ii) Six Sigma alone cannot dramatically improve process speed or reduce invested capital (George, 2002, p. v)

iii) Lean and Six Sigma facilitates cost of complexity reduction (George, 2003, p. 6)

Corresponding to that George (2002, p. iv) defines Lean Six Sigma as,

> "*Lean Six Sigma is a methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed and invested capital*"

More than its differences, Lean and Six Sigma are universally complimentary as denoted by many (Salah et al., 2010). Combining the both largely resides in the idea that both concepts' tools, techniques, practices and methodologies are used conjointly (George 2002; George, 2003; Salah et al., 2010). Traditionally, Lean focuses on waste elimination (Womack & Jones, 1996; Womack et al., 1990) whereas Six Sigma focuses on variance reduction (Pande et al., 2000; Pyzdek, 2003). Thus drawing Lean into Six Sigma would streamline workflows expelling slow movements, whereas drawing Six Sigma into Lean would provide a structure for consistency and predictability (Arnheiter & Maleyeff, 2005; George, 2002; George & George, 2003) This integration or blending of two methodologies refers to the means of getting things done faster, better, cheaper, safer and greener (Pacheco, Pergher, Vaccaro, Jung & ten Caten, 2015).

The viable argument behind the integration can also be related to the notion of gaining competitive advantage or the means of sustaining it (George, 2002). As a standalone, Lean and Six Sigma has its limiations which Pepper and Spedding (2010) submitted in terms of scope and size of improvements that could be achieved. Antony, Escamilla and Caine (2003) delimit the idea that the philosophies' improvement capabailities had reached the optimal point or ceiling and that an integration would provide an organization with process acceleration and responsiveness to customer, operate at lower cost of poor quality, strive for perfection through 'six' sigma capability and provides greater flexbiltiy throughout the business. Arnheiter and Maleyeff (2005) augments the limitations and flexibiility in competitiveness through producer and customer viewpoint.

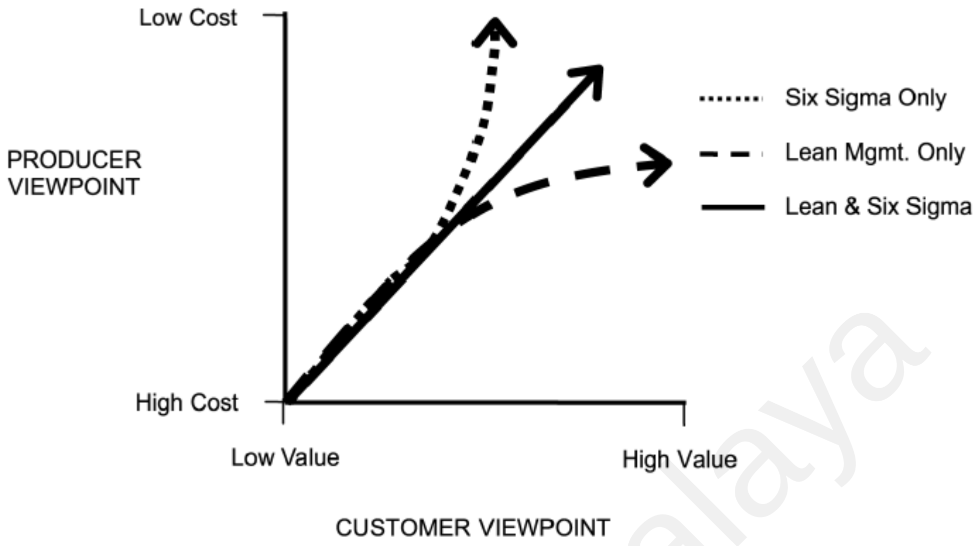


Figure 2.11: Nature of Competitive Advantage

Source: Arnheiter and Maleyeff (2005)

Figure 2.11 portrays the standalone implementation of Lean tends to produce high value for customers. However, overtime providing higher value may require additional cost. On the contrary Six Sigma fends off this factor by decreasing cost continuously overtime but at the expense of providing high value to customers. The integration nevertheless cushions off both limitation thus breaking the barricade by improving both cost reduction and high value justifying the nature of competitive advantage the fusion holds. George (2003) explicates that the companies which are not employed with Lean Six Sigma are likely to outrun by competing firms who embraced this concept as the author preached Lean Six Sigma is consistent with five fundamental laws of the business field which provide direction for improvement. The law of the market considers cultivation of critical to quality, ROIC (Return on Invested Capital) and Net Present Value, the law of flexibility providing elasticity for process maneuvers and changes according to internal and external environmental stimuli, law of velocity that stipulates on Little's law where the process is being elongated and the law of complexity where complexity of the system adds to the non-value adding activity, poor quality and deceleration of speed (George, 2003).

Stoiljković, Trajković and Stoiljković (2011) case study analysis on microbiology laboratory exhibited that both of these concepts are indeed intertwined whereby Lean's acceleration enables Six Sigma's process capability and quality meanwhile Six Sigma's advantage leads to Lean's speed. Laureani and Antony (2012) define this criteria in terms of tools and techniques that both concepts uses. The use of both toolboxes gets the best out of the two methodology implying to the concurrent improvement in speed and accuracy. Salah et al. (2010) illustrate some of the common tools or practices that can be integrated which are brainstorming, process mapping, standardization and mistake-proofing amidst the arsenal of techniques as shown in Figure 2.12. Kumar, Antony, Singh, Tiwari and Perry (2006) suggested 5 Why, cause and effect, Pareto analysis, change management tools, histograms, control charts and scatter diagrams are common set of tools that can be used interactively between Lean and Six Sigma.

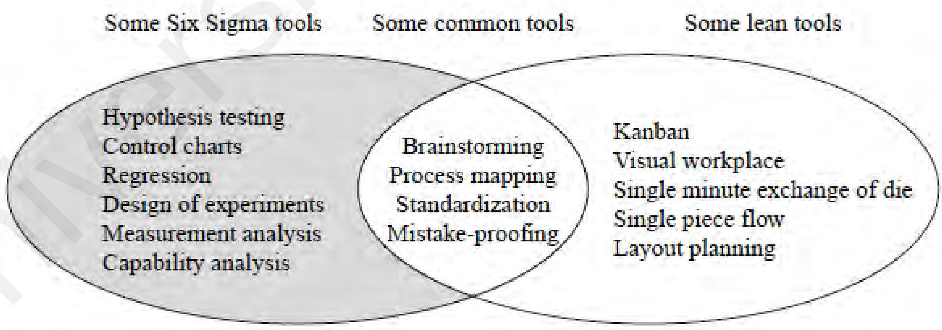


Figure 2.12: An Example of Six Sigma and Lean Common Tools

Source: Salah et al. (2010)

In Wheat, Mills and Carnell (2003), it was revealed that Lean will eliminate noises and establishes a standard for the process. Six Sigma's tools, techniques and method attends to the negative deviation from the standards. This elucidates the stabilizing mechanism that each concept's method or philosophy inspires towards disabling each other's stop-gaps.

Montgomery and Woodall (2008) expounded that Lean combined with Six Sigma is consistent with Deming's System of Profound Knowledge. Six Sigma has an orientation that is focused towards the system's perspective which Deming proposed. Every personnel should view an organization as a system. Six Sigma's DMAIC structure works in a way of how a system should be perceived and this bodes well to the nature of human problem solving from which DMAIC's logic model came about. Knowledge variation refers to the underlying principle of Six Sigma. Theory of knowledge refers to the mechanics in the DMAIC cycle that intends to function in a scientific fashion towards identifying the utilities of a process, why certain problems tend to accrue and how could that be resolved. All these reveals a theory attached to the process under study. Theory of psychology refers to enabling employees and management to be coherent, understand the complexity at both ends and work cooperatively to bring meaningful ends in every improvement endeavor. Six Sigma's parallel meso structure and wide-ranging involvement, respect to employees or people of the Lean philosophy is a two in one, specialized and generic emphasis recognized as a significant underlining in this aspect (Deming, 1986; Montgomery & Woodall, 2008).

The methodology that both utilizes are also in line to each other's which when combined would not complicate the processes progress. Lean is parallel to the PDCA cycle whereas Six Sigma's typical DMAIC cycle have streaks of compatibility as shown in the Table 2.3 below. The Define (D), Measure (M) and Analyze (A) phase is inclusive of the Plan phase of PDCA. The DMA backs all that needs in planning to make the necessary changes that is to define the problem, measure it and analyze to identify the vital factors. Improve (I) is synonymous to doing or making the changes as stipulated through the earlier phases. The Control (C) stage consist of two portions of checking and acting in PDCA wherein it is the actual stage of changes taking place and the means of controlling it.

Table 2.3: PDCA and DMAIC Cycle Compatibility

<table>
<tr><th>PDCA (LEAN)</th><th>DMAIC (SIX SIGMA)</th></tr>
<tr><td rowspan="3">Plan (P): Plan for the changes or improvement deemed necessary</td><td>Define (D): Define the problem to focus on improvement area</td></tr>
<tr><td>Measure (M): Measure the existing process under study</td></tr>
<tr><td>Analyze (A): Analyze the factors to identify the most vital ones affecting the problem</td></tr>
<tr><td>Do (D): Make the changes by doing the necessary as per planned in pilot perspective</td><td>Improve (I): Improve the process by eliminating the root cause and develop possible solution</td></tr>
<tr><td>Check (C): Make a review on how it has turn out in relevance to the problem of the study</td><td rowspan="2">Control (C): Control the process by monitoring the changes continuously and documenting best practice.</td></tr>
<tr><td>Act (A): Take action on what has been learnt or studied and use it as a cycle to improve continuously</td></tr>
</table>

Source: Author

Bhuiyan and Baghel (2005) mentioned of this fusion is where organizations could drive out of their limitations in case of using either one of the approach thus, enhancing the boundary of their potential. Chapman and Hyland (1997) highlights the underlying significance of continuous effort in improvement is having a common set of problem-solving tools which Byrne et al. (2007b) supported by informing this could indeed provide breakthrough improvement and innovativeness. As displayed in Table 2.4 below, Pyzdek (2003) enlightens the complementarity between Lean and Six Sigma synergy that proves worthy of the combination compared to standalone advantages.

Table 2.4: The Synergy of Six Sigma and Lean

Lean	Six Sigma
Establish a methodology for improvement	Policy deployment methodology
Focus on customer value stream	Customer requirements measurement, cross-functional management
Use a project-based implementation	Project management skills
Understand current conditions	Knowledge discovery
Collect product and production data	Data collection and analysis tools
Document current layout and flow	Process mapping and flowcharting
Time the process	Data collection tools and techniques, SPC
Calculate process capacity and Takt time	Process control planning
Create standard work combination sheets	Cause-and-effect, FMEA
Evaluate the options	Team skills, project management
Plan new layouts	Statistical methods for valid comparison, SPC
Test to confirm improvement	Seven management tools, seven quality control tools, design of experiments
Reduce cycle times, product defects, changeover time, equipment failures, etc.	

Source: Pyzdek, 2003

One lacking perspective on this fusion however that should be noted is the lack of standard methodology in implementing Lean Six Sigma. Bendell (2006) argues for a common model that supports theoretical compatibility for all process which could be a guiding reference in general besides debating on the level of maturity the fusion had achieved thus far. Pepper and Spedding (2010) submit for this notion of lack of comprehensive framework that represents a roadmap for the fusion. Kumar et al. (2006) in the effort of fusing Lean and Six Sigma in Indian SME environment found evidence of the same, lack of standard framework, lack of clarity on tools usage all of which eventually yielded to a lack of clear direction for a proper strategy selection.

The cogency for this can be exemplified in multitude of perspective. Both of these concepts represents efforts to improve process through which the resulting outcome yields in the desired quality. The fusion provides enhanced capability that enables each limitation to be offset therefore leaping into the zone beyond any single methodology. The idea behind utilizing Lean Six Sigma as a framework is indeed flexible and this is largely to an extent associated to the organization's capability, feasibility and problem description. This explains for the various models for implementation being prompted in scholarly literatures nowadays. Take for example a firm which has no relevant engagement in either Lean or Six Sigma and is enduring a horrid experience in its processes.

At this point it would be hard for it to kick off on both foot of the methodology. A more realistic action would be to start off by leaning their processes making it stable and then concentrate in reducing process variation in pursuit of perfection. Whereas for a firm that has experience in Lean or process improvement endeavors could rightfully start to reduce variation as the likelihood of process in a stable range is high. Thereby involving Lean and Six Sigma together would be plausible. Antony (2011) compiled the views of practitioners and academicians. All the participants around the globe concur to the idea that Lean Six Sigma as a fusion derives and sustain competitive advantage. In spite of both concepts differences in the area of training, investment and impact focus, both share identical benefits that are larger than the differences identified. One of the participants, V. Arumugam delineates the nature of both improvement ideology where Lean is an approach for inter-process improvement, promoting flow meanwhile Six Sigma an intra-process improvement for variance reduction. The clarity of this statement is imperative for firms to understand how, where and why both are used as depicted below in Figure 2.13.

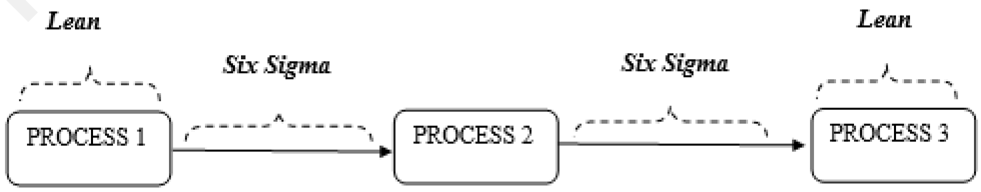


Figure 2.13: Positioning Lean and Six Sigma in Process

2.3 Content Analysis on Lean Six Sigma

A research is known to be extensive, to some the directions and branches of a particular field of study may even seem almost infinite, endless or inestimable as there are studies being conducted at every moment in time on the topic of interest in any corner of the literary world. It is why when conducting a literature search and review, a certain approach for a systematic review is advised.

In scrutinizing a field of study or the state of knowledge in a field or subject, Li and Cavusgil (1995) informed of three ways in accomplishing it, a Delphi method, meta-analysis and content analysis. A Delphi method is a way of analyzing information through the reviewing feedbacks and survey from a panel of experts in a particular field of study such as academicians, professionals, business experts, authorized personnel and the likes. Anderson et al. (1994) used this method to identify the underlying concepts in the Deming's management method. Meta-analysis is a way where empirical studies of the particular subject are gathered and analyzed statistically. Ranjan, Sugathan and Rossmann (2015) undertook a meta-analytic method in analyzing literatures in service interaction quality. The final method is known as content analysis, a technique to manifest the content of literature in a systematic, qualitative and quantitative fashion. As per Harwood and Garry (2003) it was first used in analyzing hymns, newspaper and magazine articles, advertisements and political speeches in the 19th century. Ibrahim, Zailani and Tan (2015) applied this method in reviewing the field of global supply chain and identifying the research gaps in it.

Similar to the last method, this study will take on a content analysis in reviewing what has been studied thus far in the field of Lean Six Sigma and what are the research gap extant to be propagated and researched on. According to Ibrahim et al. (2015), there are three main steps in conducting content analysis: 1) analysis of articles 2) content definition within category 3) identification of literature review gaps. A detailed steps of enduring the process of content analysis for this study is portrayed in Figure 2.14 (p. 71).

The first step in moving about the research was to search for articles related to Lean Six Sigma. This search was limited to only academic journals which were found to be evident in several journals in the area of production management, quality management, business excellence, healthcare management and management in general. In order to capitalize as much details and materials as possible, no starting date or year of the search was stipulated however, the cutoff point was as of June of 2016. However the review of the literatures showed articles published between 2000 and 2016 matching the cut off year. "Lean Six Sigma" was used as the search term, in conducting the literature search which resulted in inclusion of keywords and articles of "Lean" and "Six Sigma" discretely as well. It must be noted that the isolated literatures on Lean and Six Sigma are abundantly available but scarcely for the integrated or fused structure of Lean Six Sigma (Yadav & Desai, 2016). Corresponding to the interest of this study on the hybrid model, the search is focused on Lean Six Sigma in addition to narrowing the scarcity in the literature. The search outcome still contained some discrete articles on either concepts as before mentioned, however for the goodness of the search, was not discarded as it falls under the search term and was used for the analysis as the contents contain some articulation on the fusion model of Lean Six Sigma as well.

Upon searching with the results obtained from each database, the content and text of each article was scrutinized in order to determine whether the article is in parallel to the need of the study. Articles that articulate on the integration of both concepts of Lean and Six Sigma practices, effects towards organizational performance and outcomes, operational excellence, theoretical elucidation were highlighted and collected as main target for the study whereas those that do not seem relevant was eliminated. Many articles look to be repetitive across databases hence those that were redundant in every other subsequent database were also eliminated thus retaining only a single copy obtain from either one database to avoid further confusion.

The search for the articles took place in an extensive manner to congregate as much articles as possible ranging from various databases which includes ABI/INFORMS Complete ProQuest, Emerald, ScienceDirect, Business Source Elite @EBSCOhost, SpringerLink and Wiley Online Library as these databanks contains most reputable journals in the field of operations, quality and industrial management. A latest review on Lean Six Sigma literature by Yadav and Desai (2016) also mentioned similar list of database that prompted the choice of these outlets in addition to suggestions from past studies. It has to be noted that this study discarded articles that were not included or not published in the abovementioned databases. It also did not consider short survey, book chapter, conference review, prefaces, book review, editorial notes, master's theses, doctoral dissertations and textbook. To classify the search as exhaustive may be debatable nevertheless, the articles reviewed from selection of journals and databases which is cited by many authors in this field of study is reasonably representative and comprehensive to the body of research related to Lean Six Sigma.

As a result of the extensive search, 257 articles in the field of Lean Six Sigma were identified. Given the nature of content analysis, several dimensions need to be analyzed, amongst are; 1) Purpose or Focus of Study 2) Years of publication 3) Journal published 4) Methodologies 5) Theory used 6) Country of study and 7) Industry sub-sectors. These dimensions where analyzed in the 257 articles reviewed.

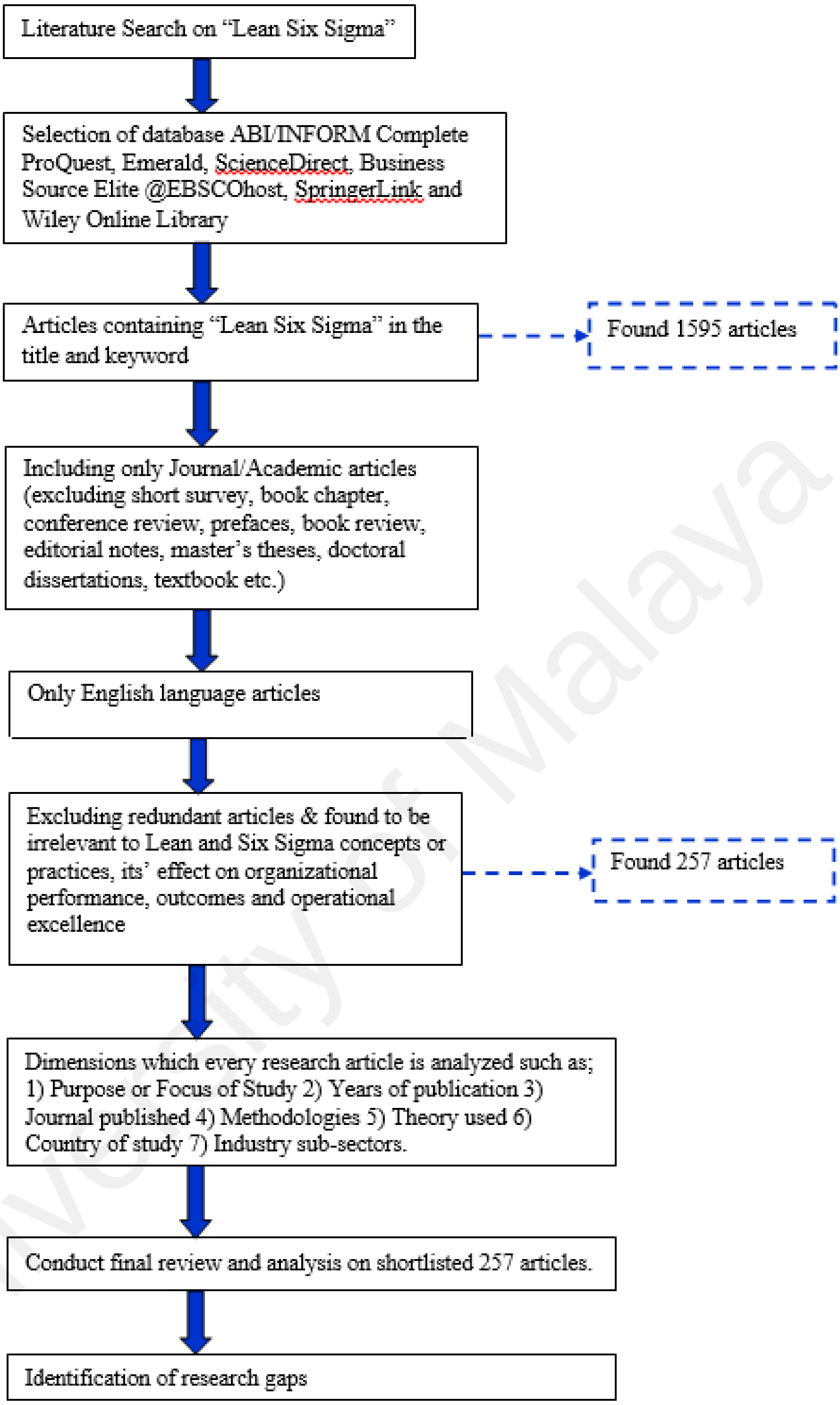


Figure 2.14: Steps in Content Analysis

Prasanna and Vinodh (2013) explored the literatures using leading journal databases in Lean Six Sigma emphasized in SMEs wherein they found two key perspectives theoretical or methodological orientation and application orientation.

Gonzalez Aleu, Van Aken and Antony (2016) systematic literature review between 1996 to 2014 found *Engineering Management Journal, International Journal of Productivity and Performance Management*, and *Pediatric Anesthesia* as the most frequently used academic journals besides the practitioner based magazines*, Quality Progress publications, ASQ Six Sigma Forum Magazine, Performance Improvement, and Quality and Reliability Engineering International*. Embase, PubMed, MEDLINE, EconLit, Psychology Journals, Business Source Premier, CINAHL, EBM reviews (Cochrane databases, DARE, HTA, NHSEED), are eight notable outlets used by Deblois and Lepanto (2016) for a systematic literature review of Lean and Six Sigma in the field of acute care settings between 1999 and January 2015.

In a latest review of the Lean Six Sigma subject, Yadav and Desai (2016) conducted a categorized review for the past 14 years between 2001 and 2014. The 189 articles were obtain from well reputed databases such as Emerald Fulltext, ScienceDirect, Inderscience, Taylor & Francis database, SpringerLink and Wiley Publication from which it was found *International Journal of Lean Six Sigma, International Journal of Six Sigma and Competitive Advantage , The TQM Journal (TQM Magazine), International Journal of Productivity and Performance Management, International Journal of Quality & Reliability Management, Total Quality Management & Business Excellence, International Journal of Production Research and International Journal of Productivity and Quality Management* were amongst the topping journals which were used to identify the trends and emerging aspects in the Lean Six Sigma field.

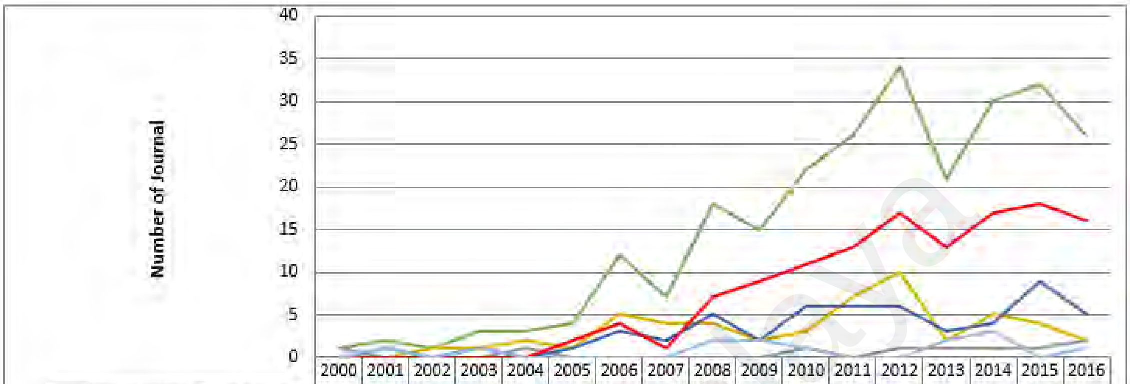
Albliwi, Antony & Lim (2015), to address the gaps in the Lean Six Sigma literature focused in manufacturing industry conducted a systematic review from 2000 to 2013 using well-known databases such as Emerald, American Society for Quality (ASQ), Inderscience, Taylor & Francis, Elsevier, Informs, IEEE Xplore, John Wiley & Sons and ProQuest. Those journals specified as specialist and has the most relevant hit (papers) were *International Journal of Lean Six Sigma, International Journal of Six Sigma & Competitive Advantages, Six Sigma Forum Magazine (ASQ), Quality Progress (ASQ), Performance Management, International Journal of Productivity & Performance Management, International Journal of Quality and Reliability Management, Production Planning and Control Journal, TQM Journal, Journal of Manufacturing Technology Management, Quality and Reliability Engineering International, International Journal of Technology Management, Manufacturing Engineer (IEE Transactions), TQM* and *Business Excellence and European Journal of Industrial Engineering.* These journals contributed into learning the themes that were motivation factors and preventers of Lean Six Sigma implementation in the manufacturing sector.

2.3.1 Analysis of Articles

Since the study intends to see the progress or development of Lean Six Sigma in the field of scholarly research, the 257 articles are clustered and classified into Lean, Six Sigma, Lean and Six Sigma, Lean Six Sigma and others. The reason for such variation is due to the fact, as we already know, Lean Six Sigma is the latest hybrid model of process improvement which arose through the fusion of Lean and Six Sigma. The search for the article did also capture the isolated or individual concept of Lean and Six Sigma in the keywords, additionally with other concepts that were studied together with it such as TQM, JIT, BPR, Quality Management and Continuous Improvement in general. Therefore this classification would enable us to view in contrast the conceptual pattern of the studies throughout the years (Refer Appendix AI for the complete list of the 257 articles).

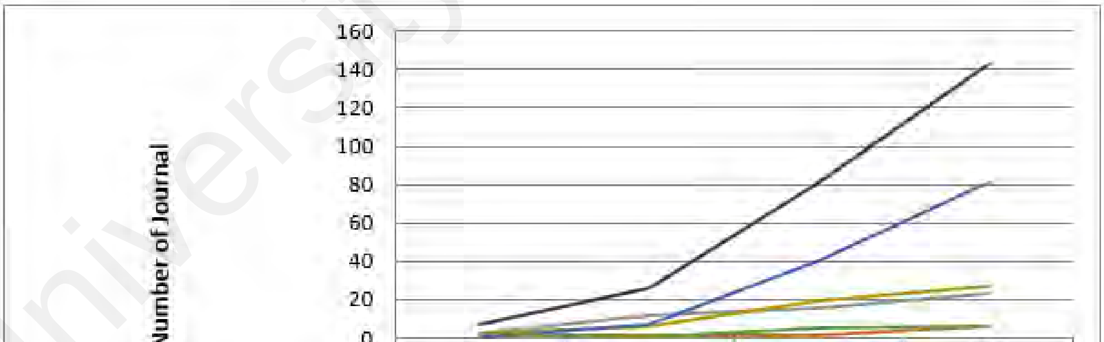
The overall movement of the study in the field of Lean Six Sigma is in fact had been on a growth pattern moving forward. The study of the hybrid model of Lean Six Sigma accounts for 49.81%. The research of the combination of Lean and Six Sigma is 21.01%

of the total amount whereas Six Sigma and Lean as a standalone sums up at 20.62% and 3.50% respectively while the rest are combination of other concepts (Refer to Figure 2.15 below). Thus it can be concluded that Lean Six Sigma is a study increasing in focus in the research realm.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number of Journal Published	1	2	1	3	3	4	12	7	18	15	22	26	34	21	30	32	26
Lean	1	0	0	0	1	0	0	0	0	0	1	0	1	1	1	1	2
Six Sigma	0	0	1	1	2	1	5	4	4	2	3	7	10	2	5	4	2
Lean and Six Sigma	0	1	0	1	0	1	3	2	5	2	6	6	6	3	4	9	5
Lean Six Sigma	0	0	0	0	0	2	4	1	7	9	11	13	17	13	17	18	16
Others	0	1	0	1	0	0	0	0	2	2	1	0	0	2	3	0	1

Figure 2.15: Journals Reviewed on Lean, Six Sigma and Lean Six Sigma



	2000-2003	2004-2007	2008-2011	2012 Onwards
Number of Journal Published	7	26	81	143
Lean	1	1	1	6
Six Sigma	2	12	16	23
Lean and Six Sigma	2	6	19	27
Lean Six Sigma	0	7	40	81
Others	2	0	5	6

Figure 2.16: Journals Reviewed on Lean Six Sigma

For a closer analysis of this lenghty period of research timelime of seventeen years chronologically, the period of investigation are segregated into a four year interval: from 2000 to 2003, 2004 to 2007, 2008 to 2011 and 2012 onwards. As shown in Figure 2.15 and 2.16, the number of articles had risen dramatically after the 2004-2007 period or since 2008. It can be said the attention in the fused model of Lean Six Sigma began to attract scholars after this period. Prior to that, it can be seen in the illustration that the discrete study of Lean and Six Sigma were very much in attention, marked by the pattern on the trend lying above that of Lean Six Sigma's. However, right after the stipulated period of 2004 and 2007, the study in the latter's field had actually begun to take off quite vividly above the isolated approaches. Number of articles in 2000-2003 and 2004-2007 were donned mainly by the discretely model of Lean and Six Sigma with 5 and 19 (combination of Lean, Six Sigma and Lean and Six Sigma articles) articles respectively compared with 7 of Lean Six Sigma in total. After that, Lean Six Sigma articles took center stage with 40 and 81 articles registered in 2008-2011 and 2012 onwards over and above the combined articles of 36 and 56 for the discrete articles on that period. The jump in Lean Six Sigma articles represents a 471.43% rise in the 2008-2011 period from the preceding period and 102.5% increase on 2012 onwards period. This is an immense disparity as compared to the proportion of Lean, Six Sigma and Lean and Six Sigma combined where the percentage of increase in 2008-2011 period is only 89.47% and subsequently endured a slowdown to 55.55%. This justifies the moving of the trend towards the Lean Six Sigma hybrid paradigm.

Some regard the George Group were the first to use the combination of Lean and Six Sigma interactively since 1986 and popularly coined the term "Lean Six Sigma" (Salah et al., 2010). But as many quotes, the hybrid model did not come to much attention after the new millennium (Byrne et al., 2007b; Sheridan, 2000). This explains the slow pick up even by academicians as well, noticeable in diagram above. The 2008 economic recession is an important agenda that have caused a shift in the attention where many businesses worldwide suffered a setback and were in dire need of cutbacks, savings, efficiencies, cost reduction and significant improvement. Following the limitations reported in the isolated concepts and the growing attention of industry to scour for an innovative approach parallel to the evolving nature of the business environment, the hybrid model soon began to pick up in thoughts. Mader (2009) is one of the first few to articulate on the diversity of the Lean Six Sigma model along with the likes of Näslund (2008), Pepper and Spedding (2010), Salah et al. (2010), Maleyeff, Arnheiter and Venkateswaran (2012), Hilton and Sohal (2012) amongst the important ones. An important feature to be noted here is the year published of the articles which range after 2000s and most importantly after 2008 wherein the Lean Six Sigma model became evidently popular among academicians and industrialists alike. This justifies the takeoff in the pattern of the graph of Lean Six Sigma studies.

Table 2.5: Journal Published Related to Lean Six Sigma

No.	Journal Published	2000-2003	2004-2007	2008-2011	2012 Onwards	Total
1	Academy Of Business Journal			1		1
2	Academy of Information and Management Sciences Journal			1		1
3	Academy of management review	1				1
4	Aircraft Engineering and Aerospace Technology	1				1
5	American Journal of Business				1	1
6	Amfiteatru Economic				1	1
7	Armed Forces Comptroller		1	4		5
8	Asian Journal on Quality	1	2			3
9	BMC health services research				1	1
10	Business Management and Strategy				1	1
11	Business Performance Management			1		1
12	Business Performance Management Magazine			1		1
13	Business Process Management Journal			1	2	3
14	Cardiovascular Revascularization Medicine				1	1
15	Decision Sciences			1		1
16	Decision Sciences Journal of Innovative Education				1	1
17	Drug discovery today			2		2
18	Economic and Organization		1			1
19	European Journal of Operational Research.				1	1

Table 2.5: continued

No.	Journal Published	2000-2003	2004-2007	2008-2011	2012 Onwards	Total
20	Global Business and Organizational Excellence			2		2
21	IEEE Transactions On Engineering Management			1		1
22	IFAC Proceedings Volumes				1	1
23	In Healthcare Management Forum				1	1
24	Industrial Engineer: IE				2	2
25	Industrial Management & Data Systems				1	1
26	Interdisciplinary Journal of Contemporary research in business				1	1
27	International Journal of Automotive Technology				1	1
28	International Journal of Business and Management				1	1
29	International Journal of Business Research and Development				1	1
30	International Journal of Emerging Sciences			1		1
31	International journal of health care quality assurance				4	4
32	International Journal of Innovation Science				1	1
33	International Journal of Innovation, Management and Technology			1		1
34	**International Journal of Lean Six Sigma**			**14**	**28**	**42**
35	**International Journal of Operations & Production Management**	**1**	**1**	**2**	**4**	**8**
36	International Journal of Pediatrics and Adolescent Medicine				1	1
37	International Journal of Production Economics				2	2
38	International Journal of Production Research			2	3	5
39	**International Journal of Productivity and Performance Management**		**1**	**4**	**7**	**12**
40	International Journal of Project Management			1		1
41	**International Journal of Quality & Reliability Management**			**2**	**9**	**11**
42	International Journal of Quality and Service Sciences				2	2
43	International Journal Of Scientific And Research Publications				1	1
44	**International Journal of Six Sigma and Competitive Advantage**		**2**	**3**	**3**	**8**
45	International Statistical Review			1		1
46	Investment Management and Financial Innovations			1		1
47	IOSR Journal of Business and Management				1	1
48	IUP Journal of Operations Management			1	1	2
49	IUP Journal of Supply Chain Management				1	1
50	Journal for Healthcare Quality			4		4

Table 2.5: continued

No.	Journal Published	2000-2003	2004-2007	2008-2011	2012 Onwards	Total
51	Journal of advances in Management Research			1		1
52	Journal of Business Case Studies			1		1
53	Journal of Business Strategy			1		1
54	Journal of Chemical Health and Safety				1	1
55	Journal of Computer Information Systems				1	1
56	Journal of digital imaging				1	1
57	Journal of Engineering, Design and Technology				1	1
58	Journal of evaluation in clinical practice				2	2
59	Journal of Facilities Management				1	1
60	Journal of Management & Engineering Integration			1		1
61	Journal of Manufacturing Technology Management			3	1	4
62	**Journal of Operations Management**	**2**	**2**	**4**	**3**	**11**
63	Journal of Technology Studies				1	1
64	Journal of the Operational Research Society				1	1
65	Leadership in Health Services				1	1
66	Learned Publishing			1		1
67	Management Science		1			1
68	Operations Management Research			2		2
69	Organization Development Journal		1			1
70	Physician Exec			2		2
71	Physics Procedia				1	1
72	Procedia Computer Science				1	1
73	Procedia Engineering				1	1
74	Procedia Manufacturing				2	2
75	Procedia-Social and Behavioral Sciences				5	5
76	Quality & quantity				1	1
77	Quality and Reliability Engineering International	1				1
78	Quality control and applied statistics.			1		1
79	Quality Engineering			2	1	3
80	Quality Innovation Prosperity				1	1
81	Quality Progress		1			1
82	R&d Management			1		1
83	Serbian Journal of Management				1	1
84	South East Asian Journal of Management				1	1
85	Strategic HR Review				1	1
86	Strategy & Leadership		1			1
87	Supply Chain Management: An International Journal		1			1
88	Technology Innovation Management Review				2	2
89	Technovation			1		1
90	The American Statistician			1		1
91	The Annals of the University of Oradea, Economic Sciences series			1		1
92	The International Journal of Advanced Manufacturing Technology		1			1
93	The International Journal of Human Resource Management				3	3

Table 2.5: continued

No.	Journal Published	2000-2003	2004-2007	2008-2011	2012 Onwards	Total
94	The Journal of Applied Business and Economics			1		1
95	The Journal of high technology management research		1			1
96	**The Quality Management Journal**			**4**	**7**	**11**
97	The Romanian Economic Journal			1		1
98	The Surgeon				1	1
99	**The TQM Journal**				**6**	**6**
100	**The TQM magazine**		**5**			**5**
101	**Total Quality Management & Business Excellence**		**3**		**8**	**11**
102	Transfusion			1		1
	Grand Total	**7**	**25**	**82**	**143**	**257**

As shown in Table 2.5, the primary publication outlet for research in Lean Six Sigma are *International Journal of Lean Six Sigma, International Journal of Operations & Production Management, International Journal of Productivity and Performance Management, International Journal of Quality & Reliability Management, International Journal of Six Sigma and Competitive Advantage, Journal of Operations Management, The Quality Management Journal, The TQM Journal, The TQM magazine*, and *Total Quality Management & Business Excellence.* As evident, Lean Six Sigma has a dedicated journal itself which accounts for the majority of the published articles (16.34%), the *International Journal of Lean Six Sigma. International Journal of Productivity and Performance Management* stands second with 4.67% and *International Journal of Quality & Reliability Management, Journal of Operations Management, The Quality Management Journal* and *Total Quality Management & Business Excellence* are next closest contributors with 4.28% each.

The TQM Journal which used to be called as *The TQM magazine* (Yadav & Desai, 2016) is also a significant contributor with a combination of 4.28% of the total articles. *International Journal of Six Sigma and Competitive Advantage* and *International Journal of Operations & Production Management* accounts 3.11% of publication respectively. As mentioned by Yadav and Desai (2016) the nature of research in the field of Lean Six Sigma is diverse thus it would be hard to merge the literature under any discipline which explains the vast amount of journal that has registered the interest in the subject. Nevertheless, the rest of the journals are not as significant contributor as the highlighted articles abovementioned.

Technically on a broad-based perspective the study type or methodology can be divided into quantitative or qualitative. Malhotra and Grover (1998) scrutinized the field-based empirical methodologies in the production and operations management (POM) which shed light on the types of methodologies that can be dissected. They explained there are six main methodologies: descriptive, conceptual, perspective, empirical, exploratory cross-sectional and explanatory longitudinal. The descriptive methodology describes, formulates and makes or modifies models of the Lean Six Sigma concepts. Conceptual methodology explains the basic and fundamental concepts of Lean Six Sigma. Empirical modelling refers to the methodology of data or empirical evidence taken from the existing surveys, case studies, literature reviews and the likes which are translated into mathematical or statistical modelling that are usually subject to equation scrutiny. Exploratory cross-sectional is a methodology wherein the data or information is collected through a survey at one or a particular point in time. Explanatory longitudinal refers to data collection through a prolonged period of time, two or more points in time within a same organization or case subject. Given the extent of the study two more methodologies were included for detailed analysis. These were review, which are articles based on literature reviews and case study, those articles that are based on cases.

Such a variation in the methodologies used in various studies will allow for a detailed inspection on how the studies are being carried out or which type of methodology seems appropriate and given importance in the subject of the study. Similar implementation was adopted by Ibrahim et al. (2015), which also provides a reference point as the motive of this analysis is in parallel to the said study's too, which is to learn the pattern and trend of the subject matter and identify literature gaps.

Table 2.6: Distribution of Research Methodologies

Methodologies	Number of Papers					Total Number of Papers	Percentage (%)
	Lean	Six Sigma	Lean and Six Sigma	Lean Six Sigma	Others		
Review	1	3	6	15	2	27	10.04
Perspective		**8**	**15**	**24**	**3**	**50**	**18.59**
Conceptual	1	2	8	18	1	30	11.15
Descriptive	1	8	2	29	2	42	15.61
Empirical (Survey/ exploratory cross-sectional)	**4**	**23**	**5**	**13**	**3**	**48**	**17.84**
Explanatory (Longitudinal)		3	1	3	2	9	3.35
Exploratory (Case study)	**2**	**4**	**16**	**38**		**60**	**22.30**
Empirical (Modelling)			2	1		3	1.12
TOTAL	**9**	**51**	**55**	**141**	**13**	**269**	**100.00**

Note: 12 articles had mixed mode methodology (8, 13, 35, 57, 120, 125, 128, 130, 151, 182, 190 and 241) (Refer Appendix A1)

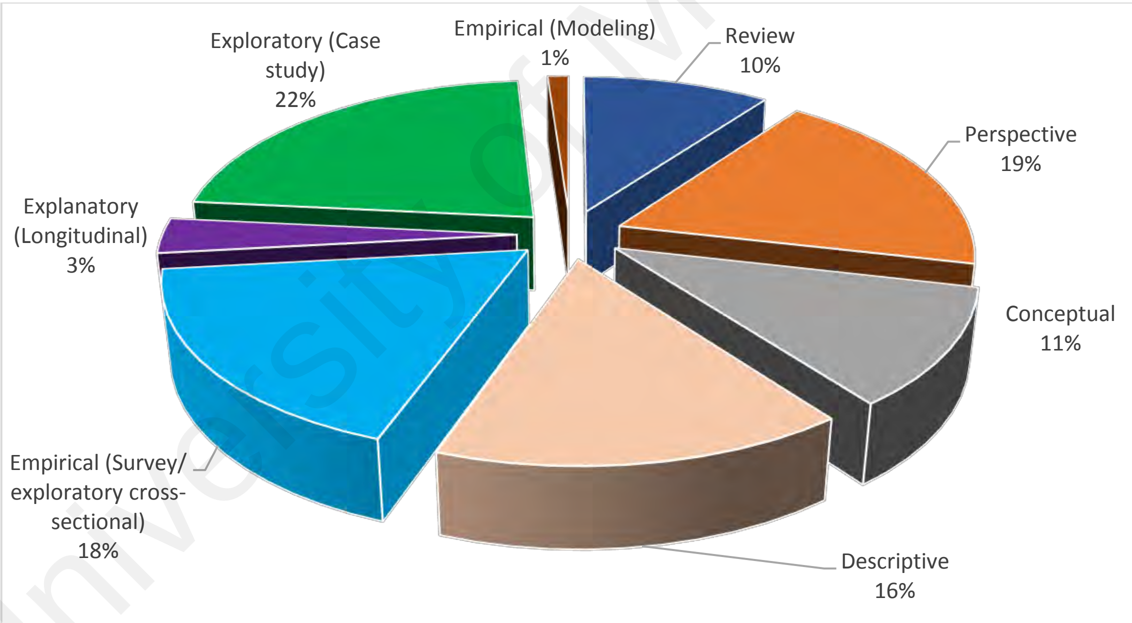


Figure 2.17: Distribution of Methodologies

The 257 articles were reviewed and analyzed based on the eight types of methodologies as stipulated and as per displayed in the table above. As depicted in Table 2.6 and Figure 2.17, case study based research on Lean Six Sigma stands atop at 22.30% followed by perspectives and empirical investigation at 18.59% and 17.84% respectively. Typically case studies would be used to analyze the real life situation or occurrence before putting it to empirical test. The evidence above suggest that the study in Lean Six Sigma is largely on a case study basis but relatively begun to move into empirical testing. However it has to be noted that this would be an overall statement. Given the division of the studies, it can be seen that the hybrid model of Lean Six Sigma is pretty much still on an exploratory stage with case study reporting 38 research in total and empirical research is still lacking. Additionally the review also observed that from the modest amount of empirical investigation of Lean Six Sigma, most of them account to best practices investigation like critical success factors and conceptually articulate on the benefits of Lean and Six Sigma integration. It is also interesting to see thus far though the literature reviewed there is no empirical evidence stating to the enhanced effectiveness of the Lean Six Sigma hybrid model. Shah et al. (2008) studied the joint implementation of the isolated concepts but not the inherent modalities of each concept or what are the impact of the interaction of their idiosyncrasies which would be useful in validating all the anecdotal perspectives available in abundance.

Most empirical based studies are reported by Six Sigma as a standalone with 23 studies. Besides case study, scholars are also increasingly interested in providing perspective on the subject matter, describe the underlying concepts, and provide customized models of Lean Six Sigma which also ranked top or above from empirical studies (13 papers) in perspective (24 papers), conceptual (18 papers) and descriptive (29 papers) based investigation. These findings are in line to Yadav and Desai (2016) who found a similar pattern. Empirical or mathematical modeling and longitudinal based studies are very rare as reported in the articles reviewed with just over 1% and 3% respectively. Reviews in this study are also moderately available (10.04%) however much of it is concentrated in Lean Six Sigma purview compared to others with 15 papers. This study therefore adds to the knowledge base in the extant literature by targeting empirical investigation on Lean Six Sigma.

In conjunction to the examination of methodologies, the study also examined the use of theories in line to the concept of Lean Six Sigma.

Table 2.7: Analysis of the Theories

Theories	Number of Papers					Total Number of Papers
	Lean	Six Sigma	Lean and Six Sigma	Lean Six Sigma	Others	
None specified	6	25	45	125	6	207
Absorptive Capacity		4	1	1	2	8
Organizational Learning		6	1	1		8
Goal setting theory		5	2		1	8
Dynamic Capability		3	2	1	1	7
Resource-based View of Firm (RBV)	1	3	2			6
Organizational Knowledge Creation	1	3			1	5
Socio-Technical Systems theory	1	1			2	4
Knowledge Management		3				3
Rational Choice Theory				1		1
Efficient Market Hypothesis				1		1
Capital Asset Pricing Model				1		1
Modern Portfolio Theory				1		1
Organization ambidexterity			1			1
Diffusion of Innovation				1		1
Systems Thinking			1			1
Expectancy theory of motivation		1				1
Fit Theory					1	1
Regulatory Fit Theory		1				1
Concept of Fit					1	1
Institutional theory		1				1
Signalling theory					1	1
Stakeholder theory				1		1
Stretch Strategy		1				1
System of Profound Knowledge			1			1
Theory of Realistic Evaluation (RE)				1		1
Contextual theory					1	1
Complementarity Theory			1			1

Note: There were 13 articles using more than one theory. Amongst are articles 1, 31, 47, 125, 139, 144, 170, 210, 225, 226, 239, 244 and 255 (Refer Appendix A1).

As displayed in Table 2.7, studies in Lean Six Sigma generally lacks in theoretical justification which accounts for 207 articles, an 80.55% of the total. This supports the proclamation by Zhang et al. (2008) that this line of study lacks a theoretical guidance.

However there are indications on attempts on theoretical based studies in the domain of Absorptive Capacity, Organizational Learning, Goal-setting theory, Dynamic Capability, Resource-based View of Firm (RBV), Organizational Knowledge Creation, Socio-Technical Systems theory and Knowledge Management. Not many studies amongst these reported that drilled deep into the theoretical underpinnings of the study as mostly were done based on the context of the research and acted as a supporting mechanism to justify findings.

All the reported theories have some parts to play in the implementation or embracement of the Lean and Six Sigma concepts as mostly perceived to be in accordance to the context of the studies. Nonetheless a couple of them are crucial in justifying the functioning mechanism of the concept. The RBV could be regarded as a theory describing the resource nature of Lean Six Sigma implementation particularly explaining the sustainability on competitive advantage. Absorptive capacity relates several other theories notably organizational learning and knowledge management as the fundamentals of absorptive capacity is in gaining and exploiting knowledge. Another theory that is of significance is Dynamic Capability which assumes firms ability to systematically generate and modify operation routines to continuously improve its' effectiveness hence its' competitive advantage (Teece et al., 1997; Zollo & Winter, 2002). Other noteworthy theories include goal setting theory that's very much attached to Six Sigma underlying principles more than Lean given the eminence of the former's emphasis in adhering to targets and hard metrics and the organizational knowledge creation theory of which Sin, Zailani, Iranmanesh and Ramayah (2015) used to explain the process of knowledge generation individually and collectively through the use of DMAIC phases of Six Sigma. Many of the authors in the articles reviewed had encouraged the use of theories and examine the underlying theories surrounding the concept of Lean Six Sigma, since as demonstrated most articles rarely used any theoretical support.

Both Lean and Six Sigma germinated from the manufacturing industry which then found its way in just about any process regardless of industries and tasks which made it a universal improvement method. The literature search shows us that the Manufacturing industry was the focus of attention (as depicted in Table 2.8).

Table 2.8: Classification of Industry Sectors

No.	Industry Sub-Sectors	Number of Papers					Total Frequency of Industries in the Papers	Percentage (%)
		Lean	Six Sigma	Lean and Six Sigma	Lean Six Sigma	Others		
1	None specified	5	32	17	24	7	85	28.33
2	Aerospace			4	2		6	2.00
3	Airline				4		4	1.33
4	Airport			1			1	0.33
5	Automotive		1		5		6	2.00
6	Banking			1	3		4	1.33
7	Business Process Outsourcing (BPO)			1	1		2	0.67
8	Call Center				1		1	0.33
9	Chemical				1		1	0.33
10	Construction of large machinery				1		1	0.33
11	Construction Industry				3		3	1.00
12	Consultancy			3	3		6	2.00
13	Courier Service				1		1	0.33
14	Direct Selling Service			1			1	0.33
15	Education			1	2		3	1.00
16	Electronics				3	1	4	1.33
17	Engineering/ Engineering Design			1	1		2	0.67
18	Entrepreneurial firms					1	1	0.33
19	**Finance**			**3**	**4**		**7**	**2.33**
20	Food and Beverages				1		1	0.33
21	Food Industry			1	2		3	1.00
22	Government/Government Operations			2	1		3	1.00
23	**Healthcare**		**3**	**9**	**18**	**3**	**33**	**11.00**
24	Higher Education Institutes (HEIs)			1	4		5	1.67
25	High-tech engineering		1				1	0.33
26	**Hospitals**		**1**	**2**	**7**		**10**	**3.33**
27	Human Resource				2		2	0.67

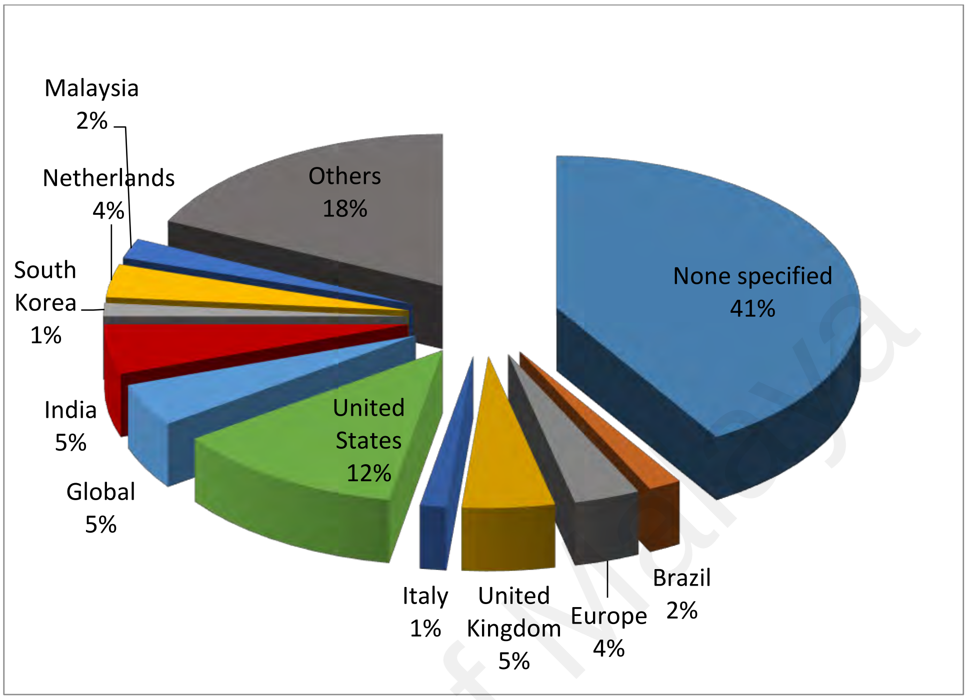
Table 2.8 continued

No.	Industry Sub-Sectors	Number of Papers					Total Frequency of Industries in the Papers	Percentage (%)
		Lean	Six Sigma	Lean and Six Sigma	Lean Six Sigma	Others		
28	Insurance				2		2	0.67
29	Investment				1		1	0.33
30	IT		1	1	5		7	2.33
31	Local Government					1	1	0.33
32	Machinery and Transportation parts Industry					1	1	0.33
33	Maintenance			1	3		4	1.33
34	**Manufacturing Industry**	**3**	**12**	**10**	**18**	**2**	**45**	**15.00**
35	Manufacturing R&D				1		1	0.33
36	Maritime Operations				1		1	0.33
37	Military				6		6	2.00
38	Multinational Corporation		1		1		2	0.67
39	Non-profit Organizations (NPO)				1		1	0.33
40	Oil and gas and Energy			1	1		2	0.67
41	Pharmaceutical				4		4	1.33
42	Publishing				2		2	0.67
43	Recycling Industry				1		1	0.33
44	Semiconductor		1				1	0.33
45	**Services Industry**	**1**	**3**	**2**	**3**	**1**	**10**	**3.33**
46	Shared Services			1			1	0.33
47	SMEs				3		3	1.00
48	Telecommunication			2	3		5	1.67
49	Universities				2		2	0.67
Grand Total		**9**	**56**	**66**	**152**	**17**	**300**	**100.00**

This was so for all categories of the clusters be it Lean, Six Sigma, Lean and Six Sigma or Lean Six Sigma. The concentration is reportedly at 15%. Next to it is the surprise focus of Healthcare industry which had an 11% contribution to the research, most of which is an emphasis of the hybrid model with a total of 18 papers, which is equivalent to that of manufacturing. This could also be substantiated with the hospitals sub sector which also falls within this category which marks at 3.33%. The medical line and healthcare are in need of more quality and focused improvement in line to growing population and even ageing in some countries. Besides the demographic concern, the healthcare industry has substantial objectives that associate human lives. Thus medical errors are a cause for concern which the United States chiefly have found accounts for quite a considerable loss of lives. And with the complexity of organization and job structure, the healthcare needs improved, robust and flexible apparatus like Lean Six Sigma to tackle its complexities. Most papers in this arena focused on case studies.

The other parallel focus industry is the service industry at 3.33%. George and George (2003) advocated the necessity of using Lean Six Sigma in service industries wherein they emphasized the sluggishness service process may possess. This is mainly due to the fact that services' output are intangible. It's invisible to the eye and measurable only through satisfaction of the customers. So for one that could not see the processes they're going through, its relatively hard to improve it which is why the use of data, process mapping, statistical tools from the Lean Six Sigma approach assists. As notified in the table, there is an increasing trend to the studies focused in the services industry nowadays. Besides service in general, Finance, Banking, IT, Business Process Outsourcing, Shared Services, Call Centers have also registered interest in the concept. Interestingly government operations and the military are also in a rising attentiveness in the use of the concept especially in the United States which this study managed to find 2% contribution for the latter. It is surprising how Lean Six Sigma can be innovatively used for instances such as logistical battles as described by Hook (2016). Another thriving area for Lean Six Sigma research is the Higher Education Institutes (HEIs). There has been an increasing focus on the need to embed Lean Six Sigma in the educational institutions (Antony et al., 2012; Sunder, 2016; Svensson et al., 2015) for administrative and education betterment or innovation (Ellis, Goldsby, Bailey & Oh, 2014; Kanigolla et al., 2014; Pavlovic, Todorovic, Mladenovic & Milosavljevic, 2014; Shokri & Nabhani, 2015).

Lean, through the Toyota Production system in Japan and Six Sigma from Motorola at the United States did not take long to cross boundaries and permeate into every corner of the globe given the stature of its success that lured in many around the world to explore the ooportunity it offers.



None Specified: Country not specified
Others: Other countries as stated in table below

Figure 2.18: Geographic Distribution of Articles

Figure 2.18 associates the top ten geographic distribution in the articles reviewed. Parallel to its stature in the world economy, United States ranked in most where the studies had taken place with 12.32% of the total reviewed of the 257 articles. India is considered a fast growing nation in this area which raked up second spot with globally studied articles at around 5.28%. United Kingdom are the subsequent leads followed by Global coverage with 4.93% and 4.58% respectively. Europe and Netherlands ranked fifth spot jointly at 3.52%. Malaysia stands with a 2.11% conribution. It needs to be highlighted the studies of Lean Six Sigma in Malaysia is low, along with the likes of Brazil and Italy with 3 articles apiece. Of the three articles, two of them studied crtitical success factors of Lean Six Sigma implementation (Habidin & Yusof, 2012; Jeyaraman & Kee Teo, 2010) and the other being a conceptual framework of Lean Six Sigma's interaction with Green concept and its effect to financial performance (Zamri et al., 2013). Although efforted, the studies on the hybrid model are substantially low and are in need of further academic contribution of its phenomena in the country. Brazil, South Korea and Italy are subsequent countries within the top ten list of Lean Six Sigma related studies (refer Table 2.9 for complete list).

Table 2.9: Geographic Distribution of Articles

No.	Geographic Distribution	Number of Papers					Total Frequency Papers	Percentage (%)
		Lean	Six Sigma	Lean and Six Sigma	Lean Six Sigma	Others		
1	None specified	4	27	26	54	6	117	41.20
2	Algeria				1		1	0.35
3	Australia			1	2		3	1.06
4	**Brazil**	**1**		**1**	**3**		**5**	**1.76**
5	Canada			1		1	2	0.70
6	China		1				1	0.35
7	Denmark			1			1	0.35
8	**Europe**		**5**	**1**	**3**	**1**	**10**	**3.52**
9	France	1		1			2	0.70
10	Sweden			2	1		3	1.06
11	**United Kingdom**	**2**		**4**	**7**	**1**	**14**	**4.93**
12	Belgium	1					1	0.35
13	Germany				1	1	2	0.70
14	**Italy**				**3**	**1**	**4**	**1.41**
15	Japan					1	1	0.35
16	**United States**	**1**	**6**	**8**	**18**	**2**	**35**	**12.32**
17	**Global**		**4**	**1**	**8**		**13**	**4.58**
18	**India**		**1**	**4**	**10**		**15**	**5.28**
19	Indonesia				1		1	0.35
20	Iraq		1				1	0.35
21	Ireland			2	1		3	1.06
22	Kenya				2		2	0.70
23	Uganda				1		1	0.35
24	Tanzania				1		1	0.35
25	Rwanda				1		1	0.35
26	**South Korea**		**3**	**1**			**4**	**1.41**
27	Spain					2	2	0.70
28	Taiwan			1	2		3	1.06
29	Thailand				1		1	0.35
30	Turkey				1		1	0.35

Table 2.9 continued

No.	Geographic Distribution	Number of Papers					Total Frequency Papers	Percentage (%)
		Lean	Six Sigma	Lean and Six Sigma	Lean Six Sigma	Others		
31	**Netherlands**			**2**	**8**		**10**	**3.52**
32	Lithuania	1					1	0.35
33	**Malaysia**		**3**		**3**		**6**	**2.11**
34	Mexico			1			1	0.35
35	New Zealand				1		1	0.35
36	North America					1	1	0.35
37	Portugal			1	1		2	0.70
38	Saudi Arabia				1		1	0.35
39	Scandinavia			1			1	0.35
40	Scotland			1			1	0.35
41	Serbia				1		1	0.35
42	Finland			1			1	0.35
43	Singapore			2			2	0.70
44	Hong Kong			1			1	0.35
45	Philippines			1			1	0.35
46	Sri Lanka			1			1	0.35
47	Pakistan			1			1	0.35
Grand Total		**11**	**51**	**68**	**137**	**17**	**284**	**100.00**

The final step of the content analysis will focus on recognizing the gaps in the literature which was detected from the analysis.

2.3.2 Identifications of Literature Review Gaps

A central and decisive step in the initial process of an academic research is the literature review. It is a time consuming and extensive process as one is required to scour about the field of study to gain as much as insight into defining the purposefulness of the research. There are several important functions and purposes of this process. According to Sekaran and Bougie (2003), the role of literature review is to position the research relative to existing knowledge and build on it; elude the risk of re-inventing the wheel; revisit the backgrounds and viewpoint of problems at multiple angles; frame ones thinking for insights on research; provide significant and researchable ideas and provide guidance on conceptual and theoretical frameworks. Adding to this, Hart (1998) also specified literature review serves to identify relationship between ideas and practice; ideas and theories; understanding structure of the subject; identify main methodologies and research techniques; identify what has been done and what needs to be done; extend a research interest; and displaying a historical context on the development of a study.

In this study, a total of 257 articles have been identified and reviewed which shed some lights on the gaps in Lean Six Sigma literature:

i) This study provided a dynamic evolution of Lean Six Sigma over different periods of time. And to explore further, the study period was segregated into four year intervals to specify their incremental effects. The analysis showed that study in the field of Lean Six Sigma has begun to grow since the new millennium (after 2000) but more significantly after the 2004-2007 periods or since 2008. It can be argued that standalone models of Lean and Six Sigma are well researched compared to Lean Six Sigma. Also it can be considered that the field is relatively new and could use much focus.

ii) This change in pattern was very notable for the hybrid model studies of Lean Six Sigma, which implies to more of scholars and practitioners are focusing on the merging of Lean and Six Sigma. Arnheiter and Maleyeff (2005) mentioned organizations should be able to capitalize on the strengths of Lean and Six Sigma practices. This may be a reflection on the industry level as there happen to be buzzwords where firms who were incumbently using either Six Sigma or Lean practice are contemplating to add the other half for the hybrid model to surpass the 'low hanging fruit scenario'. But aspects that maybe stopping them are the lack of a methodology for a proper implementation which explains the large proportion of perspective, conceptual and descriptive based studies as exemplified. These studies found were in suggestion on the best possible ways and manner of implementing

Lean Six Sigma and most case studies depicts organization's unique way of handling the concept.

iii) This suggest to the lack of theoretical understanding that drives behind the philosophy which could very well explain the purpose of using them and highlight on how it could be handled more efficiently. Linderman et al. (2003) on Six Sigma highlighted there is no basis for research in the area other than best practice studies given the lackluster of theories that explains the phenomenon. Zhang et al. (2008) went to the same extend in defining this scenario as was the case with many subsequent scholars. And even till now this seems to be a lackluster in tackling this issue as shown in the analysis 80.55% are without a theoretical basis meanwhile as displayed in the analysis of content only 20.23% of the articles explains the phenomenon of theoretical underpinnings. This calls for more emphasis in this area which would be useful to industry managers to justify on the importance of using process improvement philosophies within their organizations.

iv) Another concern on the contemplation on embracing the dual approach may be the lack of empirical validity on the fusion of Lean and Six Sigma. As depicted in the Figure 2.19 below, Lean Six Sigma articles focuses mainly on case studies, descriptive, perspective, and conceptual methodologies topping the categories with 26.95%, 20.57%, 17.02%, and 12.77% respectively. Empirical distributions are fairly low with only 9.22%. It was found in the review that almost all the articles on the integration of Lean and Six Sigma in the build up to the hybrid model are anecdotal and qualitative based explicating the incremental effects they could have. Thus far, based on the review on the articles in this study there has not been any empirical validation that explains the enhanced effectiveness the fusion model could bring. More precisely, the interaction terms of both concept had not been studied. Correspondingly, there is a lack of theories explaining this incremental phenomenon.

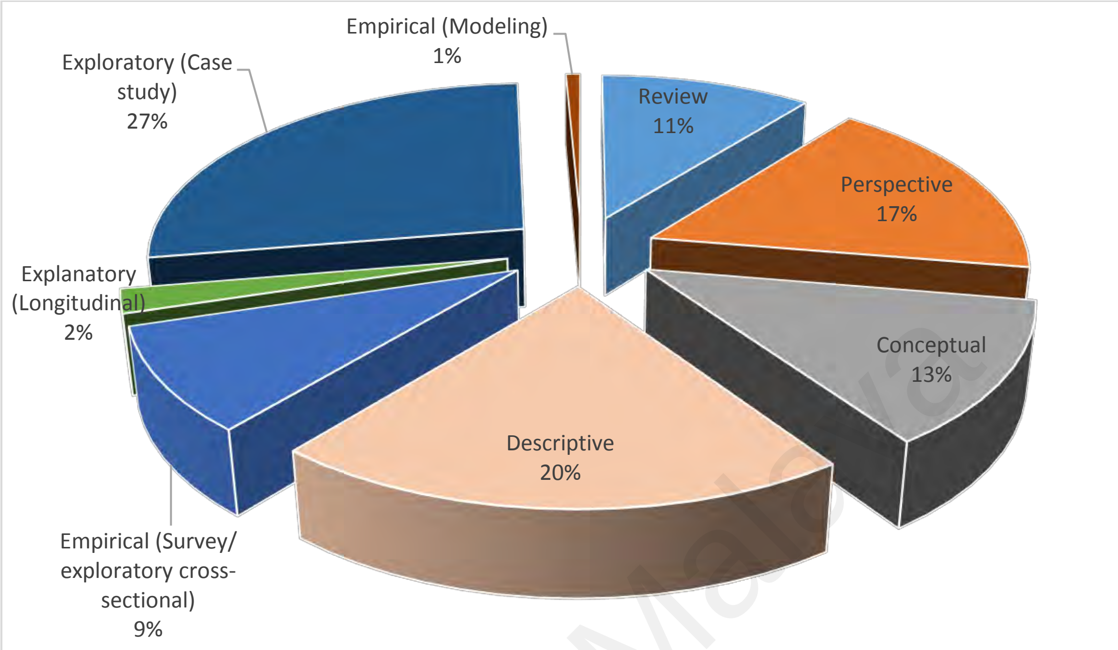


Figure 2.19: Distribution of Methodologies for Lean Six Sigma Articles

v) Since process improvement is applicable almost universally as explained in the review, the dimensions in which it could permeate are wide-ranging. Accordingly many theories could be used to define its existence. It was found notable theories used thus far were Absorptive Capacity, Organizational Learning, Goal-setting theory, Dynamic Capability, Resource-based View of Firm (RBV), Organizational Knowledge Creation, Socio-Technical Systems theory and Knowledge Management. Lean Six Sigma or process improvement activities are knowledge based in general, thus it shows the prevalence of knowledge oriented theories as stated. However as before mentioned this study articulates that some of the theories could be placed as the underpinnings that explain the Lean Six Sigma phenomenon like Absorptive Capacity, Dynamic Capability and RBV. It has to be mentioned that the theory of absorptive capacity especially as re-conceptualized by Zahra and George (2002) who advocated that the construct is multidimensional, has not been examined to greater length although the literatures concerning this theory had mentioned about this multidimensional aspect however failed to examine how they are related into providing an impact. The theory of Dynamic Capability is valuable in explaining the concepts of Lean and Six Sigma either discreetly or fused. The definition of the theory itself is self-explanatory and with the latest hybrid model it can explain the interaction dynamics of two concepts that complement each other.

vi) Many articles observed had placed much focus on examining the performance outcome of using Lean, Six Sigma or Lean Six Sigma. This is a natural response especially as largely evident through many case studies in depicting how the usage of the philosophies enables process excellence and enhance performance outcomes. There are also a considerable amount of studies which have various organizational outcomes these approaches could bring which were elucidated by the eminence of the firms who succeeded in using them. However, there is a lack of studies that actually justifies the sustainability of competitive advantage attained in using the approach, especially when it is being submitted that Lean Six Sigma is a much enhanced approach surpassing the isolated models as it could advance the envelope of firms' ability.

vii) Country wise, it is evident that most studies took place in the developed part of the world being United States and United Kingdom. But concentration in developing countries like in India has been growing as many countries are in the effort to lead itself for more development. Malaysia stands in one of them however efforts to enhance the knowledge base are inviting especially robust ones.

viii) There is a debate between exploration and exploitation in process management literatures that process management activities largely focuses on exploitative manners alone without considering exploration thereby stunting certain aspects of innovation (Benner & Tushman, 2003). However it was argued by some that this may not be the case as process improvement activities like Lean Six Sigma could instead promote both types of innovation radical and incremental, therefore supporting exploration traits (Antony et al., 2016; Azis & Osada, 2010; Hoerl & Gardner, 2010).

ix) There are evidence of organizations muddled in a dilemma between which strategy to use to tackle problems, Lean, Six Sigma or Lean Six Sigma (Antony et al., 2003; Antony et al., 2016; Snee & Hoerl, 2007).

The content analysis provided observant details on the current status of Lean Six Sigma studies. Further synthesis or review of literature will be carried out in the next section outlining the focus of the study based on the gaps perceived.

2.4 Implementation of Lean Six Sigma in ASEAN Countries

Given the proximity of this research which falls within the Southeast Asian region, it is worthwhile to touch upon the implementation of this philosophy succinctly on this part of the continent. This section will provide a brief review on the implementation of Lean Six Sigma within the ten countries of Association of the Southeast Asian Nations (ASEAN) which include Singapore, Indonesia, Thailand, Vietnam, Philippines, Myanmar, Laos, Brunei and Cambodia in addition to Malaysia.

Undeniably one of the most prosperous nation in the world and the most developed country among the ASEAN region, Singapore's economy is braced by its strength in the services industry amongst others. Given its status and history as an entrepot nation, it has grown to modernize many services sectors as well (Wilson, 2011). Lean Six Sigma implementation in the country can be trace to the education sector such as library process or operations of the national university (Ean Lee, Cheng Kan & Chuin Foo, 2012), healthcare industry (Alam, Osama, Iqbal & Sawar, 2018), information technology (Shamsi & Alam, 2018), logistics operations and transportation (Zhang, Luo, Shi, Chia

& Sim, 2016), public services, insurance, real estate, telecommunication, tourism, travel and engineering services (Chakrabarty & Chuan, 2009). However, it is claimed that the implementation of this philosophy in Singapore is regarded as a complex task which involves the hiring of additional employees due to lack of resources (Chakrabarty & Chuan, 2009).

Ranked 16th in the world, Indonesia is the leading ASEAN nation in terms of gross domestic product (GDP) who's manufacturing industry accounts for 20.51% of the GDP. The small and medium enterprises (SMEs) in Indonesia is regarded as the most important sector which makes up most registered companies in Indonesia (Amar & Akpolat, 2005). The country embarked on Total Quality Management (TQM) initiative through Japan-ASEAN TQM project between 1995 and 2000 which was quite encouraging at the beginning however slowly spiraled into stagnation on the latter stages (Amar & Akpolat, 2005). SMEs of the manufacturing sector is a potential for Lean Six Sigma development, besides construction, mining and industrial related services such as metal and iron ore (Amar & Davis, 2015) and even telecommunication (Sitorus, 2011). Consistent to being the largest natural rubber exporter in the world, Thailand's implementation of continuous quality improvement centers mostly on its manufacturing sector (Nonthaleerak & Hendry, 2008) which includes rubber manufacturing (Jirasukprasert, Arturo Garza-Reyes, Kumar & Lim, 2014). Besides, multinational corporations (MNCs) plays a key role in bringing Lean Six Sigma into the country (Lertwattanapongchai & Swierczek, 2014) with some traces of application in the financial institution as well (Buavaraporn & Tannock, 2013). Philippines' association to Lean Six Sigma application can be found in call center operations for which the nation is renowned for (Laureani, Antony & Douglas, 2010; Vijaya Sunder, 2015).

The implementation of Lean Six Sigma in the rest of the ASEAN countries Vietnam, Cambodia, Myanmar, Laos and Brunei are significantly limited especially in terms of publication (Son, Rashid, Nguyen & Nakano, 2011). However hints of Lean Six Sigma application in the healthcare industry within these countries are evident (Ponanake, Limnararat, Pithuncharurnlap & Sangmanee, 2014). The lack of evidence of Lean Six Sigma implementation does not necessarily imply to a lack of implementation as businesses in respective countries may as well utilize the philosophy to a certain extent without acknowledging it publicly. Nevertheless, one sector which may utilize Lean Six Sigma commonly across all ASEAN countries, including Malaysia, is possibly the automotive supply chain as this part of the world is known for its lower labor cost, proximity of raw materials and market opportunities (Phusavat & Kanchana, 2008; Punnakitikashem, Laosirihongthong, Adebanjo & McLean, 2010).

With reference to Malaysia's implementation of Lean Six Sigma as mentioned in the earlier section, and with the review of its implementation in other ASEAN countries it can be summarized that Lean Six Sigma implementation is very much diverse and offer a mixed outline within this region across every country. Malaysia, Singapore, Indonesia, Thailand and Philippines share a similarity in application of this quality management concept in a way that is tied to its major economic activity or major business attributes. For instance, Malaysia's large extent of Lean Six Sigma application can be attributed to the manufacturing sector although the service sector is also on the rise. Singapore on the other hand focuses on logistical operations and services as evidenced by literature given its major economic contribution being services and its characteristics of an entrepot nation. Philippines is fairly known as a hub for call centers, Indonesia focuses on SMEs meanwhile Thailand on rubber manufacturing sector and its reliance on MNCs. Comparatively on a global scale, Lean Six Sigma is still relatively incipient in ASEAN countries given the evidence from scholarly works and arguably in practical application. As Mustapha, Abu Hasan and Muda (2018) puts it, research done along this region may in fact be helpful for replication or comparison of the findings in other ASEAN countries.

2.5 Idiosyncrasies of Six Sigma

2.5.1 Structured Improvement Procedure

Quality improvement processes as a structured method of solving problems could be traced back to the ages of Galileo who came up with the idea of scientific method during the experiment of material strengths and object motion. Following which Francis Bacon (1561-1626) a philosopher who proclaimed that knowledge progress as a planned structure and suitably inspired the interchange between deductive and inductive reasoning to experimentation in real world which combines hypothesis and theories with observation and carrying out tests to look for the differences between theories and realities (Moen & Norman, 2006).

The idea of a scientific method in quality management was a stepping stone as many would agree to the work of Walter Shewhart's cycle of process control, or earlier known as the "Shewhart Cycle". The cycle, Plan, Do, Study, Act (PDSA) is meant to make hypothesis, carry out experiment and testing the hypothesis through specification, production and inspection (Shewhart & Deming, 1986). His disciple who became a fundamental proponent in the domain of quality management, Edward Deming, stretched out his theory into what became known as the Plan, Do, Check, Act (PDCA) cycle when it was lectured at the Japanese Union of Scientists and Engineers (JUSE) seminar in 1950 to educate the Japanese managers and engineers of statistical quality control in order to boost the country's export and manufacturing industry following Japan's demise after the World War II (Deming, 1952; Imai, 1986). The Deming wheel was a portrayal of the interaction between design of the product, production, sales by placing it on the market to reach end users and testing the demand and finally redesigning the product following the reactions from end user (Deming, 1952). Deming later in 1986 introduced the official version of his predecessor's cycles as the Plan, So, Study, Act (PDSA) cycle with a slight revision on between the concepts of Check and Study which the later implies to "hold back" in western comprehension and that the later may suit the idea to study on the problem (Deming, 1986). The PDCA or PDSA cycle reflects a method for solving problem or engaging in an appropriate execution of a process that includes planning, by defining and hypothesizing a problem, execution meaning to do or implement, evaluating the results of the process, and taking necessary action upon the receipt of the feedback. In implementing the cycle, a process is assured of certain standards from which the quality of the outcome will be secured.

As defined by Palady and Olyai (2002), typically problem-solving is divided into three distinct stages which are identification of the problem, investigation of causes of problem and finally concluding the solution for the problem. The notion behind this structured approach in seeking resolution to a problem had become somewhat omnipresent in that we have to organize and do things systematically to achieve desired objective. With the thought of the conception, Mikel J. Harry developed "The Logic Filters" between 1980 and 1984 (Times, 2013). The logic filters is based on a logical approach to solve problem underpinning the problem solving theory aforementioned, which outlines methodical manner to go by reducing defects and errors. This includes recognizing all possible and associated problems and hypothesis. Next would be to classify the hypothesis on measurable terms, analyze to reduce the number of variables and identifying the few factors that really matters to a process which confirms the causal linkage and finally control the desired outcomes using statistical methods (Times, 2013). On another strand of this story, veteran Motorola engineer Bill Smith published a research business report in which he elucidated the products at market that works well and has a high life span are those with less rework during production. By which he meant that those products with lesser or no rework has a tendency for an extended life span that spells better quality (Harry & Schroeder, 2000).

The combination of these discoveries led to Bill and Harry working together to create a breakthrough in the problem-solving heuristics that is now known as the DMAIC phases (Harry, 1994; Business Improvement Times, 2013). In a Six Sigma project, as shown in Figure 2.20 the team members *Define (D)* the project problem and goal requirements, secondly *Measure (M)* the process to identify current process performance, third *Analyze (A)* and determine the root causes of the problem to scale down the vital-few factors of the process, *Improve (I)* the process by defect eradication and finally *Control (C)* the renewed process through statistical measures and continuous monitoring (Pyzdek, 2003). The product of the logic filter model had been fitted with range of statistical tools and techniques prescribed to support project teams to obtain the objective of each phase accordingly which make Six Sigma a data driven approach (Pande et al., 2000) as depicted by Montgomery and Woodall (2008) in subsequent Figure 2.21. The specification of tools across the phases of the methodology is something unique compared to other initiatives as signified by Linderman et al. (2003). Besides offering a roadmap to quality improvement through a well-defined steps and tools as guidance (Harry, 1994), it is also viewed as knowledge-creating process that occurs intuitively as articulated by Garvin (1993), Wu and Lin (2009) and Sin et al. (2015).

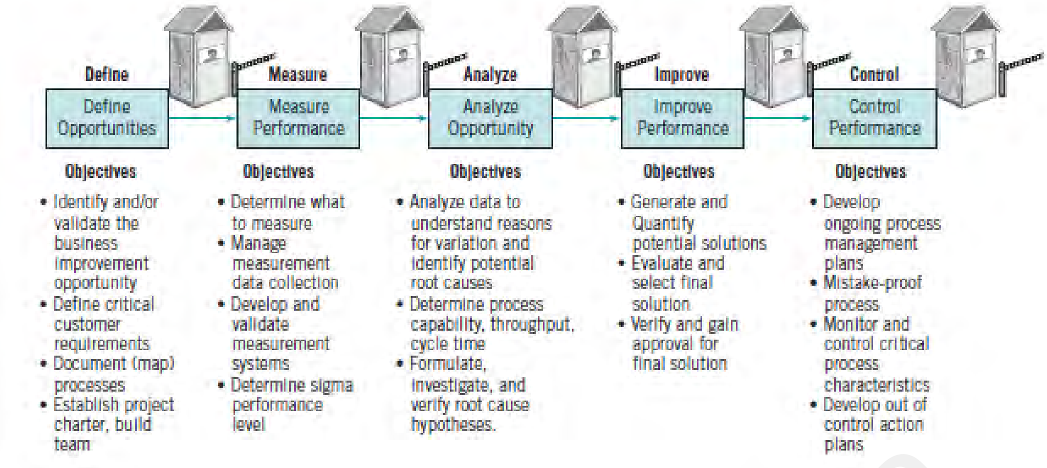


Figure 2.20: The DMAIC Process

Source: Montgomery (2008)

Tool	Define	Measure	Analyze	Improve	Control
Project charter	X				
Process maps & flow charts	X	X			
Cause and effect analysis		X			
Process capability analysis		X			
Hypothesis tests, confidence intervals			X		
Regression analysis, other multivariate methods			X		
Gauge R&R		X			
Failure mode & effects analysis			X		
Designed experiments			X	X	
SPC and process control plans		X	X		X

Figure 2.21: Some Statistical Tools used in DMAIC

Source: Montgomery and Woodall (2008)

Problem solving is a significant aspect and a predominant competency of the human cognition. The ability of human beings to solve problems is what makes them an idiosyncratic component of an organization, one that is a source of intangible assets. The nature of human mind is computational which enabled the replication of this feature into artificial intelligence for models of problem solving (Langley & Trivedi, 2013). Newell and Simon (1976) bolstered that humans use symbolized structures to form hypothesis in search of resolution in which heuristics mechanize the process by analyzing *means-ends,* that considers the impediments between current state and the goal or desired state. As a result, improvisation in organizational routines matters when dealing with organizational problem since heuristic approach is likewise entrenched within quality management which Winter (1994) expressed as quest for improvement in organizational routines. Organizational routines govern the efficiency of processes and tasks. Adler, Goldoftas & Levine (1999) study on NUMMI, an above average performing Toyota subsidiary found that organizations may indeed effort the privilege of being ambidextrous, being both efficient and flexible that accommodates learning behavior and knowledge creation within an organization.

Taylor (1911) put forward that improvement is accomplished via routinization of tasks. An organization typically comprises of routine and non-routine tasks. Routine tasks are customarily identified best practices, simple and stable tasks that are proceduralised for sake of uniformity that warranties efficiency. Whereas non-routine tasks includes those that are meant to scour for innovativeness, trouble shooting and problem solving, tasks that's complex and ever-changing in which being bureaucratic about it would not do any good. Adler et al. (1999) discover one of the elements of ambidexterity of organization would be meta-routines which resembles adherence to a structured method (Choo et al., 2007b). Meta-routines, regardless of routine or non-routine tasks, systemizes creative process which sustains efficiency without impairing innovativeness subsequently gaining both potentials. Meta-routines in other words create routines for non-routines, changing existing routines or creating new ones (Nelson & Winter, 1982; Volberda, 1996). Adding to that, the rationale behind large firms' competitive advantage ascendency, is due to their ability to routinize innovation (non-routine/ problem solving) processes (Schumpeter, 1976).

With meta-routine, routine tasks can be fitted with improvement goals as in Six Sigma projects. While strictly enduring the structured DMAIC phase in revising and re-constructing process, team members will also be attentive in identifying improvement opportunities which requires flexibility and being more organic or fluid, adding innovativeness into efficiency goals. Meta-routine substantiates Six Sigma's structured method as a process for changing other processes (Adler et al., 1999; Choo et al., 2007b), as standardized problem solving methodologies nurture continuous improvement efforts (Adler et al., 1999). As a systematic and structured improvement procedure, this practice would function to regulate ways to acquire, assimilate, transform and exploit knowledge throughout the improvement project.

2.5.2 Role Structure

Many employees laments the idea and responsibility when it comes to accepting quality related role. The idea of quality being a peripheral management, added burden to the already extant duties and roles fend off any interest in this subject as many tend to view quality suprisingly as something that is of non value adding activity and resolving to focus on core duties. Awareness on quality may be questionable for such cases however in the case of Six Sigma as compared to other quality or process initiatives this is undertaken rather instituitionally. One of the idiosyncracies notable and non-existence than any other initiatives is the Belt system Six Sigma uses (Pande et al., 2000; Pyzdek, 2003; Zu et al., 2008).

The emphasis of the organizational infrastructure of Six Sigma can be seen in the definition given by Schroeder et al. (2008, p. 540):

> "*Six Sigma is an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives*"

The relevance of Six Sigma's belt system is nevertheless tied to the idea of traditional quality circles promoted by Ishikawa. Ishikawa famously known as the father of quality circles in which he advocated the functions of every employee regardless of designation and level, as all are accountable in the respect of quality undertakings (Watson, 2004). Ishikawa emphasized a more fluid and invisible structure in which people has to view quality as that is pretty much discretionary, nevertheless it gave more flexibility and a more liberal means of taking quality problems into view which according to him is a conviction to the workers creativity. A parallel structure refers to additional creation outside of the typical organization structure which does not effect the core structure (Lawler, 2008). Nonetheless Lawler (2008) submits that eventhough being flexible and all-ranging in terms of participation, suggestions and ideas in the quality circle are often overlooked and in most cases goes unimplemented given a relative lack of authority and power of quality circles. Hence the idea of a parallel structure in the context of quality is not a new aspect (Zhang et al., 2008). But in the context of Six Sigma, it is scrutinized with greater extend wherein these personnel who engages in process improvement efforts are instead known as specialist who receive tailormade training session accroding to capacity (Breyfogle III, 2003; Pyzdek & Keller, 2014; Zu et al., 2008).

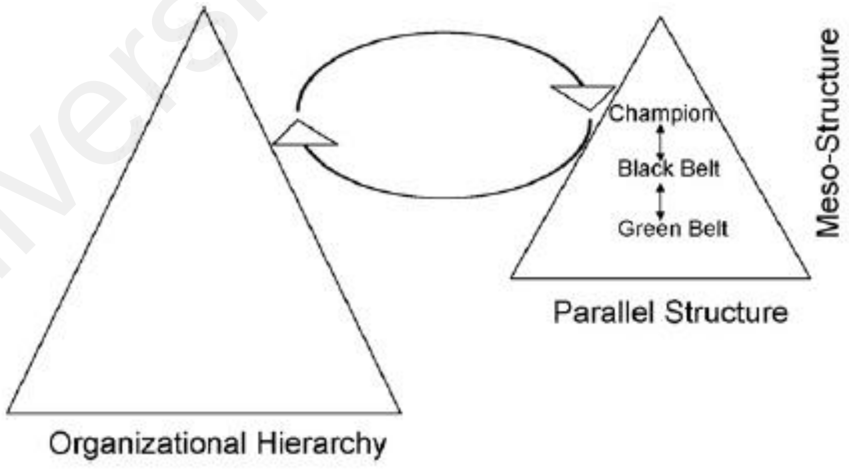


Figure 2.22: Six Sigma Parallel-meso Structure

Source: Schroeder et al. (2008)

Figure 2.22 portrays the interrelationship between an organization's core structure that typically signifies the traditional roles and responsibilites of organizational members. A Six Sigma organization however adapts a structure that lies outside the core stucture which does not embodies any adverse effects. Instead this structure represents the organizational hierrachy in that it is specialized for the purpose of improvement errands. This specialized meso structure reveals the intensity of making process improvement as a professional course of action amidst the organization's core tasks unlike other improvement inititiatives that treats it inherent which could possibly resort to warding off improvement efforts in favor of core task significance (Laureani & Antony, 2018; Laureani & Antony, 2017). In a way of having a meso-structure reliefs the rest of the personnel of further burden by passing the torch of detailing the focus on improvement by specialist per se, half of whom (Black belters and Master Black belters) are on it on a full time basis. This way, organization characterizes ambidexterity by focusing on core tasks reflecting their typical business functions and at the meantime directing improvement along the way through improvement specialists.

These specialists are known in the term of martial arts proficiency level (Caulcutt, 2001; Pande & Holpp, 2002). These specially trained and designated personnel are mostly known as Green Belts (GBs), Black Belts (BBs), and Master Black Belts (MBBs) (Montgomery & Woodall, 2008) however in general the linked down may reach to Yellow Belt who receive basic awareness and Champion who supports from the 'C' level (Kwak & Anbari, 2004). According to Pyzdek (2003) MBBs are specialized and experienced Black belters that takes on a mentorship role for the level below especially BBs and identifies high level opportunities within the organization. BBs a technical experts in the utilization of Six Sigma tools and techniques who leads the process improvement projects and handles high impact, cross functional projects besides training GBs. GBs are project leaders who undertakes the local improvement projects within their department and teaches and shares the knowledge to other members. GBs operate in a part time basis compared to the former two whom are full time personnel (Pyzdek, 2003). The structure created in Six Sigma cascades down the mentorship from one level to another enables the meso structure for close tutorship of expertise and knowledge fostering sustainable organization learning of intricate subject matter like Six Sigma. This creates learning in high end capacity of a firm indirectly excluding the additional training that the project team members had enrolled earlier.

Zhang et al. (2008) expresses Six Sigma's infrastructure as an emergent structural evolution in quality following Barney (2002) description that Six Sigma is a merger between macro and micro aspects of organization strategy. This implication is in line to the notion of differences between micro and macro population of the organization population. The meso theory explains the median of these two aspects from which the average standings emerge, is called as 'meso' (Daft, 2006). The meso structure of Six Sigma takes into consideration personnel from both aspect, the top management who focuses on macro aspect of the organization such as corporate strategy, organization mission and vision that maps the satelite level of the firm and merge them with the operational level personnel who attends to the day to day endevors who are 'know-how' savvy at the ground level with micro facet of the business.

The fusion of two organization structural level allows the interaction of ideas and knowledge of the two region within the organization allowing organization members a platform for creativity to spur by integrating top level vision and ground level operational matters. This closes the proximity of visionary gaps wherein learning between the two level are likely to accrue. In such a circumstances, Sinha and Van de Ven (2005) views this as a mechanism that coordinates and control work across organzational levels that synchronizes the tactical tasks and organizational strategy. Having an inherent or designated improvement specialist is akin to having boundary spanning agents who's function is to accumulate knowledge stock and dispense them where and when necessary, prompting learning, execution and exploitation methodically.

2.5.3 Focus on Metrics

Deming had previously mentioned that setting high goals may result in deterioration of efforts to continously improve (Deming, 1986; Deming, 2000). Therefore, traditional measures of quality doesnt set much goals instead opting for 'do best' attitude. This condition, throughout the evolution, had become a debate. Robbins and Judge (2003) made an annotation to this stance implying that individuals are naturally motivated with intensity, direction and persistence when moving towards a goal or when focused on it.

Goal setting theory gives a relative answer to this frame. This is supported by Pinder (1984) by claiming that the goal theory had made scientific validation on the effect on motivation. Locke and Latham (1990) finding was 90% representative in the psychological literature which showed positive outcome in confirming that specific and challenging goals yields higher performance compared to "do your best" goals (Locke & Latham, 1990; Locke, Shaw, Saari & Latham, 1981). The authors elucidate that directing attention, mobilizing effort, increasing persistence and motivating strategy development happens to be the main mechanism wherein goals effect performance. Exploring deeper on the field of goal theory, Meichenbaum (1977) explains that goal setting consist in the domain of cognitive psychology specifically cognitive behaviour modification. In explaining the detail mechanics in goal settings Rand (1990) explains setting aims is related to mental processes which comprises two major attributes, content and intensity. Content refers to the specificity, clarity and precision of the level of performance sought whereas intensity speaks of the means of setting and process of achieving the goal (Rand, 1990).

Given individual prevalance, O'Leary-Kelly, Martocchio and Frink (1994) studied this scenario through meta-analytic review in a group's context where they found a significant relationship between group goals and group performance where the group goal effect revealed a strong impact. Locke et al. (1981) signifies setting challenging goals actually improves performance than deteriorating it. They went on to orate that when a goal is difficult to achieve, but had been accepted individual effort and perisistence tend to flourish. For this to be adapted rightfully the goals have to be superior in terms of clarity and specificity which is absent in the case of 'do-your-best' type of goals (Locke & Latham, 1990; O'Leary-Kelly et al., 1994). Linderman et al. (2006) however had put a footnote on this when he implied that goals although owning to the specificity and clarity but if it is too outlandish may infact lead to a deteriotation in performance.

This is practically manifested when goals are beyond reach of effort or restricted by means of time, resources, motivational support and the likes which may in fact supress the motivation to engage it in the first place. Therefore, following Linderman and authors' suppositions, the relationship could be illustrated as shown in Figure 2.23, where goal level and performance are concavely related. The higher the goal, performance level rises but only to a certain extent or a stipulated optimality. The breach of that point may trigger a diminishing effect on performance level. Erez and Zidon (1984) claims as difficulty increases on goals beyond a certain point, a drop-off in performance ensues.

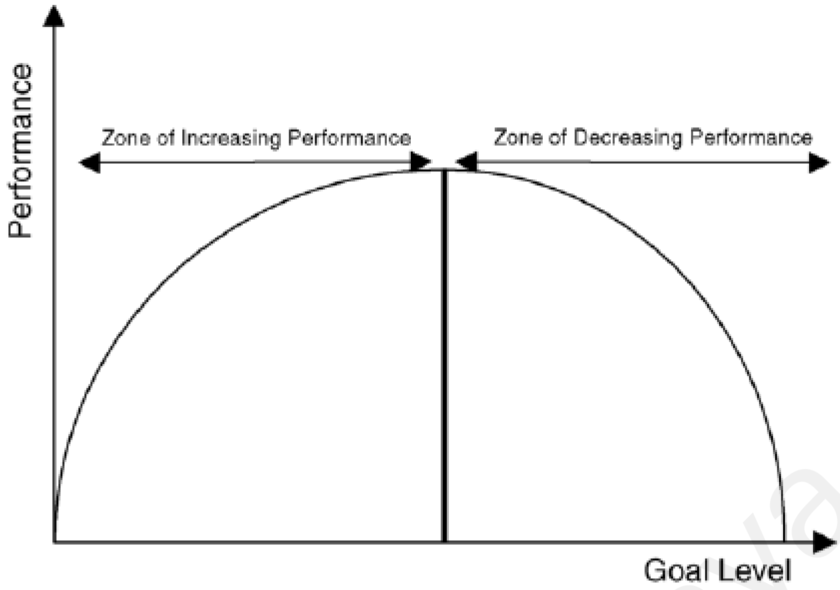


Figure 2.23: Goal Level and Performance

Source: Linderman et al. (2006)

Six Sigma has a rigorous motivation towards achieving targets. Six Sigma emphasizes on a bundle of quantitative metrics such as the 3.4 DPMO, process capability, defect measures, ten-fold improvement from current capability and the likes (Breyfogle III, 2003; Zu et al., 2008). Usual management decisions on typical stance arrive through subjective judgements, anecdotal based verdicts which makes a leader's decisions questionable especially when something goes wrong. Brewer (2004) voiced this concern by implying without objective oriented data, firms are highly likely to be biased towards political and personal agendas in decision making processes. With availability of objective-based data, management are constricted to make decisions quanititiatively eliciting transparency of judgement. On a performance perspective when goals are not objectively motivated or vague, this intends to create performance variability whereby individuals tend to have varying intepretations (Linderman et al., 2003).

The number of fold of improvement is one common feature in Six Sigma embracing companies deciding to opt to an improvement standard. For instance reduce the manufacturing DPMO of 100,000 by ten fold to 10,000 or from a percentage view could be a reduction in critical care unit adverse drug events from 1.8% discharges to 0.18% (Caldwell, Butler, Posten & Quality, 2009). The sigma level is an important predictor of the number of defects presently dwells within a process which could be estimated on a million opportunity basis (or DPMO). Evans and Lindsay (2007) attest that the 10 fold improvement resides in the 3 to 4 sigma level mark whereas from four to five sigma requires a 30 fold improvement subsequently, a mammoth 70 fold improvement between five to six sigma level. As many in experience would agree reaching a sigma level to the extend of two, three or four will be relatively easy at first but to move beyond that may require advance statistical tools, techniques, methods such as Design for Six Sigma (DFSS) (Breyfogle III, 2003; Harry & Schroeder, 2000; Mader, 2003; Pande et al., 2000; Pyzdek, 2003).

A complex task will always trigger the minds of one on how to go about in completing and resolving the complexity involved. So he or she will indefinitely begin to think out a way for it. Therefore a complex, challenging yet specific goals triggers the cognitive process related to strategy development (Campbell, 1988; Earley & Perry, 1987; Locke et al., 1981). Earley, Lee and Hanson (1990) found that the goal setting composite impels one to generate an effective work strategy. This work strategy could be said to be accompanied by the DMAIC methodology in Six Sigma where along the way of resorting effective work strategy, the effort is augmented by a systematic formula that further expedites the process. Besides, in Six Sigma a structured and tailor made traning scheme is provided for every end of complexity, Black belters are advanced experts in resolving high-end complex matter. Linderman et al. (2003) subsumes this by explaining Six Sigma does not only suffuse declarative knowledge knowdege in training from a theoretical perspective but also the procedural knowledge involved in knowing-how to apply the theoretical knowledge. Besides that Linderman et al. (2003) also proposed conditions on which explicit goals of Six Sigma relates task complexity. Complex tasks are easily handled using stuctured method of Six Sigma. Tailored training accompanies goal commitment by proposing effort, persistence and direction are all but superior with Six Sigma goals in that they mediate Six Sigma goals and performance outcome (as shown in Figure 2.24). Focusing on metrics or particular targets enable the process of using a common language regardless of occupational context. This, in turn, assist in the process of developing shared understanding using which knowledge can be transferred and exploited.

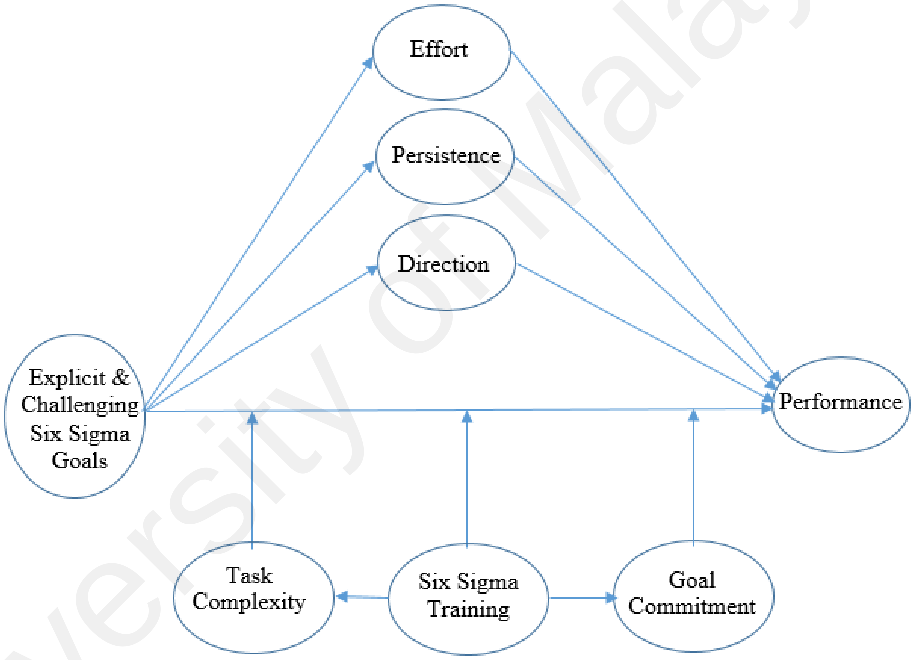


Figure 2.24: Six Sigma Goals, Performance and Intervening Factors

Source: Adapted and modified from Linderman et al. (2003)

2.6 Idiosyncrasies of Lean

As delineated through earlier explication of the history and evolution of Lean which came through the TPS idelogy, the starting point of Lean came about through the various concepts of doing things the best way, or the best practice ideas. Hence, many of the ideas and best practices were made into tools and techniques that give a picture of how things should be done. Scrutinizing on this historical aspect of Lean's evolution even through literatures it can be said that Lean is divided into two streams, one being technical in the sense of the toolboxes it possesses and another being philosophical, in terms of the practice or management (Rymaszewska, 2013). Lean, for the most part in universal understanding is described on two accounts, one from an overaching principle or philosophy that guides the implementation and another on a practical perspective in terms of tools, techniques and management practice (Shah & Ward, 2003, 2007; Spear & Bowen, 1999; Womack & Jones, 1996). Consequently Shah et al. (2008) conceptualized Lean at differing level of abstraction as a philosophy, set of principles and bundles of practice. Hines et al. (2004) declared that Lean exist at two levels strategic and opertional.

2.6.1 Lean Technical Practice

Sakiichi Toyoda invented many remarkable improvements in weaving machine or looms. An important invention of his was the 'Type G' automatic loom which automatically stops when a thread breaks (Austenfeld Jr, 2006). The man operating the machince automatically halts any further process and restricted on moving further. This concept was later known famously as '*Jidoka'*, one of the two main pillars of TPS which means autonomation, or machine handling with human intelligence (Baudin, 2007; Kim & Gershwin, 2005; Sugimori, Kusunoki, Cho & Uchikawa, 1977). The work stops immediately in the face of a problem which requires human intervention to identify the cause of the problem and the machine signals the problem through stalling further production of defective goods. This means, machines and man shut down the system in the light of any imperfection (Liker & Morgan, 2006).

Eiji Toyoda went for a second pilgrimage of the Toyoda family to the United States (the first being Kiichiro Toyoda) to Ford's Rouge plant in Detroit with an effort to uplift the dwindling flow of the company following the World War II, economic recession and series of financial problem of the company (Austenfeld Jr, 2006; Womack et al., 1990). Kiichiro's earlier observation on his first pilgrimage impressed him on a supermarket which replenishes products just in time after customer purchased them (Liker, 2004). Eiji this time around observed Ford's continous flow of the assembly line but marginalised the batch and queue system of making parts (Austenfeld Jr, 2006). Eiji concedes that American companies like Ford and GM were financially fit and sizeable compared to Toyota. They could not afford leakages or unleaness of the batch and queue system. So he brought the idea to Taichi Ohno, a production genius along with whom the both perfected the idea of Just-In-Time (JIT) by affixing the 'pull' system in the assembly line to overcome the batch and queue system's deficiency (Austenfeld Jr, 2006; Hutchins, 1999; Sugimori et al., 1977). With this it means that the process is of continous flow with zero iventory without any work-in-progress (Hutchins, 1999) and shorter lead time from the point of raw material entry to the completion of product with only essential processes and with necessary production time (Monden, 2011; Sugimori et al., 1977).

This was the start of the evolution of many tools, techniques and practices which became the subsection of the principle of TPS or Lean. The chief pillars in the system is Jidoka and JIT. Spear and Bowen (1999) claimed that the principles of Lean lies on a set of tenets. Many agree that the dominant view of Lean is describable by a set of practices and tools used in eliminating waste (Li, Rao & Ragu-Nathan, 2005; Narasimhan, Swink & Kim, 2006). The primary condition of utilizing Lean is to eliminate waste and once these sources of waste are defined, these tools will guide in making the corrective actions and eliminating them (Fawaz, 2003). As Shah and Ward (2007) puts it, wastes commonly noted in excess inventory or capacity from human and machine perspective that are subject to eradication to ameliorate the effects of variability in supply, processing time or demand. The systematic constituent of Lean is viewed through Kilpatrick's (2003, p. 2) quote on National Institute of Standards and Technology Manufacturing Extension

Partnership's Lean Network defintion who mentioned Lean as "*a systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection*".

Basically what has been implanted through the formulation of tools and techniques is that those are best practices made available in guiding the personnel in work routines to ensure the stipulated objective of waste elimination, continuous production flow and efficiency are obtained in the rightful manner. The tools being used in the Lean system is not a one-off feature but are carefully crafted apparatus that was designed and tested for many intervals through the hard and experiential learning since the early Toyota undertakings (Austenfeld Jr, 2006; Womack et al., 1990). As expressed by Shah and Ward (2003), the tools are indeed synergistic as each one of them chains to another set of tools or techniques that achieves the objective of waste alleviation resulting in a process full of added value. The futuristic tools' design started off with infant ideas based on logic and practical possibility that was tried out, tested and reviewed over and over again until it made sense to be applied in a mass context. However it has to be noted that within this purview, learning was held to be key in defining the progress. Toyota was committed to learning as Spear and Bowen (1999) proclaimed it to be within the DNA of the company. Workers are taught to solve problems using the Lean tools in a scientific method and more so to think in scientific fashion.

The tools used in Lean such as 5s, Kanban, Quality Function Deployment (QFD), process mapping, Value Stream Mapping (VSM), Poke-Yoke (Mistake Proofing), Andon, Kano analysis, and various other brainstorming activities generates dynamic learning capabilities individually and collectively within the organization and externally to its suppliers or other stakeholders. Dyer and Nobeoka (2000) describes this as inter-organizational or network-level learning with bilateral and multilateral knowledge-sharing routines. This learning advantage was advocated in greater theoretical articulation by Nonaka (1994) wherein the learning systems such as the TPS creates organizational knowledge through a spiral of socialization, externalization, combination and internalization through the interaction of both explicit and tacit knowledge. Hobbs (2003) clarified that a proper implementation should not only comprehend on how to use the tools but on why it is being utilized.

As cited in Bhasin (2015), companies using four or more Lean tools acquire greater benefits in their Lean endeavours. The Lean tools provide explicit interpretations on engaging in the process improvement activity. The quintessence of Toyota's operation can be regarded as a series of controlled experiments centred upon scientific method (Spear & Bowen, 1999). Womack et al. (1990) suggested that Lean practices and tools are actually a formed system as what the proponents strived to conceptualize.

Given the prevalence of the abundance of tools created and utilized in Lean and the success that came by with it; identifying wastes, making continuous flows, generating cost-effective changes and the likes, Shah and Ward (2003) branded Lean as collection of practices of its tools that work together synergistically. The tools and techniques of Lean serves certain purpose under specific circumstances. The efficiency of this tools and techniques are reliant upon the ability to acquire the necessary information which needs to be nourished into them prior to their application. The need to use Lean's tools and techniques would then indirectly impel the need to scour for information prior to exploiting them.

2.6.2 Lean Social Practice

Spear and Bowen (1999) believe that people always had it misinterpreted between the tools and practices they observe in Lean with the system as a whole. The fact is, tools or technical practices do not form the only fundamentals of Toyota Production System. Toyota educates its employees on the science behind these methods, the idea that forms in using these methods which is the essence of Toyota's system (Spear and Bowen, 1999). Consequently, Shah and Ward (2007) expounded on this assertion by claiming that Lean is not just about the concepts but an integrated system of sociotechnical aspects composed of highly interrelated elements. As Mann (2014) affirms most prescription of Lean are missing a critical ingredient, in the form of its social management system to sustain the holistic idea of Lean. He mentioned that a Lean social management system extends the results from the technical aspects.

The Lean system is in fact manifested across many dimensions and facets (Ngo, 2010). Lean's attention on customer-centric and strategic thinking is applicable universally within the organization as compared to Lean's shop floor tools (Siemerink, 2014). Hines et al. (2004) conferred on the use of Lean production for shop-floor movement and Lean thinking for strategic value chain dimensions. Sohal and Egglestone (1994) claims only ten percent have appropriately instituted the Lean philosophy. And those that have, achieved a balance between the technical and social practice.

Therefore, it can be conceded that Lean's role comes in the form of operational term, through the usage of its tools and techniques that can also be called as technical practices. And another being the social management of the philosophy depicted in the way Lean is being managed in the company's policy and social management practices on a broader or macro term. Angelis, Conti, Cooper, and Gill (2011) claim that conducive culture that supports Lean implementation is vital. In adapting Lean, conventional disciplinary and personnel administration had to be sacrificed (Montgomery, 2010) with knowledgeable leaders stepping in for motivation and enthusiasm for employees (Bhasin, 2015).

Shah and Ward (2007) had provided an illustration on the difference of perspective in viewing Lean from philosophical orientation in the conceptual world and tools and practices in the empirical or technical side of the world (as shown in Figure 2.25).

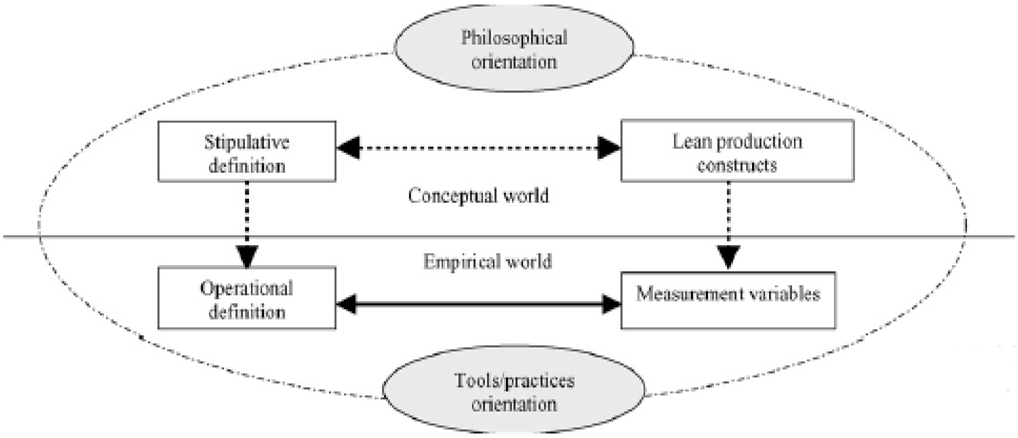


Figure 2.25: Existing state of knowledge of the conceptual and empirical world as related to Lean production

Source: Shah and Ward (2007)

As Mann (2014) explains the physical changes in Lean implementation that largely associated with tools and techniques like layout changes, mahnice efficiency, workers' effectiveness are obvious or visible for the eyes. However changes in the management system are hard to come by and a bit more subjective to be assesed. The tools and techniques or technical practice of Lean provides the explicit means of "know-what" knowledge of the process meanwhile the social management system embeds the tacit knowledge of Lean philosophy that is not easily made explicit. It can be assumed that the 'know-how' knowledge is an apparition from the explict knowledge gradually gained in the process of adaptation. Bhasin and Burcher's (2006) literature analysis revealed that knowledge on tools is not much of a concern however to ensure realization they claim firms need to apply five or more technical tools, view Lean in a long-term perspective, institute continuous improvement viewpoint and make numerous cultural changes embracing empowerment and sponsor the Lean principles through-out the value chain.

Siemerink (2014) outlined that Lean philosphy have a relative effect to the structure of the organizaiton where a supportive structure is required. The author explains that different factors of the structure will be impacted by Lean implementation while some imply Lean will elicit a focused and organic organizational structure (Sohal & Egglestone, 1994). Nahm, Vonderembse and Koufteros (2003) outlined five features of this organic organizational structure in which a firm would have rules and regulations that encourage creative, autonomous work and learning; few layers in the organizational hierarchy to enable quick response; a high level of horizontal integration to increase knowledge transfer; a decentralized decision-making so operating issues can be dealt with effectively and quickly, and; a high level of vertical and horizontal communication to ensure coordinated action. Siemerink's (2014) research revealed all the companies have structural variable changes and innovation upon implmenting Lean.

Looking at problems as opportunity is an imperative part of this process, particularly at the problem-definition stage as claimed by MacDuffie (1997). This is because the intensity of the problem will define the plausible and extent of opportunity prevalent and this circumstance would define the amount of learning and improvement that can be pursued (Levin, 2000). Kaizen known in Japanese for continous improvement is meant to have revolutionize through the Lean concept as well. As Imai (1986) delineates Kaizen is a process of continous improvement in any area of life, personal, social, home, or work that professes gradual and incremental improvement. In order to perform with sustaining performance and dynamism organization needs to be applying a systematic approach on this line of idea (Imai, 1997).

As highlighted in previous section, the Lean or TPS ideology underscores a great deal of respect towards it's workforce aside continous improvement. This is the fluid part of the philosophy which firms have to understand above and beyond the infactuation on the tools and techniques. By way of intepretation by Jeffrey and David (2005), the Toyota Way or TPS is more tacit knowledge-centric. And this procedural knowledge and know-hows of the continous improvement philosophy is learned by doing it with a coach or 'sensei'. By means of work, the Lean philosophy otherwise emphasizes the improtance of its workforce's knowledge and the sureity on cascading the knowledge one might have learnt to their peers consequently throughout the organization. Connecting Lean on knowledge or knwoledge management in precise, Rooke, Sapountzis, Koskela, Codinhoto and Kagioglo (2010) presented the idea is about getting the right information, in the right form, to the right people at the right time. Since all work consist of the combination of physical and information load, known as "knowledge work" (Drucker, 1999), the level of delegation of knowledge throughout the workforce streams in an all-rounding fashion, comprising from the significance of top management to the most technical points of operation on a long term basis (Alukal, 2006; Olivella, Cuatrecasas & Gavilan, 2008; Womack et al., 1990).

It is acclaimed in researches that a successful Lean implementation involves judicious Human Resource Management (HRM) practice (Ehrlich, 2006; Suárez-Barraza & Ramis-Pujol, 2010). Following Shah and Ward (2007) perspective that Lean encapsulates sociotechnical perspective, Hadid and Mansouri (2014) studied Lean from the technical and social point of view in which the latter constitutes bundle of Human Resource Management (HRM) practice. They highlighted social systems in Lean as supportive practices such as an appropriate rewarding system, effective communication system, employee empowerment, employee commitment, employee involvement, having performance measurement system, possessing multifunctional employees, encourage leadership, catering training for quality programs and etcetera. Hadid et al. (2016) studied Lean in the services sector again from a sociotechnical perspective. The study found that Lean's tehnical bundle had an independent postive effect on operational performance. However, the technical and social bundles interacted positively to improve operational and financial performance, suggesting both social and technical aspects of Lean are imperative ingredients in the success of Lean implementation.

As Drucker (1999) explains, knowledge workers need to have autonomy to manage themselves, require continous innovation, teaching and learning to be part of their responsibility and accountability. This underlines to the need of workforce flexibility instead of being rigid and standard operating procedure oriented that stunts them most of the time from learning abilities or giving out more of what was learnt through progressive findings. Georgescu (2011) contends that the conventional mass production manufacturing models lack the flexibility to respond as what is much needed in today's swift environment. However it is learnt that flexible and motivated workforce brings agility in a successful Lean program in improving bottom line results (Georgescu, 2011).

For firms to leverage the comprehensive benefit of Lean, all subsystem of the firm needs to acclimatize to the subject to Lean's philosophy (Hancock & Zayko, 1998). Meanwhile viewing Lean as a philosophy cultivates certain way of thinking wherein the tactics becomes the action mechanisms for the thinking (Bhasin & Burcher, 2006). Therefore, supplementing Siemerink (2014) on the link between strategic and operational level, firms should be complimenting both angles to work out improvement process continuously.

This organic reflection of Lean philosophy as reviewed in the literatures range from an organizational model stemming from the Lean way of life, a systematic initiative of continuous improvement, a high delegation and importance of workforce knowledge and greater workforce flexibility. All in all, the social practice of Lean should coexist with the technical aspect in ensuring the balance of the philosophy. The social and technical aspect should play a combinative role that supplements each other. The crucial aspect of the social practice of Lean, lies in the ability of an organization to trigger the socialization mechanism which has been largely known to cater learning and exploiting the learning outcomes.

2.7 Sustainable Competitive Advantage

There happens to be a time where organizations were in dire rush of earning profits as it centered around the idea that the more profit it earns, the more advantageous it is in the market. As time ticks of the faith in this assumption deteriorated. Organizations now are always on the lookout for ways that could generate itself competitive advantage and means of sustaining it. As Barney (1991) postulated competitive advantage is sustained when firms implement strategies that exploit their internal strength, respond to external environmental opportunities, neutralizing threats and improving internal weakness. To view the conception in much detail, sustainable competitive advantage (SCA) is achieved by firms through implementation of value creating strategy that is not being implemented by any competitors and they are unable to duplicate them or the benefits attained by the firm (Barney, 1991). Besides that, a SCA is said to be consistent when efforts by other firms to duplicate the advantage had ended (Lippman & Rumelt, 1982; Rumelt, 1984). Porter (1985) believes that a competitive advantage is sustainable when a firm is able to create and sustain a superior performance which last longer period in calendar time. A firm's generic strategy does not always lead to above average performance given that leadership change may affect firm strategy, there's a risk of differentiation and risk in losing focus of strategy structure and customer demand (Porter, 1985).

The idea of attaining SCA or let alone competitive advantage resides in firms' resources. Firms resources include all assets, capabilities, organizational processes, firm attributes, information, knowledge and the likes that are under the purview of firms (Daft, 2012) which firms utilize to galvanize its strength and implement their value creating strategies (Porter, 1981). Heterogeneity of resources is one of the aspect that determines competitive advantage and means of sustaining it. If firms possess resources that are homogenous, identical strategies are conceivable for implementation by the many firms (Hatten & Hatten, 1987). In that sense, if one firm implements a strategy that holds an advantage, it will not take long for other firms, which also possess similar resources, to conceive this strategy and implement it. This results in the pioneering firm losing its advantage as the market becomes somewhat perfectly competitive (Barney, 1991). Thus, heterogeneity of firm's resource plays a vital role in delaying and precluding other firms to duplicate and employ similar strategies. Heterogeneity of resources allows a firm to own "first-mover advantages" in which the firm is able to recognize opportunities for distinct strategies and will be the first to implement the particular strategy that enables it to gain access to distribution channels, develop good will with customers, positive reputation and the likes prior to any other firm's ability to do so hence sustain the advantages it possess (Barney, 1991; Lieberman & Montgomery, 1988).

For a facet to be considered as resources it has to be valuable. On the conservative model of strengths- weaknesses-opportunities-threats, Barney (1991) explains that valuable resources will impel firms to conceive and implement strategies that improve efficiency by exploiting opportunities and neutralizing threats in the market. Synonymous to the notion of heterogeneity, a firm's resources need to be rare or uncommon. A common resource will lead to an industry achieving competitive parity. In turn this would lead to common strategy in the market eroding advantages firms hold (Barney, 1989). One other characteristics of SCA is that a resources should be imperfectly imitable according to Lippman and Rumelt (1982).

Dierickx and Cool (1989a) provided combinations in which resources are imperfectly imitable. Wherein the ability of firm to obtain a resource is dependent upon unique historical conditions, the link between resources possessed and SCA is causally ambiguous and the advantageous resource is socially complex. Finally, a resource is considered a source of SCA when it is not easily substitutable or replaceable. This means there exist no strategically equivalent resource as this impedes possibility of other firms to implement similar strategy (Barney, 1991).

Hatch and Dyer (2004) believe human capital and learning by doing stands as a source of SCA. Amit (1986) explains that firms that are thorough in the learning curve would earn a cost advantage. This would in turn deter competitors from entering into the market given the position of the exploiting firm enjoying large sustainable cost advantage through possession of SCA (Lieberman, 1987; Spence, 1981). Lubit (2001) espoused two paths in which knowledge can create SCA which is when a firm emphasize on fostering tacit knowledge which is hard to codify and imitate and generating superior knowledge management capabilities that impels innovation. This is consistent with the Knowledge-Based View of the Firm which theorizes knowledge as a predominant key towards SCA (Grant, 1996b). Kogut and Zander (1996) and Spender (1996) views firms as distributed repositories of tacit and explicit knowledge whereby the heterogeneity of the knowledge bases would determine sustenance of competitive advantage.

Therefore, in line with Lubit's (2001) exposition of superior knowledge management capability, the ability to manage and create knowledge dynamically would lead to the attainment of SCA (Argyris, 1999; Davenport & Prusak, 1998; De Geus, 1988; Hatch & Dyer, 2004; Hayes & Allinson, 1988; Prahalad & Hamel, 1990). The ability to sustain competitive advantage resembles the aptitude of organization to withstand the turbulence brought along by forces of change hence, corroborates organizations dynamism to improvise to external or environmental shock.

2.8 Innovation Performance

The seminal description of innovation came through the work of Schumpeter in the context of economic development whereby it is defined as a new combination of productive resources (Iwai, 1984). It is defined in five elucidations which are introduction of new products, new production methods, exploration of new markets, conquering of new sources of supply and new ways of organizing business (Hidalgo & Albors, 2008).

Following this conception to innovation, the characterization had evolved to conceive diverse views such as problem-solving process (Dosi, 1982), an interactive process involving relationships between firms with different actors (Kline & Rosenberg, 1986), a diverse learning process such as learning-by-using, learning-by-doing or learning-by-sharing, internal or external sources of knowledge and the absorption capacity of firms (Cohen & Levinthal, 1990; Dodgson, 1991), a process involving the exchange of codified and tacit knowledge (Patel and Pavitt, 1994), an interactive process of learning and exchange where interdependence between actors generates an innovative system or an innovation cluster (Edquist, 1997) and related to the generation of innovative goods or services and processes (Garcia & Calantone, 2002; Rogers, 2010; Urabe, Child & Kagono, 1988; Utterback, 1994; Utterback & Afuah, 1998).

Schlegelmilch, Diamantopoulos and Kreuz (2003) explicated that innovation could be driven through internal and external context. Internal factors include senior management attitudes, marketing, information technology departments and the organization's employees. Whereas external orientation is driven by knowledge-intensive organizations (KIOs) which classifies knowledge as a principal value-adding process (Hidalgo & Albors, 2008). Stewart (1997) claims management of knowledge and human capital is an essential element in the handling of businesses regardless of types or industry. In that he mentioned, knowledge management capabilities and intellectual capitals are vital sources of innovation. Gloet and Terziovski (2004) explicate the process of innovation depends heavily on knowledge given that the power of knowledge lies in its subjectivity, underlying values and assumptions that underpin the learning process as advocated by Nonaka and Takeuchi (1995b). It is emphatically understood that the notion of innovation lies in how knowledge is being transformed into new products, processes, fulfil customer's changing needs consequently improve competitive advantage (Nyström, 1990).

In explaining how innovation relates to a firm's prevalence in competitive advantage, Carnegie and Butlin (1993) claim innovation is where something new or improved carried out by firm that significantly create value addition either directly to the firm or to the customers. Livingstone, Palich and Carini (1998) puts innovation in the perspective of new products or processes that adds or increases value such as patents, creative use of information and effective use of human resource management system. Talking about creativity, Amabile (1996) looks at innovation as a successful implementation of creative ideas by the organization. Following Thompson's (1965) definition of innovation as generation, acceptance, and implementation of new ideas, processes, products, or services, Calantone, Cavusgil and Zhao (2002) studied how learning orientation in the form of commitment, shared vision, open-mindedness and intra-organizational knowledge sharing leads to firm innovativeness and performance improvement. Learning orientation composed of the aforesaid dimensions has a significant impact on the ability of firms to generate innovation wherein firm seeks to be adept in understanding its environment, customers, competitors and technological changes. The ability to assimilate new ideas provides firms with value added resources (Hurley & Hult, 1998). In turn, enhancement in firm performance is achieved through the continuity of innovation actions that stems from learning orientation in which this feature is substantial for firms in gaining competitive advantage (Calantone et al., 2002).

Given the high intensive competition faced nowadays, firms will find it increasingly tough to compete with already existing and established companies especially new and young organizations. The continuance of competition will result in failure due to resource shortcomings, scale diseconomies, and questionable reputation. Therefore, firms should differentiate themselves from current players through improvising resources, new ways of doing things, new products and processes, different marketing strategies and the likes which means by innovating, the firm could gain and sustain competitive advantages (Lee

& Cunningham, 2001). Additionally, maintaining superior performance requires innovation through the likes of developing new capabilities which ultimately leads to continual renewal and sustenance of competitive advantages (Grant, 1996a). Grant (1996a) explained there's two propositions towards this circumstance, one, by extending existing capabilities that captures additional knowledge and two, reconfiguring existing knowledge into new types of capabilities. Distinguishing and enriching combination of resources in the course of innovation implies to value-adding resources and making them unique. This optimizes performance level which offers a competitive edge to firms. Knowledge per se may not necessarily entail innovation. Transformation and exploitation of knowledge is crucial in realizing the outcomes of innovation.

2.9 Quality Management and Sustainable Competitive Advantage

Quality in a product and services had become an important element in the eyes of both customers and manufacturers (or providers). The growth of the field of quality management is a standing proof as to why the regulation of quality within an organization is as imperative as other areas within an organization such as human resource, finance, procurement, operations and the likes. It is because quality runs through every other department as how the nature of the element is associated. Research on how quality and process improvement establishes and maintain global competitiveness had risen dramatically in parallel to the field of quality management (Flynn, Schroeder and Sakakibara, 1995; Stalk Jr & Hout, 1990) as strategic management thought moves from industry level structure to internal firm specific 'within strategic group' factors (Cool & Schendel, 1988).

Flynn et al. (1995) studied on how core quality management practices and quality management infrastructure components propell competitive advantage. By infrastrucure they implied to top management support, customer and supplier relationship, work force management and attitudes whereas core practices include product design process, process flow management and statistical control and feedback. Their postulation is that a good infrastructure would drive the core practices which results in the optimization of quality performance in the form of reduced rework and perceived quality market outcomes. These are the necessities that establishes and sustains competitive edge for firms from quality management perspective. In adressing the prominence of Total Quality Management (TQM), Powell (1995) deliberated the concept from a strategic resource perspective consequential to a source of competitive advantage. Being veiwed as a source of economic value, he debated on how philosophies such as TQM render a sustained competitive advantage to firms that employs it and those that does not. The findings of the study clarified that although technical asepects of TQM does not pose as a principal factor to the generation of competitive advantage, the intangible outcomes such as executive commitment, open organization, employee empowerment and the likes are much vital, posing as a source of tacit feature. It is perceived that TQM sets a path towards achieving this tacit nature that is inimitable, non-substitutable and value adding to firms which gains and sustains competitive advantage.

Given the paucity of theoretical underpinning in how quality management such as TQM can engender sustainable competitive advantage, Reed et al. (2000) attempted a theoretical linkage between the said's path through the use of market-based, theory of competitive advantage, resource-based theory of the firm, and systems theory. The study viewed the context of leadership and commitment, training and education, teams and culture to interpret the tacit content and how do these four components has the potential to interact to form the complexity as a resource. Through the augmentation it was deduced that such a quality framework provides cost and differentitation advantage besides the tacitness and complexity through the interaction acts as an impediment to imitation (Reed et al., 2000). This augmentation explains the importance of veiwing quality context as gestalts to achieve competitive advantage.

The immediate notion of quality management or process improvement is to lower cost, reduce reworks and errors and provide the means of consistent improvement. Lowering costs would imply to firm having a superior cost structure in the market therefore, this feature puts the firm in a defensible position, providing the firm with competitive edge (Flynn & Flynn, 1996). In another way superior cost structure adds value to customer orientation. Customer satisfaction is also one feature that is highly market driven in quality practices (Reed et al., 2000). As Day George (1990) explicates, market advantage is achieved from being market-driven, being able to differentiate products to fulfill customer demands. And adding value to it refers to differentation advantages through a higher reliability nature of the firm (Reed et al., 2000), which Hill (1988) believes consistent differentiation will lead to increased market share. Hence, differentiation acts as a component of uniqueness and inimitability. Product design efficiency on the other hand helps to add the differentiation value to customer's desires and demands by eliminating non-value adding requriements (Flynn, Schroeder and Sakakibara, 1996; Reed et al., 2000). Process efficiency through quality practice fosters a learning curve and the experience effects helps to reduce cost in the long run by managing the flow of the process (Flynn et al., 1996; Lapré, Mukherjee & Van Wassenhove, 2000; Reed et al., 2000).

Through the knowledge-based view of the firm, knowledge is increasingly viewed as a fundemental source of sustainable competitive advantage (Davenport & Prusak, 1998; Grant, 1996b). It is inevitable that quality management practies is closely linked with knowledge creation processes (Choo et al., 2007a; Linderman, Schroeder, Zaheer, Liedtke & Choo, 2004). Deming advocate on how quality management is emphatically connected to driving knowledge through the System of Profound Knowledge (Deming, 1990). Linderman et al. (2004) explained how quality practices leads to knowledge creation through Nonaka's theory of knowledge creation consequentially effecting firm performance. The use of quality practices enhances socialization process where transference of knowledge takes place, ceating a pool of information where employees learn internally from each other and externally from customers, suppliers and changing market needs. Mukherjee, Lapré and Van Wassenhove (1998) also augmented further that quality improvement is highly knowledge driven. Their research delineated on the importance of conceptual and operational learning in quality improvement endevours that plays a crucial role in achieving goals, creating new technological kowledge and changing employees' attention. The authors construed learning patterns codifies knowledge which enhances the dissemination for present and future use for the organization. Learning and knowledge creation exposes opportunities and highlights threats in the environment besides understanding the internal weaknesses in existent. Consequentially, this galvanize firms to exploit the opportunities by responding to the threats in the market.

These essentials of quality management practices, as demostrated reveals how it manages to establish and sustain competitive advantages whereby enabling firms to gain unique, valuable, inimitable and non-substitutable features through tacit and explicit interfaces.

2.10 Quality Management and Innovation Performance

Articulation on the relationship between the implementation of quality management practices and innovation had surged with great interest lately in lieu to the challenging business environment (Abrunhosa & Sa, 2008; Hoang, Igel & Laosirihongthong, 2006; Martínez-Costa & Martínez-Lorente, 2008; Prajogo & Sohal, 2004). Godfrey (1996) enlightened that creativity, innovation and quality are interrelated. He mentioned that creativity and innovation are related to change. Quality management or process improvement are associated with continuous improvement which facilitates change. Godfrey (1996) posits quality management could be used to grow business, expand, explore new horizons and new directions. Some of the factors that leads to idea creation, creativity and innovation through quality management includes opening the doors for ideas from all level of employees, use of brainstorming tools and techniques to spur ideas for innovation, compile ideas through vendors and understand the voice of customers on their desires on product or services, facilitate a suggestion system that actively support idea implementation and train employee for creativity. Leadership from quality management could also create a vision for idea flows. Besides, quality improvement are team driven which provides basis for teamwork in resolving problems creatively (Godfrey, 1996).

Schroeder and Robinson (1991) explained continuous improvement programs through quality management unleashes employee experience and creativity in improving product, services and processes. This is due to the fact that continuous improvement efforts are channeled through efficient coordinating mechanisms to gather, evaluate, implement and reward improvement ideas. Using a structural equation modelling method, Hoang et al. (2006) investigated the relationship between TQM and innovation performance in the Vietnam industry. It was discovered that TQM’s quality practices such as leadership and people management, process and strategic management, and open organization has a positive impact on firm’s innovation performance. The authors recommended that firm’s intending to enhance business performance could utilize quality practices which supports firm's product and services innovation efforts as well. Prajogo and Sohal (2003) carried out a survey of 194 managers in the Australian industry to corroborate the relationship between TQM and innovation performance wherein they found achieving quality performance resulting from quality practices propels the realization of innovation performance.

Through the perspective of resource-based view of the firm, Camisón and Puig-Denia (2016) outlined 6 competing models, examining the relativeness of quality management practices (QMP) on process innovation performance with the mediating role of dynamic capabilities on 550 Spanish industrial companies. Their findings submitted that QMP implementation does not have a direct impact on process innovation performance however it is triggered through dynamic capabilities such as learning and technological capabilities which completely mediates this relationship. Consequently, they proposed that QMP needs to enhance and develop dynamic capabilities in order to achieve improvement and transformation in the context of innovation.

Organizations have a knack of transpiring innovation through continuous improvement efforts. Toyota is one organization that is renowned for continuous improvement success through their Lean or Toyota Production System. Toyota have a structure in place to encourage and stimulate ideas among all level of its employees known as Toyota's Creative Idea Suggestion System where it inspired 20 over million ideas in 40 years (Lee, 1992). Schroeder and Robinson (1991) assented that cumulative effect of successive incremental improvements and modification in products and processes can have a substantial impact in organizations and may lead to technological breakthroughs. Bon and Mustafa (2013) conceptualized a framework underlining TQM practices such as top management leadership, employee involvement, employee empowerment, customer focus, training, information analysis, and continuous improvement and how they relate to innovation in the context of products, process and administration.

Flynn, Schroeder and Sakakibara (1994) submitted quality foundation and a quality oriented organizational infrastructure such as human resource management, Just-in-time, and organizational characteristics that are parallel to elements of world class manufacturing supports fast product innovation which yields firms competitive advantage. Similarly, Kim, Kumar and Kumar (2012) scrutinized the relationship between quality management practices and five types of innovation namely radical product, radical process, incremental product, incremental process, and administrative innovation. They found process management to be significantly and positively related to incremental, radical, and administrative innovation, concluding that capability of organizations to manage processes is imperative in streamlining routines, establishing a learning base and supporting innovative activities. The authors clarified that the value of an individual quality management practice is linked to other quality management practices. They emphasized quality management practices should be used as a gestalt to garner creative problem solving and innovation (Kim et al., 2012).

2.11 Lean and Knowledge

One of the many renowned operations management system that results in greater efficiency in ways of work and management is Lean. As indisputably recognized by quality practitioners everywhere the roots of Lean budded from Toyota Production System (TPS) (Hino, 2006; Liker, 2004). At first it was known that Lean is applicable for manufacturing per se as the techniques and concepts are largely production oriented. However, even in manufacturing the implementation of Lean does vary across different manufacturing settings due to contextual differences (De Treville & Antonakis, 2006). As the debate for Lean application for context specific goes along, Shah et al. (2008) provided justification as to why the implementation of Lean in services context is equally promising as to that of manufacturing. Following this consensus many organizations had started to apply Lean in knowledge works wherein raw material involves the use of information rather than physical goods (Poppendieck & Poppendieck, 2003; Schutta, 2006; Staats, Brunner & Upton, 2011). Knowledge as per Garud (1997) is divided into "Know-Whats", "Know-Hows" and "Know-Whys". Researchers and schools of thought is understood to be expressive on the importance of Know-How transfers in which knowledge assimilation tends to happen through a knowledge sharing network that involves social or socio-technical interactions (Cohen & Levinthal, 1990; Marsden, 1990; Szulanski, 1996; Von Hippel, 1988).

Dombrowski, Mielke and Engel (2012) explained that many companies failed in implementing Lean because of their isolated approaches of executing the tools and techniques alone rather than a holistic approach which involves people as they stressed a seminal change need to be infused in people's knowledge. Dombrowski and Crespo (2008) provided a roadmap on the implementation of Lean which is staggered into four phases. Basic planning is centralized in which awareness of the philosophy is emphasized, assessment of strategic planning, conceptual design and master plan for execution is conducted. In the second phase the organizational changes kick off with detailed planning. Thereafter a completed rollout of the plan and continuous improvement will assume phase three and four respectively. Liker and Convis (2011) elucidated the failure of Lean implementation of companies due to Tayloristic imprints wherein knowledge and workers are separated whereby the latter is obliged to work on the system developed by the management. They justly went on to claim that such a method should be casted-off as information distribution is crucial and Lean could only work when its methods and tools are deeply understood by all relevant personnel.

Following Zhuge (2006) knowledge flow network, it was concluded that Lean implementation involves many possible knowledge flows (Dombrowski et al., 2012). Evidently this befitted a classification wherein Lean and knowledge are highly interconnected. Skogmalm (2015) studied about knowledge management within Volvo Cars as one of a Lean organization from the viewpoints of knowledge management and learning organization. The study found that there are many ways in which Lean can be used to apply knowledge management and information sharing since advantageous information are gathered in strategic ways. Skogmalm acclaimed that with Lean new knowledge is created through problem solving and disseminated throughout organizations, through which knowledge management facets comes into play. Solutions through Lean had freed up time for employees at Volvo and a culture to improve further by thinking creatively involves searching for knowledge and to look for improved actions from time to time.

This have increase synchronization between operational and strategic level of the company corresponding to a high level of knowledge sharing within the organization in improving and improvising the company's routines (Skogmalm, 2015). Besides knowledge management, concerns on how Lean philosophy regulate knowledge transfer and knowledge creation had been documented. Tyagi et al. (2015) studied on how Lean thinking affect knowledge creation in which they explain the effects of ten Lean tools supporting the knowledge creation process. Lindlöf, Söderberg and Persson (2013) on the other hand took on a research which enlightened how three specific Lean tools had a significant influence on knowledge transfer process in product development. The many evidence stating how Lean is connected with knowledge can be clarified through the theory of organizational knowledge creation by Professor Ikujiro Nonaka (Nonaka, 1994; Nonaka, Toyama & Konno, 2000; Takeuchi & Nonaka, 2001). Nonaka (1994) enlightened that knowledge of an organization is created through modes known as 'Ba' which are in four modes; Socialization, Externalization, Combination and Internalization (SECI).

2.12 Lean and Absorptive Capacity

One other school of thought of knowledge that is correspondingly dynamic and closely knitted to performance and operations management is absorptive capacity. As aforementioned, absorptive capacity is the ability of firms to recognize the value of new, external information, assimilate it and apply to business and commercial needs (Cohen & Levinthal, 1990). Zahra and George (2002) reconceptualized the view of absorptive capacity in which they acclaimed it as a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability. This definition is much relevant to the nature of process improvement philosophies like Lean. This version of absorptive capacity refers to the ability of companies to change routines or processes to fit into business needs, which concepts like Lean operationalizes on. Talking about dynamism in capability, Teece et al. (1997) said it best in which it relates to the ability of firm to continually learn, adapt and upgrade its capabilities is key to competitive success. Dyer and Nobeoka (2000) research on how Toyota, the predecessor of Lean, facilitates inter-organizational learning, knowledge transfer and sharing which explains this dynamism is one study that explicates the connections overtly.

Toyota as part of their production system established such network amongst the supply chain network known as 'Kyohokai' which purpose is for information exchange, mutual development and training between member companies and socialization (Dyer & Hatch, 2004). The network reportedly increased knowledge base subsequently triggering the absorptive capacity of the member companies which formed a set of nested networks (Dyer & Nobeoka, 2000). According to Dyer and Nobeoka (2000) this inevitably facilitated the transfer of explicit and tacit knowledge. There are two levels of meetings under this network one being general assembly meeting where explicit knowledge is shared through production plans, policies and market trends and the other is the topic committee meeting where cost, quality, safety and social activities are discussed in detail in which transfer of tacit knowledge among the parties tend to happen (Dyer & Hatch, 2004). The ability of Toyota in operationalizing the TPS to create a network of learning through problem solving groups alike which facilitate transfer of their best practice knowledge depicts the inherent idea of not only to acquire and assimilate those knowledge (potential absorptive capacity) among member firms but to realize perceptible benefits by transforming those knowledges and exploiting them (realized absorptive capacity) in operations and management. This is vindicated through a colossal rise in labor productivity by Toyota and its suppliers by approximately 700% between 1965 and 1992 (Dyer & Hatch, 2004).

Given the complexity of Lean transitions, many company tend to hire consultants in implementing it (Dombrowski et al., 2012). It was therefore subsumed that Lean is crucial for the identification, acquisition, development, transfer, application and preservation of knowledge or in technical terms these are known to be the fundamentals of knowledge management (Dombrowski, Schmidt & Crespo, 2007). This gave rise to the facet of knowledge flows in Lean implementation.

MacDuffie and Helper (1997) research on Honda's BP program is one other example which explicates Lean production techniques inciting absorptive capacity. The BP teams are technically cross-functional as it involves members from various departments and levels in the suppliers' organization to ensure richness and diversity of perspective. The rationale behind this correspond to one of their goal which is to encourage new and fresh thoughts therefore supplementing already existing ideas (MacDuffie & Helper, 1997). Here, an already existing knowledge regardless of its level is being supplemented with additional ones reflecting an incremental effect in the suppliers' potential absorptive capacity. Additionally, Honda's agreement with its suppliers to move freely about the suppliers' production facility and access to information and technology enables both parties to leverage on the knowledge pool and convey them into production techniques by realizing the absorptive capacity. Boeing and Airbus' emphasis on Lean supply chain network by collaborating with their partners in designing, development, production and after-market support to transfer, accumulate and assimilate knowledge of processes displays the ability of Lean oriented companies to possess the traits of absorptive capacity and leverage towards innovating their performances through the information sharing that takes place (Horng, 2006).

In defining social interaction patterns through learning within subsidiaries, Hotho, Becker-Ritterspach and Saka-Helmhout (2012) defined how Lean implementation could enhance capability of organization units to acquire, absorb and transform the knowledge gained for performance enhancement. Their study found the greater strength in Lean implementation lies in having strong social cohesions and frequently sustained interaction that accommodates knowledge transfer activities. In analyzing the impact of Lean manufacturing and management, Lis and Sudolska (2015) submitted how Frauenthal Automotive Toruń in Poland influenced absorptive capacity in dual dimension of potential and realized absorptive capacity. The researchers found that the firm was particularly good in intra-organizational knowledge transfer among the employees as they coherently recognize and acquire new external knowledge according to changes. Program such as Lean management enabled a conducive environment for intra and inter-organizational learning through a wide spectrum of activities related to potential and realized absorptive capacity. The firm developed a good IT infrastructure supporting knowledge management known as Frauenthalpedia and Management Planet and a good relational capital with suppliers, customers and higher education institutions in its ability to absorb knowledge.

Through a consistent improvement effort via Lean, it is believed to impel the need for firms to move into learning and interacting or more so to socialize with partners or stakeholders that could provide them relevant knowledge, incidentally enhancing their capacity to perform and innovate indefinitely. As knowledge becomes stagnated and sticky to a certain extent whereby moving beyond a point becomes a hardship. The need to search for knowledge beyond their internal precincts becomes a necessity. In order to break this chain, is where absorptive capacity becomes pivotal in the continuing efforts to maintain and stretch improvements.

2.13 The Association between Lean, Innovation Performance and Sustainable Competitive Advantage

Urabe et al. (1988) defined innovation as generation of a new idea and the manner of implementing it into a new product, process or services. As researches shown, Lean has what it takes to transform organization into an open and proactive culture that impel organizational learning and innovation (Bhasin, 2011; Dahlgaard & Dahlgaard-Park, 2006; Johnstone, Pairaudeau & Pettersson, 2011). Todorova and Durisin (2007) claim that assimilation and accommodation of new knowledge in new or existing schemata would lead to innovation. In order to achieve a magnificent knowledge network, Toyota was believed to institutionalize innovation through supplier network, in-house knowledge transfer consultants and small learning groups known as *Jishuken* (Dyer & Nobeoka, 2000). As many perceived that Lean is only an improvement method, they failed to see the extent of the concept and what it brings about.

This of course is in lieu to the fact that Lean is highly regarded as an improvement method adopted to bring about operational and organizational related success. It is why many research has greater tendency to associate Lean to a dependent variable that points out to organizational performance (Anand & Kodali, 2009; Bhasin, 2011; Bonavia & Marin-Garcia, 2011; Fadly Habidin & Mohd Yusof, 2013; Keitany & Riwo-Abudho, 2014; Shah & Ward, 2003; Stone, 2012; Verrier, Rose, Caillaud & Remita, 2014; Yang, Hong & Modi, 2011), operational performance (Anvari, Zulkifli, Yusuff, Hojjati & Ismail, 2011; Chavez, Gimenez, Fynes, Wiengarten & Yu, 2013; Eroglu & Hofer, 2011; Fullerton & McWatters, 2001; Rahman, Laosirihongthong & Sohal, 2010; Shah & Ward, 2003; Uhrin, Bruque-Cámara, & Moyano-Fuentes, 2017; Wickramasinghe et al., 2017), financial performance (Christopher & Towill, 2000; Claycomb, Germain & Dröge, 1999; Fullerton, McWatters & Fawson, 2003; Fullerton & Wempe, 2009), market performance (Eroglu & Hofer, 2011; Losonci & Demeter, 2013; Tu et al., 2006), environmental performance (King & Lenox, 2001a; Melnyk, Sroufe & Calantone, 2003; Rothenberg, Pil & Maxwell, 2001; Sroufe, 2003) and the likes.

Seldom has it been referred by authors that Lean could affect far reaching impact such as innovation and sustenance of competitive advantage. The rationale behind this is due to the fact that improvements implemented would bring about optimistic changes to the processes subsequently to the organization. However, Lean emphasizes on continuous improvement wherein, in order to sustain the success, the organization need to keep developing products or services that meets customer's requirement and find ways to suit the gaps deemed necessary to that requirements. In other words, the improvements need to keep on going. In order to achieve this consistency, the organization needs to create new ways of producing products, providing services or even the manner of executing a process. This is where the catalyst towards creativity and innovation kicks in. Sehested and Sonnenberg (2010) expounded on this notion from the perspective of Lean innovation. They believe Lean innovation enables a firm to 'do the right things', 'do things right' and 'do it better all the time'. In explaining the necessity for Lean innovation, they debated that market opportunities quickly arise, competition tends to increase, new collaborative networks and customer groups develop frequently. This compels firm to possess strategic agility in order to stay ahead in the market and strategies need to be quickly transformed into actions. This puts pressure to develop fast innovation process where the strategic combination of Lean plays a vital role (Sehested & Sonnenberg, 2010).

Through an appropriate practice of the Lean philosophy, organizations are mulled to bring in new products or services to the market in order to cater customer's requirement.

When the demands in the market or customer needs are deemed to be new and fresh, a firm need to accelerate the process of catering to this opportunity which delivers a competitive edge to that firm. Being a renowned Lean company, Toyota is regarded as superior in terms of speed to market products and ensure product freshness. For instance, the duration from styling freeze or new design and start of production of a car would require only between 12 to 15 months versus 20 to 30 months to that of competitors (Liker & Morgan, 2006). According to Fine, Hansen and Roggenhofer (2008) an organization that has Lean experts or leaders does not only possess skills such as high concentration, root cause problem solving, clear expectations, aligned strategy, purposefulness and supports their people but they also encourage new ideas for improvement and working.

Without waste in the production process and being rather flexible (MacDuffie, 1995), Lean organization are able to change production method or service provisions at relatively greater speed. As with competencies being valued apart from the hard practices, people become an integral part of a Lean company (Liker, 2004). Therefore, management approach of Lean is regarded as combination of hard and soft practice which has a succinct impact towards operational and organizational elements that are considered rather innovative. In other words, reconfiguring and strategizing resources in such a way that leverage market information and internal competencies, transforming it into operational routine creates the novelty in firm's outcome and combination of resources that are exclusive.

Gong and Janssen (2015) studied Lean from the viewpoint of service innovation in the banking sector leading to formulation of a framework to analyze the benefits and risks of Lean innovation. Components of the framework which included "creating value to customer" and "flow and pull" reflected the techniques used to design processes within the bank to create value-adding process. Whereas "think systematically" and "continuous improvement" emphasizes on the streamline of thought in Lean where communications and management are internally driven towards a value adding scale. Using Knowledge Based View of the Firm (KBV) as the basis for the framework the authors identified that Lean is coordinated through two critical knowledge-based process which are knowledge accessing and knowledge integration (Gong & Janssen, 2015). Johnstone et al. (2011) believe that Lean could instigate new ideas and creation of knowledge through its plenty analyses like root cause and problem solving techniques that are constructive however one should note the human side to them which creates commitment, engagement, autonomous, flexibility and self-confidence. These aspects of hard and soft measures leads to innovation through knowledge seeking process. Plsek (2013) claimed in order to stimulate innovative thinking through Lean, a culture that views it as a form of continuous process need to be fostered.

Lewis (2000) provided an insightful explanation on the relationship between Lean and sustainable competitive advantage. It was stated that with Lean, firms increase its overall effectiveness in converting resource inputs into outputs which lowers relative costs consequently improving overall business performance. Continuous improvement approach enables fast and flexible change in processes therefore impels swift change in products or services according to changes in the external environment. This creates an ability to leverage market knowledge. Lewis (2000) mentioned that unique internal resources such as this are equally important to external market factors which creates competitive advantages, given its capacity to create effective barriers to imitation. Besides, such process, products and services that arise from it adds value to customer's necessities.

In addition to increasing productivity efficiency, improving firm financial position by enlarging profit margin and lowering of cost, Lean also impels learning in organization. Given Lean's enactment of resources to create and add value to processes, products and services, it provides firms with sustainable competitive advantage provided the productivity savings from continuous improvement are appropriated to fuel the resource capabilities and differentiation. Lewis (2000) summarized that implementation of Lean in organizational processes can form strategic resources that underpins sustainable competitive advantage.

As Lean focuses on adding value to customers, focus is placed on identifying and satisfying their demands and desires. This propels the creation of strategic combination of resources that offers novel process, management and product or services. To achieve this, information and knowledge in relation to the demands in the market need to be acquired and assimilated to the existing knowledge base of the organization in order to understand those necessities and delineate the feasibility of those knowledge. To transpire the demands and desires, those knowledge need to be transformed and exploited into the processes, products or services. As Lis and Sudolska (2015) propagated in their case study of Frauenthal Automotive Toruń, through implementations like Lean management and their ability to recognize valuable external knowledge, enable firms to realize their prospective to innovation and competitive edge.

Collis and Montgomery (1995) asserted Lean principles are based on organizational resources, embedded in culture, routine and processes of a company. Given this facet, firms are able to differentiate themselves continually which functions as a source of competitive advantage. Prahalad and Hamel (1990) believe the ability to improve existing skills and learn new ones is the most defensible competitive advantage since to remain competitive throughout time, firms need to continually adapt (Hamel & Prahalad, 1994). In Crute, Wickham, Johns and Graves' (2008) case study of the aerospace industry, interviews with firms revealed Lean craft a learning curve in such a way competitors may always be behind the first movers' improvement. However, another interview response from the study disclosed improvement advantage only leads to competitive advantage if the producer recycles the profits earned through higher margins into delivery attributes that adds value in the market. It is proposed to induce Lean as a sustainable source of competitive advantage, firms need to ascertain adequate resources to maintain the momentum of continuous improvement efforts (Crute et al., 2008). Therefore, innovation in performance via Lean comes as a by-product more than a direct relationship.

2.14 Six Sigma and Knowledge

Since the days of its evolution, Six Sigma is known to many as a rigorous and structured quality methodology or principle created by Motorola (Pande et al., 2000; Pyzdek, 2003). Quality methods traditionally used to be researched in the context of learning (Fine, 1986), is now been heavily studied in the context of knowledge (Linderman et al., 2004; Molina, Lloréns-Montes & Ruiz-Moreno, 2007). As the literatures and theories largely suggest, the constituents of learning and knowledge and all that is in relevance to it are interconnected.

The development of Six Sigma methodology involves the characteristics of logical element in problem solving behavior. The DMAIC was established through a combination of scientific experimentation using sequential logic filters for problem solving following Mikel Harry's, doctoral research combined with Perez-Wilson (1989) study on machine and process controls (Watson & DeYong, 2010). The method used a scientific based variable reduction through logical filters; recognition, classification, analysis and control (Harry, 1985). Given the logical nature of the methodology, Six Sigma was highly regarded as a knowledge based approach with a high target on goals (Linderman et al., 2003). Scott (1987) explain that improvement efforts are guided by knowledge and motivation, in which without the former improvements are rather incidental. Linderman et al. (2003) elaborated that Six Sigma cultivates intentional learning compared to implicit learning through which creation of knowledge occurs.

Further they mentioned that high improvement goals motivate members to engage in intentional learning to achieve the targets set.

The training procedure of Six Sigma is on an alternate basis. Whereby every phase's training will be followed by application of the concepts in improvement projects. This process does not only promote declarative knowledge but also procedural knowledge in that participants or project leaders would acquire the know-hows of what is learnt (Linderman et al., 2003). Anand et al. (2010) studied the role of tacit and explicit knowledge in how it impacts differential Six Sigma project success. Their research results support both type of knowledge positively relating to project success of Six Sigma. Both technically oriented knowledge through explicit content and socially oriented knowledge which is tacit content has a significant impact however it was noticed that tacit knowledge explains greater variance in project success. This explains the need for more tacit knowledge acquisition to gain project success.

Sin et al. (2015) studied how Six Sigma's DMAIC methodology fosters knowledge creation through Nonaka and Takeuchi (1995b) organizational knowledge creation theory. The theory which explicates the creation of knowledge through modes of spiral movement as it creates an interaction between tacit and explicit knowledge from individual to organizational level resulting in knowledge of the organization. These modes known as SECI was articulated by Sin et al. (2015) to be prevalent in the DMAIC phases of Six Sigma. The authors went on to validate a conceptual model whereby the SECI modes which is inherent in the DMAIC phases creating knowledge which subsequently has a positive relationship with Six Sigma project success. Six Sigma project success consequently brings about a positive outcome in organizational performance (Sin et al., 2015).

Gowen, Stock and McFadden (2008) studied the relevance of knowledge management and implementation of Six Sigma. Ensuing their research in hospital backgrounds, they found knowledge management expressively enhances success of Six Sigma initiatives citing the importance of knowledge management in the implementation of the concept. Choo et al. (2007a) deliberated on how structured method and psychological safety in a Six Sigma project affects knowledge creation and learning behaviors subsequently project performance. It was found that structured method impels learning behavior whereas psychological safety induces knowledge creation. The path to project performance from structured method and psychological safety were both significant with learning behavior mediating structured method and performance and structure method with knowledge creation.

2.15 The Association between Six Sigma and Absorptive Capacity

As the emphasize of Six Sigma with knowledge are a plenty, with absorptive capacity there are a number of articulations to it as well given the nature of absorptive capacity is focused on recognizing new, external information, assimilating it, and apply it to organizational routines for beneficial ends (Cohen & Levinthal, 1990).

With an eclectic range of theories being applied to understand and describe the underpinnings of Six Sigma, McAdam and Hazlett (2010) compile peer-reviewed studies to explain the dynamics of Six Sigma from an absorptive capacity perspective from its multidimensional view of acquisition, assimilation, transformation and exploitation of Six Sigma as a new external knowledge. The authors found that Six Sigma has been described in multiple theoretical underpinnings such as goal setting theory, motivation theory, agency theory and the likes. However, it contains dynamism in terms of its capability to explain a whole range of organizational phenomenon. Thus viewing the concept from absorptive capacity point of view acts as an overarching framework to explain business process improvement and change management effort of an organization.

Gutiérrez et al. (2012) studied the effects of Six Sigma teamwork and process management on absorptive capacity and how does that relate to learning orientation within organizations. The study conducted in Europe which yielded a total of 58 firms of multiple industries were analyzed using EQS-SEM wherein the results showed a positive relationship between teamwork and process management on absorptive capacity. This then successfully impacted on organization's learning orientation thus validating the research framework of the authors. In this study, the authors opted for classification of absorptive capacity as per Zahra and George (2002).

While Six Sigma use teams as a systematic element in process improvement efforts, Jansen et al. (2005) explain that teams utilize lateral communication mechanisms that facilitates knowledge flow across functional borders and increasing interaction between areas. This enables communication for knowledge acquisition and assimilation and the interfaces allows for transforming the recently acquired knowledge and existing ones before putting them into use (Gutiérrez et al., 2012). Research had advocated that cross-functional interfaces assist in integrating bodies of knowledge which then can pave the way for new routine generation (Daft & Lengel, 1986).

As Park, Ntuen and Park (2009) elucidated, Six Sigma involves a lot of activities pertaining to knowledge management. Teams of Six Sigma are frequently involved in creation, capture, storage and sharing of information throughout the DMAIC cycle. One other trait of Six Sigma is the belt system (Pande & Holpp, 2002). Zu et al. (2008) identifies this as role structure in which an organization with Six Sigma deployment have a parallel-meso structure (Schroeder et al., 2008) in addition to its typical organizational structure. This structure is filled with roles like "Champions", "Sponsors", Master Black Belts", "Black Belts", "Green Belts" and Yellow Belts" (Choo et al., 2007a; Pande et al., 2000; Pyzdek, 2003). These are technically leaders of project and important personnel that acts as stakeholders to Six Sigma projects. In the words of Senge (1999), positions like these creates recognition in fostering collective desire to learn. De Mast (2006) puts this state as better use of existing knowledge in the organization besides the role structure or belt system acting as a guidance in learning activities (Choo et al., 2007a; Wiklund & Wiklund, 2002). This ensures a reliable source of potential capacity to absorb knowledge meanwhile shaping the mind-set of project leaders and team members in achieving strategic project targets. This provides necessary resources to transform and exploit solutions.

Gutiérrez et al. (2012) explains that such a leadership platform should be used to facilitate absorption of knowledge. Without a doubt, a leadership that allows for cross-functional environment would support high level interaction across divisions, departments, branches, subsidiaries or even external stakeholders of a business such as suppliers and customers. This cross functional communication would facilitate external knowledge acquisition and assimilation. The ability to use this information in Six Sigma project would render realization of the absorbed knowledge through transformation and exploitation of the knowledge for sake of improvement.

"Homophily" or the "*degree which two or more individuals who interact are similar in certain attributes*" (Rogers, 2010, p. 18-19) may also determine absorptive capacity. Gupta and Govindarajan (2000) illuminated on the importance of work unit similarity as an antecedent of absorptive capacity. A Six Sigma company would possess the feature of common language in which they talk in the language of Six Sigma through the use of metrics and statistics such as sigma level, CpK level (process capability index), DPMO (Defect per million opportunity) and the likes (Pande et al., 2000; Pyzdek, 2003). Gutiérrez Gutiérrez, Lloréns-Montes and Bustinza Sánchez (2009) corroborated the degree of Six Sigma teamwork facilitates shared vision among members of the team. This commonality provides an edge in the ability or capacity to absorb knowledge, thus imparting potential absorptive capacity. Besides that, the high target on goal ensures Six

Sigma team to put incisive efforts to achieve the goals. This greater targets would then impel Six Sigma team members to utilize their knowledge base and transform necessary knowledge in achieving the goals by means of exploitation. Specifying objective in the projects will drive team members to focus on potential and useful knowledge (Huber, 1991; Nonaka, 1994). This implies to the notion that greater goals motivate Six Sigma teams to learn and create knowledge which also means that they should concurrently develop the ability to absorb knowledge as it is interactively oriented (Gutiérrez et al., 2012).

Given the very nature of Six Sigma involving a high degree of organizational learning through problem-solving activities, Kim (1998) believes these are momentous traits of absorptive capacity. Correspondingly, Yusr and Othman (2011) believes that those features which enables problem-solving skills through special structure, tools and programs are main requirements of absorptive capacity to flourish. It does not only enhance their knowledge base through increasing potential absorptive capacity but also by realizing it when it is used to find solutions and clarification in Six Sigma project executions. All the communication establishment within the framework of Six Sigma points to the importance of socialization within and beyond organizations to acquire knowledge. Hotho et al. (2012) consider these social interaction promotes characteristics of absorptive capacity, which in the form of dimensions, refers to potential absorptive capacity. In SMEs, McAdam, Antony, Kumar and Hazlett (2014) found that implementation of Six Sigma is influenced by a series of recursive routines that creates a key construct of knowledge source for firms to acquire, assimilate, transform and exploit those knowledge for improvement purposes.

2.16 The Association between Six Sigma, Innovation Performance and Sustainable Competitive Advantage

Six Sigma is highly acclaimed for its success in delivering quality process and achieving high stringent goals. Many had researched on the ability of Six Sigma in impacting performance outcomes for instance organizational performance (Hammer, 2002; Lee, 2002; LeMahieu, Nordstrum & Cudney, 2017; Schroeder et al., 2008; Sin et al., 2015; Zu et al., 2008), financial performance (Ayeni, 2003; Pande et al., 2000; Shah & Shrivastava, 2013; Zamri et al., 2013) corporate competitiveness (Choi, Kim, Leem, Lee & Hong, 2012; Lee & Choi, 2006; Shafer & Moeller, 2012) and the likes. Some argue that process improvement endeavors such as Six Sigma does not facilitate innovation instead truncates them (Benner & Tushman, 2003; Pyzdek, 2003) which some refers to this as the Six Sigma-Innovation Paradox (Sony & Naik, 2012). While some believe that Six Sigma, if applied appropriately could convey innovation outcomes (Antony et al., 2016; Azis & Osada, 2010; Hoerl & Gardner, 2010; Johnson & Swisher, 2003). Therefore, it is necessary to understand how innovation within organizations are achieved through the implementation of management strategies such as Six Sigma hence imparting sustainability in competitive advantage.

Parast (2011) provided several propositions on how Six Sigma projects may have an impact on innovation and firm performance. It was proposed that Six Sigma has a positive influence on customer satisfaction and incremental innovation however, it has a bi-polar effect on radical innovation in which it delivers innovation for existing customer but impedes for new customers. Mo Yang, Seok Choi, Jin Park, Soo Suh and Chae (2007) described how Samsung collaborated Supply Chain Management (SCM) and Six Sigma to form a new management method with the intention of driving process innovation. Six Sigma was regarded as management innovation in Samsung as they aim to cultivate SCM talents which empowered two important enablers, group's management innovation and global operations growth. The conglomerate's SCM Six Sigma Black Belt program and projects successfully produced high qualified and talented specialist who went on to train the methodology to other members and divisions therefore enabling a knowledge transfer where other areas of the corporation will be able to absorb the expertise (Mo Yang et al., 2007).

Using a causal relationship diagram Azis and Osada (2010) illuminated how Six Sigma harmonizes and synergize people and processes through clear links among critical factors of the philosophy which they believe is a vibrant factor to spur innovation. Using Osada's management system model they laid the relevant driver, enabler and performance elements of Six Sigma. It is held that Six Sigma directs organization's way and enhances the management of strategic projects. Two positive causal loops were identified where one related to financial performance and another related to cultural value change. These loops were imperative in promoting incremental innovation in management system (Azis & Osada, 2010). Marash (2000) explicated the philosophy behind Six Sigma in which people, process, design and management systems coalesce in a systematic mode to that is truly innovative. This combination of resources points out a competitive edge a firm achieve from a resource based-view perspective.

Vest and Gamm (2009) in studying the American healthcare system described Six Sigma as a transformational strategy. Transformation requires a visionary strategy which when incorporated into the organization will develop its capabilities (Nutt & Backoff, 1997). Therefore, transformation strategy like Six Sigma enables a firm to adopt innovation by scanning the industrial environment for new information, knowledge, practice and assets (Vest & Gamm, 2009). Besides that, transformation strategies in time may evoke a culture within the organization in the way things are done. Stock, McFadden and Gowen (2007) explains how organization culture is a precursor of more innovations to come as it sets the baseline for the behavioral aspects of an organization determining the next course of action. Sony and Naik (2012) studied how Six Sigma impart administrative and technical innovation within organization through organizational learning process which involves a commitment to learning, a shared vision and open-mindedness. The learning processes infused by Six Sigma enables employees to reach out in search of new information and knowledge sources to deliver new methods and ways of doing things that innovates administrative and technical capacity of the organization.

Six Sigma is known to many as a rigorous process improvement approach that places high and challenging quality goals. The primary and immediate outcome that it seeks for, as many believe, are to increase customer satisfaction through product, services and process quality improvement and lowering of cost of poor quality (COPQ) (Gryna, 2001; Reed et al., 2000). These achievements are related to high and concentrated effort such as ten folded improvement (Breyfogle III, 2003; Linderman et al., 2003; Schroeder et al., 2008). Morgan and Piercy (1996) claimed superior quality does not automatically relate to sustainable competitive advantages as they suggest quality improvement should be integrated and made dependent on organization's competitive strategy.

De Mast (2006) study on Six Sigma and competitive advantage enlightened that using Six Sigma by the book alone allows for improvement in operational efficiency and effectiveness (OEE). Through OEE, processes deliver value to customers and improved cost structure to organizations. However, having OEE only keeps the organization in the race of competition through continuous improvement and has a minimal influence towards competitive advantage. Mast argues that through Six Sigma projects, firms avoid competitive disadvantage. He went on to claim that Six Sigma offers skills and capabilities that management can use to spur competencies that are hard to imitate by competitors. And when these competencies are befitted into the company's competitive strategies, it enhances sustainability in competitive advantages.

Effective creation and utilization of knowledge is a predominant competency which through role structure or belt system, Six Sigma facilitates people at all levels within the company to learn how their processes work and capitalize on this core capability (De Mast, 2006). With an organizational structure that is dedicated with agents (Champions, Black and Green Belters) Six Sigma kindles a culture of investigative and experimental learning which according to De Mast (2006) offers three competitive strategies; overall cost of leadership, product differentiation and focus on strategy. According to Teece et al. (1997) these aforementioned competencies enable a superior coordination and integration of processes, learning and reconfiguration and transfiguration. All of which are sources of competitive advantage. These features through Six Sigma could dynamically reinvent strategies and business models to better suit the changes in business environment (De Mast, 2006).

General Electric for instance had initiated a program called "Work Out" through its Six Sigma initiative where it adopted a "boundaryless behavior", a culture with a hunger to learn, pursuing best ideas, quick to tap into ideas and engaging every mind in the company (Amernic, Craig & Tourish, 2007; Henderson & Evans, 2000; Kerr & Ulrich, 1995). This learning ability, parallel to knowledge based-view notion, captures the company with unsurmountable and sustainable competitive advantage (De Mast, 2006). Anbari (2002) elucidated integration of process knowledge with statistics, engineering and project management allowed many organizations to sustain their competitive advantage. Choi et al. (2012) study revealed Six Sigma in Samsung Group revitalized process management in addition to improved quality which drive the competitiveness of the corporation.

2.17 Summary of the Chapter

The literature review provided valuable insights on the Lean Six Sigma phenomenon along with the studies done worldwide. The review showed abundant studies done on Lean Six Sigma and its relevant impact to organizational outcome. However, the impact on far reaching prospects such as innovation and sustained competitive advantage has just begun to take pace in parallel to the increase of competition in global industries. Nevertheless, it was noted that there is limited research on how the application of Lean Six Sigma leads to the accomplishment of the aforesaid prospects and how does the phenomenon unfolds. Correspondingly the review also found dynamic capabilities, absorptive capacity and the resource-based view of the firm are useful theories in explaining this phenomenon. Based on these theories, Lean Six Sigma can be viewed as a source of dynamic capability through its compilation of idiosyncrasies. Absorptive capacity is also known as a form of dynamic capability (Zahra & George, 2002), wherein from this viewpoint, these idiosyncrasies function as combinative capabilities that drives the ability to acquire, assimilate, transform and exploit external knowledge that differentially contributes to sustenance of competitive advantage of firms. This dynamism of Lean Six Sigma needs to be understood, considered and ratified in order for firms to appropriate the application of the philosophy in achieving more than just organizational performance per se. Subsequently a research model was developed to subsume this phenomenon and its path towards associated relationships.

CHAPTER 3: RESEARCH FRAMEWORK AND HYPOTHESES

3.1 Theoretical Research Model Development

Extant literature reviews noted that Lean Six Sigma has a significant impact towards organizational objectives and performance outcome (Pamfilie, Petcu & Draghici, 2012). Furthermore, many of the studies happen to be termed as Six Sigma alone with some explanation of Lean within it. Apart from the regular focus of Lean Six Sigma studies on organizational performance, attention on far reaching aspects such as innovation and sustainability in competitive advantage has somewhat begin to pick up given the competitiveness in global industries.

In spite of considerable discussion of Lean and Six Sigma on innovation and competitive advantage, there are no detailed discussion on the phenomenon of how Lean Six Sigma leads to innovation performance and sustainable competitive advantage. The link between Lean Six Sigma, innovation and competitive advantage has not been clearly explained and fully developed. Besides, it is also debated that process improvement activities have a tendency to truncate innovation (Benner & Tushman, 2003) and stifles creativity (Hindo, 2007) whereas some zealously believe philosophies like Lean Six Sigma does encourage innovation traits (Antony et al., 2016; Azis & Osada, 2010; Hoerl & Gardner, 2010).

It needs to be understood that there are a variety of components that make up these links and understanding their interaction will benefit practical application of Lean Six Sigma in organizations hence capitalize the intended outcome that reaches beyond organization performance alone. Being able to arrive at an understanding of how Lean Six Sigma leads to a path of innovation and sustainability in competitive advantage will unshackle the dilemma which views the philosophy as detracting far reaching performance outcomes as mentioned.

Hines et al. (2004) had indicated that Lean lacks in theoretical contingency in its application meanwhile it is also notably discoursed in the literature that Six Sigma lacks theoretical underpinnings (Antony, 2004b; Linderman et al., 2003; Schroeder et al., 2008). Snee (2010) clarified a theory for Lean Six Sigma is needed and that theories need to be continually challenged and enhanced, meaning to elicit the best of traits of the philosophy. Ang (2015) mentioned in order to do a research in a field like Six Sigma, it has to begin with the formulation and identification of useful theories that are related to the phenomenon. In this study, the dynamic characteristics of Lean Six Sigma in achieving far reaching performance outcome is considered. Lean Six Sigma is viewed as a facet of dynamic capability. Hence, theories that delineate the dynamism of Lean Six Sigma will be of focus.

A Lean Six Sigma organization will be able to achieve a point of diminishing return, therefore enhancing their competitive advantages through adding value to operational content, sturdy incentive system and incorporation of management decision making process with customers (Arnheiter & Maleyeff, 2005). Therefore, Lean Six Sigma exhibits a 'capability' to impose competitive advantage unto firms. Nevertheless, in order to arrive at deeper understanding of this 'capability', specific focus on existing theories and views of the firm are necessary.

This study moves in a direction by asking which of these theories and views of the firm are best suited for a theoretical foundation exemplifying the phenomenon of Lean Six Sigma. Scholars had corroborated that organizational capabilities are the basis for competitive advantages (Kusunoki, Nonaka & Nagata, 1998; Sharma & Vredenburg, 1998). Amit and Schoemaker (1993) and Helfat and Lieberman (2002) explained that organizational capabilities are based on the ability to use resources towards achieving organizational goals. Therefore, the study of Lean Six Sigma's resources would be the marching step towards understanding this capability. According to Westhead, Wright and

Ucbasaran (2004), resources that enable generation of capabilities can be classified into accumulated tangible and intangible resource stocks. Exploring Grant's (1991) resource classifications, resources of Lean Six Sigma cannot be concluded as tangible assets altogether, in fact it is much attributed to intangible ones, namely knowledge (Ang, 2015; Chetty & Wilson, 2003).

Past studies had considered how Lean and Six Sigma contribute to knowledge creation (Anand et al., 2010; Ang, 2015; Choo et al., 2007a; Lindlöf et al., 2013; Tyagi et al., 2015). However, there is certainly a paucity on how knowledge is being maneuvered in Lean Six Sigma towards the achievement of far reaching prospects in organizational outcomes such as innovation and sustenance in competitive advantage. Given the knowledge-based view that knowledge is a strategic resource, materializing knowledge into organizational capability would enhance dynamism in firms' capabilities thus developing sustained competitive capability (Davenport & Prusak, 1998; Grant, 1996b; Kogut & Zander, 1996; Spender, 1996). Considering the importance of knowledge-based view and resource-based view of the firm, the process of knowledge creation alone would not be able to elucidate the vigor inherent in Lean Six Sigma. The theory of dynamic capabilities and absorptive capacity addresses this shortcoming by revealing how firms are instilled with vigorous attributes through Lean Six Sigma's idiosyncrasies that enables them to learn and obtain external knowledge in addition to being able to utilize it for sake of novelty that grants them the ability to sustain their competitive position. That is, Lean Six Sigma becomes a source of dynamic capability that results in innovation performance and leads to sustainable competitive advantage.

Absorptive capacity is also a reliable form of dynamic capability as per Zahra and George (2002). The components of absorptive capacity (potential and realized absorptive capacity) are complementary and coexist, nonetheless they have differential outcome given their development path (Zahra & George, 2002). This explains the need to view the components differentially and how the idiosyncrasies of Lean Six Sigma are related to it. From the vantage of absorptive capacity, Lean Six Sigma could also be viewed as vibrant combinative capabilities of firms that enable them to synthesis and apply current and newly acquired external knowledge (Eisenhardt & Martin, 2000; Jansen et al., 2005; Kogut & Zander, 1992; Van Den Bosch, Volberda & De Boer, 1999). The combination of dynamic capability and absorptive capacity as a theoretical foundation render an overriding portrayal of a resource-based view notion whereby strategic management of resources and capabilities deliver continuance of competitiveness and innovativeness.

3.2 Underlying Theories

Arnheiter and Maleyeff (2005) claims that management theories on operational systems are still evolving. Relevant theory underpinnings that relates the knowledge base of the phenomenon of the study is imperative (Ibrahim et al., 2015). Kerlinger (1986) describes theory as a set of interrelated constrcuts, definitions and propositions that enables a systematic view of phenomena by stipulating variables' relationships. Liehr and Smith (1999) refers this as a set of interrelated concepts for the purpose of explaining or predicting as well as a blueprint and guide for modelling a structure. Meanwhile Chinn and Kramer (1999) says that theory is an expression of knowledge for creativity and idea structuring. This study utilizes three theories to expalin the phenomenon behind Lean Six Sigma application, Dynamic Capabilities, Absorptive Capacity and Resource Based View of the Firm (RBV). The foundation of these theories are discussed next.

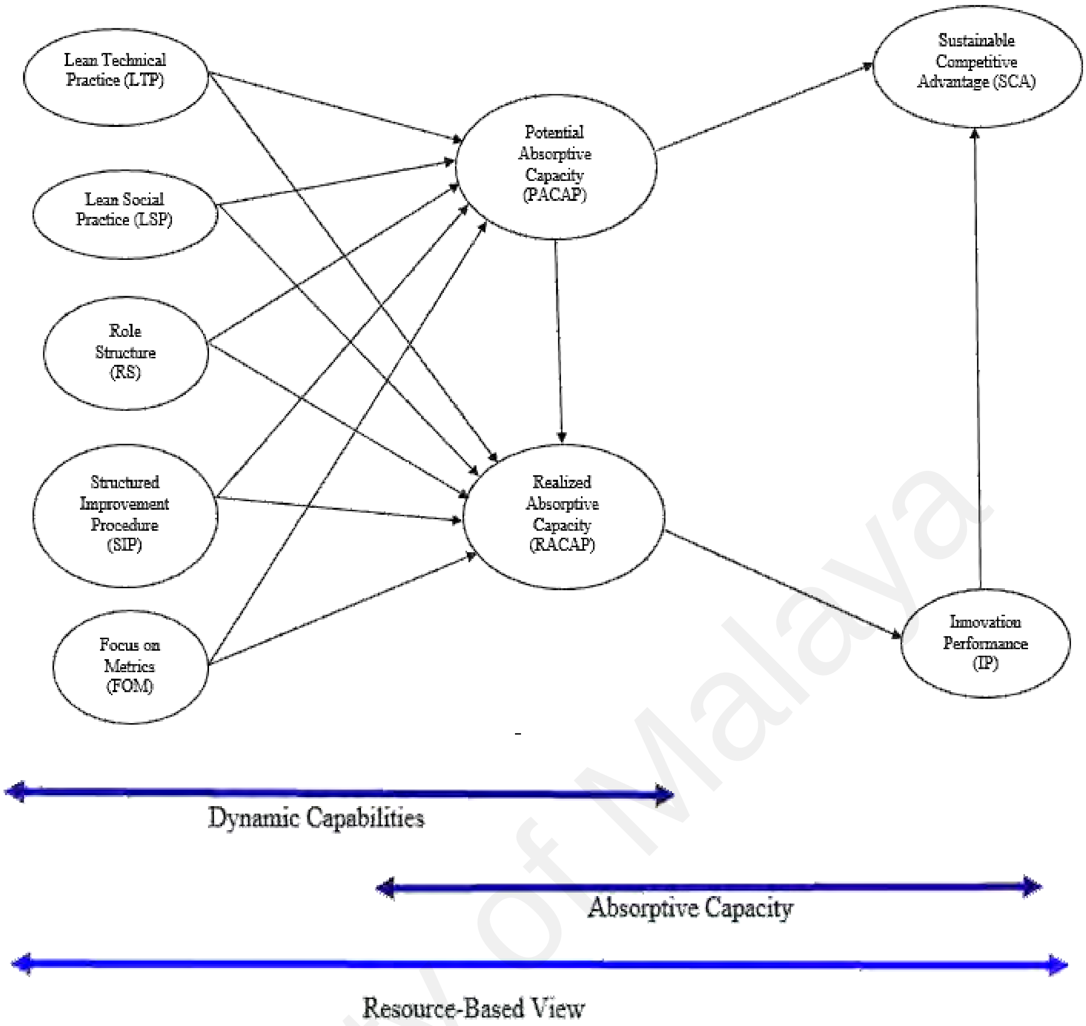


Figure 3.1: Research Model and its Underlying Theories

Source: Author

Figure 3.1 depicts the theoretical framework of this study and the associated theories connected to it.

3.2.1 Dynamic Capabilities

Firms consistently face situation to rise to the competition which cause them harm. When Ford was at it's eminence no auto company came close to its advantage with the sort of capability it had. But soon after, every other auto company caught up with Ford, matched the advantage and Ford ran out of steam in advatageous points as many of them had similar capabilities as Ford. It seems to look like a game of run and chase but what matters really is focusing internally in building up capabilities.

Teece et al. (1997) explains that certain firms are able to build competitive advatage in the midst of rapid change subject to the present Schumpetarian oriented innovation-based competition, price or performance, rivalry, increasing returns, and the 'creative destruction'. Dynamic capabilities is closely knitted to the aspects and outlines associated with Schumpetarian concept more specifically on creative destruction. Creative destruction is an economic concept augmented by Joseph Schumpeter (Schumpeter, 1942) in which he explained how innovation tends to enhance future capacity of firms however through the means of it, gradually causes destruction to the archaic and traditional functions and resources. It means that innovation reaches to a capacity to make things better but only through indirectly causing a demise at one end. For this reason firms need to keep up with evolution to avoid membership in creative destruction. Firms therefore face competiton on strategies which necessitate in altering of their position in their industry (Teece et al., 1997). Learned (1969) claim that a company's success and future development depends on its ability to find or create truly distinctive competence.

Therefore Teece et al. (1997) puts forth dynamic capabilities as the firms ability to integrate, build and reconfigure internal and external comptences to address the rapid changing environments. They claim that 'dynamic' refers to firms ability to renew their competencies in accordance to the environment turbulence whereas 'capabilities' refers to the firm's strategic management to adapt, integrate and reconfigure internal and external organizational skills, resources and functional competences in parallel to the changing environment (Teece & Pisano, 1994; Teece et al., 1997). The dynamic capabilities has an overlap to the resource based view to a certain extent where some shortcomings are expressed. Resources that are 'sticky' means that what firms have is what it has at least for the shortrun making it rigid to change and some aspects are not readily and easily tradeable or transferable citing that resources cant equilibrate through factor input markets (Dierickx & Cool, 1989a; Szulanski, 1995; Teece et al., 1997). Given such a case a firms' competitive advantage is resorted in the case where the firm is considerably lucky to possess superior information which allows it a first mover advantage (Barney, 1986). Shuen (1994) claims that learning, skills acquisition, management of know-how knowledge becomes pivotal if control over scarce resources is what determines economic profits.

Itami and Roehl (1991) elucidated the improtance of firms accumulation of invisible assets where the effective and efficient use of it like technological know-how yields the firm a strategic fit. Teece and Pisano (1994) and Teece et al. (1997) believes it is in these dimension where the greatest ability and potential lies for dynamism to thrive especially contributing to strategy. They advocate that the firms at the global level and marketplace that succeed and show superiority in times of turbulence are those that can respond in a timely manner and swiftly with flexible product innovation together with the management capability to effectively coordintate and reorganize internal and external competences. To consider, it reflects to how firms first generate or create this firm specific capabilities and at times of economic or business swings, how do they renew these competences (Teece et al., 1997).

With dynamism associated to learning Zollo and Winter provided the secondary impetus in dynamic capabilities which focuses in knowledge management or learning capabilities. Zollo and Winter (1999) gestalts the role of organizational routines in the process of dynamic capability evolution. Zollo and Winter's (1999, p. 10) deeper articulation of the concept of dynamic capability led them to define it as a "*learned pattern of collective activity through which the organization systematically generates and modifies its operational routines in pursuit of improved effectiveness*". According to them, 'learned pattern' and 'systematically' reflects the rudimentaries of the dynamism whereby they claim dynamic capabilities are structured and persistent. The reason this theory is tied down to organizational routines is because organizational routines reveals the organizations reaction to variegated, internal or external incitements (Zollo & Winter, 1999). In explaining how dynaimic capabilities are generated through organizational routines, Zollo and Winter delineated that dynamic capabilities is formed in parallel with tacit experience accumulation processes with explicit knowledge articulation and codification activities, systematically generating new and adapting existing operational routines.

The changing environment and the response to it is always embeded in tacitness of dealing in such conditions which makes it difficult to explicate them. And it is these tacitness where the key to strategic decision making lies to overcome complexities and align strategic goals. For this reason, Zollo and Winter defines the necessity to accumulate these tacit experience which could be further filtered and learned. Levinthal and March (1981) highlighted the concern of deliberation process in figuring out the plausibiliity of success of goals in organizational task execution. It means sometimes people fail to detail out the exact comprehension of task execution.

Argyris and Schön (1978) proved a remedy for this circumstance by claiming collective learning wherein individuals express opinions and beliefs engage in constructive conflict of each others' viewpoint. In other words, individual are articulating how things should be done and how one way could be efficient and effective putting forth each other's view into a discourse until there are aware of how the overall performance are implicated through their actions. The result of this cognitive effort is likely to enhance organizational competence as members of the organization engage in constructive confrontation and improve their understanding by sharing their experiences and opinion and comparing them (Zollo & Winter, 1999, 2002). An even important part of this development is codifying it. Zollo and Winter (1999) calls this a higher level of cognitive effort in codifying tacit knowledge or experience. They present the notion that this is a process of support mechanism for routine replication of processes that facilitates diffusion of knowledge through manuals or tools. In a way it is a congregation of mental models which guides or directs routines in organizations.

An organization's capability consist of a high level collection of routines which outlines the transition of its' input flows transitioning through a set of decision options towards production of significant outputs (Winter, 2003). Competitive advantage emanates from dynamic capabilities which Teece and Pisano (1994) believe rooted in high performance routines operating inside the firm, entrenched in the firm's processes and conditioned by its history in addition to continous development and exploitation of firm-specific assets analogous to the expansion in Schumpterian view.

3.2.2 Absorptive Capacity

In a world where physical assets had become somewhat indistinctive, more and more research had become focused in identfying what just might be underlying competitive resource of firms assets. To be distinctive it was discoursed that the asset needs to be idiosyncratic which many came about in realizing the property in the form of knowledge. Nonaka and Takeuchi (1995a) explicated the creation of capabilities through knowledge within organization. They expressed the eminence of knowledge at the point of creation, in making continous innovation and towards achieving competitive advantage. Nonaka (1994) elucidates the creation of knowledge within an organization happens through a dynamic process of four modes of conversion; socialization, externalization, combination and internalization.

As Nonaka and Takeuchi (1995b) claimed that individuals represent the micro components of the organization. As they learn, rather collectively and cooperatively it would generate the knowledge of the organization. As Senge (1990) puts it, the more this learning culture persist, the more the organization will turn out to be a learning organization. In other words, the organization cannot learn without the individuals in it learning in it. There is no two ways about it as individuals make the organization.

Paired on the significance in generating or creation of organizational knowledge, no firm possess all the information required to make itself distinctive as though a large storage of information for the whole of the industry. Therefore, a firm still needs to vie for the external information and knowledge residing outside the boundaries of the firm. In order to foster innovative capabiliites Cohen and Levinthal (1990) asserts that firms need to have a considerable ability of absorptive capacity. Absoprtive capacity is the ability of firms to recognize the value of new, external information, assimilate it and apply to business and commercial needs in exploitation (Cohen & Levinthal, 1990). A pre-requisite to this denotation is the accumulation or availability of prior knowledge which will facilitate the absorbtion and assimilation of the new knowledge as proclaimed by the authors.

Lane and Lubatkin (1998) asserts this is similar to the mannerism to which computers work wherein the operating system of the computer sets out ground rules of working condition and ensuing performance of sourcing and storing information. The essentiality of prior knowledge facilitating the new assimilation reflects that the construct of absorptive capacity as being cumulative and path dependent making it a source of competitive advantage. (Cohen & Levinthal, 1990; Lim et al., 2013). It was argued that although being a firm level construct, absoprtive capacity is derived out of individual members of the firm, professing that firm's absorptive capacity is equivalent to the summation of it's employees' absoprtive capacity.

Absoprtive capacity is not only dependant upon the external environment per se but also within the internal subunits of the firm as individuals standing in the inteface of the firm and external environment and between internal subunits are vital points harnessing this capability (Cohen & Levinthal, 1990). Although much of the constrcut is relevantly advocated in the context of R&D and related investments, another interesting portion of the concept states a great deal of similiarity on the development of this capacity and problem solving facet (Jensen & Webster, 2009; Robertson, Casali & Jacobson, 2012). Cohen and Levinthal (1990) submitted that problem-solving methods and heuristics stores prior knowledge that allows the individuals to acquire more information or knowledge related in the search of resolution. Ellis (1965) confers that the relation of problem-solving to cognitive structures directs individual learning to the peak especially at times where exisiting knowledge is being assimilated with new ones acquired.

In correspondence to this, it was convened that problem solving induces a learning advantage or capability which develops the competences for acquiring and assimilating new knowledge eventually creating a new one (Cohen & Levinthal, 1989, 1990; Lane & Lubatkin, 1998). Harlow (1949) experimented the learning patterns between monkeys and children with an alternation between types of problem and found that the brain-damaged monkey had a tendency to perform with efficiency than those that was not. In response to this, Ellis (1965) articulated on the yield of 'insights' which coerce to problem solutions. This synthesis of problem solving and learning generates creativity that is likely to spur innovativeness for firms.

Cohen and Levinthal (1990) intepretes this as possession of prior knowledge and skills that allows never before considered associations and linkages. Lane and Lubatkin (1998) expressed a dyad-level learning construct of absoprtive capacity under certain conditions that firms can learn from other firms by terming it as relative absorptive capacity. These conditions are knowledge bases, organizational structures and compensation policies, and dominant logics. Their study was mooted in interorganizational learning wherein firms act as student and another as teacher from which the former absorbs the capacity from the latter. Their case study between a pharmaceutical and biotechnology firm as student and teacher relationship respectively reveals that firms should not objectify imitation of capacity but instead use this to develop new capabilities (Lane & Lubatkin, 1998).

Tsai (2001) took on a knowledge transfer and network position perspective in delineating the effects of absorptive capacity on business innovation and performance. Tsai claimed that organizations should have a centralized network positions for all the units within the organization especially when the organization is build of multiunits. The rationale on it was that centralized network position will have a greater impact on business innovation and performance subject to the level of absorptove capacity of each units. Using hierarchical regression analysis with 24 and 36 business units in petrochemical and food-manufacturing companies, the author found innovativeness and performance is positively and significantly related to the centrality of intraorganizational network.

However this success is also dependant on the absorptive capacity of the organizational units, the higher it is the more successful it will be realizing the innovativeness and performance enhancement. Thus the author interprets absorptive capacity as a significant factor in affecting business performance and innovation. Another interesting findings is that the interaction between absorptive capacity and network position also results in a higher innovation and performance as he went on to suggest investment in absoprtive capacity is required when expanding unit network links as it matters to the extend of organization success (Tsai, 2001).

Van Den Bosch et al. (1999) discoursed that the antecedant view of absoprtive capacity that requires prior level knowledge may be arguable thus, they suggested a refined determinants of absoprtive capacity in the context of organizational forms and combinative capabilities. In accordance to Cohen and Levinthal (1990) absoprtive capacity concept they debated that it is similar to the notion of Grant (1996b) knowledge integration concept. Under that basis Van Den Bosch et al. (1999) analyzed knowledge absoprtion using three primary element. Efficiency refers to how firms identify, assimilate and exploit knowledge, flexibility, refers to how firms can access and reconfigure different components of knowledge and scope of knowledge which is dependent on the breadth of component knowledge the firm draws (Van Den Bosch et al., 1999). According to them, organizational forms are divided into three; *Functional Form* wich refers to the degree of functionalization of management, *Division Form*, a grouping by product-market combination, and *Matrix Form* which consist of a dual hierarchy of authority and degree of functionalization. Each of these forms represents the extent of impact on dimensions of absoprtive capacity in terms of efficiency, scope and flexibility consequently on absoprtive capacity itself. Simiarly, combinative capability also have three separate types systems capability, coordination capability and socialization capability.

Systems capability is a capability similar to Nonaka's (1994) version of combination mode that integrates explicit knowledge whereby the firm integrates direction, policies, procedures and manuals. Coordination capabilities refers to the interaction of organization members finally socialzation capability refers to the assimilation of tacit knowledge between organization members. Also these three combinative capabilites have substantial effect amongst each other towards dimensions of absorptive capacity mentioned.

These determinants of absoprtive capacity have a tendency to effect the level of absorptive capacity of firms and along with the changes in the knowldege environment which comprised of stable and turbulent milieu. A turbulent environment would compel a firm to undertake increment in absoprtive capacity through the path of exploration with low efficiency and high scope and flexibility meanwhile a stable environment will conversely encourage absoprtive capacity that focuses on exploitation with high efficiency and low scope and flexibility.

3.2.2.1 Reconceptualization: Potential and Realized Absorptive Capacity

(a) ***Acquisition of Knowledge***

Acquisition refers to the firms ability to identify and obtain external knowledge that is relevant to the firms operations. According to the proponents, there are three aspects that effect the quality of external knowledge acquisition. Instensity, in the form of greater effort put in to search and acquire the knowledge. Speed, the faster the organization reflexes are in accordance to the environmental stimuli the better it is in acquisition. And the direction in acquiring knowledge in which firms should ideally have different area of expertise with prior knowledge to what they intend to search to handle the complexity of knowledge acquisiton (Zahra & George, 2002).

(b) ***Assimilation of Knowledge***

Assimilation refers to the adjustment and integration of the external knowledge by analyzing and interpreting as per the firms processes and routines which may be different to the external knowledge acquired. As it was professed by Zahra and George (2002), external knowledge may have heuristics that may differ to the receiving organization besides being context specific. This may pose a quandary in comprehending to the knowledge. Trying and being able to understand and making sense of this knowledge will promote assimilation of new external knowledge with already existing ones within the organization.

(c) ***PACAP (Potential Absorptive Capacity)***

The above two dimensions form the component of PACAP. It enables firms to value, evaluate, recognize, intepret, congregate, integrate and incorporate external knowledge as with many sysnonyms. The bigger the size of the pool of PACAP, the richer the organization is in terms of external or perhaps novel knowledge source. However this affluence does not necessarily mean the firm will be well off in performance outcomes. As Zahra and George (2002, p. 191) explained PACAP and RACAP "*coexist at all times* *and fullfill a necessary but insufficient condition to improve firm performance*". Which implies the absence of either one of the components may impact performance outcomes adversely as it play a combinative role. The ability of organization to muster and develop PACAP will enhance their capability to react to external changes in the business environment as it tend to be more fast to react and strategies. Besides, PACAP enables organization to be more receptive to acquire and assimilate knowledge (Lane & Lubatkin, 1998) which resembles the attirbute of exploratory learning (Gebauer et al. 2012; Leal-Rodriguez et al., 2014). the more experience the organization gains in fostering PACAP will gurantee judicious management of routines which in turn will promote a reduction in cost over time. These characteristics as proposed by Zahra and George (2002) and Leal-Rodriguez et al. (2014) propogate sustainability in competitive advantage.

(d) ***Transformation of Knowledge***

Transformation comes when the acquired and assimilated knowledge is being rationalized into the routines of the firm by combining the exisiting and newly acquired knowledge which often involves bisociation where some knowledge maybe be deleted or redefined. The process of bisociation, wherein unrelatted information and transformed to transpire valuable information, galvanize enterprenurial mindset and action (McGrath & MacMillan, 2000; Smith & Di Gregorio, 2002)

(e) ***Exploitation of Knowledge***

Finally exploitation refers to putting the newly acquired and refined, assimilated and transformed knowledge into the routine where the firm will likely exploit the advantage of the new knowledge which also reflect the ability of the firm to incorporate the knowledge into its operation (Zahra & George, 2002). Having a systematic routine which enables harvesting and incorporating knowledge into operations may allow firms to sustain benefits over time (Tiemessen, Lane, Crossan & Inkpen, 1997; Van Den Bosch et al., 1999; Zahra & George, 2002).

(f) ***RACAP (Realized Absorptive Capacity)***

These two dimensions above form the RACAP component in which the preceding component's knowoledge source is being leveraged into to physical and valuable outocome. As explained, the presence of RACAP alone may also prove futile as firms wont be able to transform, exploit or leverage any knowledge without acquiring it first (Zahra & George, 2002). RACAP is a vital component that determines revenue and yield generation given the nature of this component to exploit knolwedge for profit creation. When transformation and exploitation happens, organization tends to have more process of bisociation happening. Leal-Rodriguez et al., (2014) synonymously calls this the ability to combine existing and newly acquired knowledge into operations. This triggers a force of creativity wherein it could be converted into novel processes and products by exploiting this capabilites hence leading to the notion of innovation in organization's performance (Zahra & George, 2002).

Hence the two subset of PACAP and RACAP determines the path of a firms ability to generate innovation and sustain competitive advantage. As the traditional construct of absorptive capacity promotes, prior knowledge is important for this ability to be substantial. Zahra and George (2002) claims that in order for PACAP to be loftier there needs to be an activation trigger that prompts the urgency of needs of PACAP. They claim the level of exposure, diversity, complementarity of external source of knowledge and prior experience will determine the locus of search and path dependent generation for a better PACAP. As Nonaka (1994) explains the knowledge creation at an organization level is a spiral that contains multitude of modes and conversion. The initiation however lies in socializing among members. Analogously, Zahra and George (2002) claim that social integration mechanism assist the sharing and exploitation of knowledge resources citing that the link to the connection between PACAP and RACAP abodes in the social integration mechanism and the efficiency factor. They proposed that social integration mechanism which exist in formal and informal ways narrows the gap between PACAP and RACAP intuitively increasing the efficiency factor to transform and exploit the newly acquired and assimilated knowledge.

Since Zahra and George (2002) views absoprtive capacity as a means of dynamic capability that resides in organizational routines and processes, it is a viable option as a source of innovation and sustainable competitive advantage. Competitive advantage in Barney's (1991) words are valuable, rare, inimitable and non-substitutable resources possession and claims innovation and strategic flexibility are pivotal in dynamic markets. Elements of the RACAP such as bisociation allows for greater exploitation advantage hence creating competitive advantage by leveraging and redefining knowledgable resources through innovation. PACAP on the other hand diffuses competency traps that stunts possibility of exploring new knowledges as this subset will enable firms to continously keep abreast of their knowledge stock and industry trends. Firms with operative and active RACAP likely to foster competitive advantage through innovation and product or service development manwhile those with astute PACAP likely to generate sustenance of competitive advantage given their greater flexibility in reconfiguring resource bases and timely capability deployment at lower costs (Zahra & George, 2002).

3.2.3 Resource Based View of Firm (RBV)

The Resource-Based View of the firm (RBV) attempts to explicate the black box of firm in the context of strategic management of it's' resources and capabilities (Kostopoulos, Spanos & Prastacos, 2002). The RBV focuses on the elements of intangible resources and capabilities of a firm which posits that those resources and capabilities are what transform a particular firm to be different from the rest of them in the market or industry thereby making it special, unique, dominant in it's' field of competition. The idea revolves around how does some firms fail to compete or even sustain itself in the market for that matter or how does some or one stands out from the rest of them and is able to prolong its dominance in the market, continue to be competitive, consistently entails a lower cost of production, experience and enjoy economic of scale, able to exploit the market with ease, explore and innovate daringly with lower failure rate and persistently tends to outperform others.

Resources may range in diversity in the preference of a particular firm and as Penrose (1959) argued that it is the heterogeneity instead of homogeneity that determines the uniqueness of firms within a market. The more diverse intangible strategic resource a firm holds the adept it is towards attaining a competitive advantage in the market. Wernerfelt's (1984) and Barney's (1991) presentation in evaluating resources provide insights on the assessment of resources' significance in which the latter had identified intangible resource characteristics as valuable (in the sense that they exploit opportunities and/or neutralize threats in a firm's environment), rare among a firm's current and potential competitors, inimitable, and non-substitutable. The extension of the characteristics thereafter included resource durability, non-tradeability, and idiosyncratic nature of resources (Amit & Schoemaker, 1993; Dierickx & Cool, 1989b; Mahoney & Pandian, 1992; Peteraf, 1993; Rumelt & Lamb, 1984). Resources viewed here are of elusive characteristics that enhance the ability or capability of a firm that is implicit in nature. The distinctive features gives a firm the advantage to leap over and outperform competitors that strengthens its' existence in the market.

The RBV emphasizes on the combination of resources and capabilities that are idiosyncratic, which when used and managed strategically conveys a competitive advantage to a firm. This concept of strategic management is congruently related to Ricardian rent. In Ricardian rent the difference between production and the marginal labor cost translates into profit earnings in which cost of production is based on the lowest value. Given the availability of resources that are homogenous and mediocre would imply to homogenous production which carries lack of competitive advantage between firms whereas in contrast having unique resources pervades the market's advantage into a firm given its ability to produce distinctively. Therefore Ricardian rent arises due to the scarcity or rarity of resources (Parayitam & Guru, 2010). Here, rent is characterized as profits earned by the firm that owns the resources and capability of scarcity and rarity which the firm utilized strategically to transmute the exclusive factor it holds into economical profits. This advantage gives the firm a stance in the market that is competitively evolving consequently a significant position in the industry.

The RBV puts much weight on managing the intangible resources and capability from a strategic point of view which other firms find it hard to possess or be it imitated. The RBV somewhat branches out towards the Dynamic Capabilities (DC) theory as advocated by Teece et al. (1997) in the field of strategic management. The DC claims the resources apart from being unique the firm has to know how to use it. The term 'dynamic' defines the ability to modify and renew the capability of a firm to sustain the competitive gain where market adjustment are rapid whereas 'capability' is referred to as competency, the ability to adapt, reconfigure and integrate internal and external organizational resources in the light of an ever-changing environment given path dependencies and market positions (Leonard-Barton, 1992; Teece et al., 1997)

Given this circumstance the firm that possesses the upper hand on capabilities that are dynamic would have a superior advantage to monopolize the market or industry. However it is important to note that economy is always evolving. Theoretically there are distinctive markets from perfect competition to imperfection competition whereby the latter had emerge in prevalence through time and market dominance is never really seen as the same as before where one firm that monopolizes the industry is swiftly challenged by an entering firm. In what used to be an advantage of possessing extensive physical assets though maximizing and optimal usage of same that translates into greater economic value as discoursed by neoclassical economic theories is no more to be seen in reality for the path we are in today's world (Ichrakie, 2013). If perfect competition is achieved at every end, this would imply that some of the resources and or capabilities are denied or digressed from the characteristics that impose a competitive advantage. This would mean that more and more firms are able to replicate one another in terms of one or many of its resources or capabilities, the assets the firm has may be of no actual value, the properties of the assets are or had become very much in common that it lacks the rarity which provides the distinction and finally that those resources and capabilities are easily interchangeable. And all this is down to the idea that competition lives on through various conundrum given that firms are naturally existent to compete for survival, progress and possible domination in the industry. It may as well begin with the ability to imitate front runners capabilities and the resources owned. As such becomes the case, is where the RBV takes into account the differences in characteristics a firm holds which are subject to heterogeneity, that are firm-specific, hard to imitate which in all translates to be valuable asset to the front-running firm. This enable firms to produce in a much cost-effective manner and gain consequential profits.

3.3 Research Hypotheses

3.3.1 Lean, Potential Absorptive Capacity and Realized Absorptive Capacity

Lean is a waste elimination concept under process improvement field. The core thrust of Lean would enable a streamlined and a high quality system that produces outcome bound to what customer wants, needs or desires (Shah & Ward, 2003). The philosophy of Lean consists of two important components with one being the tools and techniques, often known as hard practice and another being the social management practice which is more on the social side of Lean, known as soft practice (Larteb et al., 2015). Shah and Ward (2007) declared Lean as a sociotechnical system where both the technical and social aspect of the concept co-exist in bringing about optimistic outcome. The role of Lean in knowledge seeking behavior is fairly undisputed.

3.3.1.1 Lean Technical Practice (LTP) and Components of Absorptive Capacity

Sehested and Sonnenberg (2010) had emphasized that Lean is a form of knowledge sharing and management under the continuous improvement philosophy. In that it does, there's continuous question of making and doing new things or to innovate further which requires new knowledge and ways of doing things.

Stanica and Peydro (2016) studied how does "employee cross-training" as a lean tool affects the knowledge transfer in product development processes. This research notably had an assimilation of the human and technical aspect of Lean in that it made the change agent as a tool for knowledge exploration in cross-functional vicinity. The in-depth interviews showed that Lean company is able to create a polyvalent employee besides the approach itself being a tool which captures both extent of knowledge; explicit through training measures and tacit through learning by doing the latter being highly sought after in this era (Stanica & Peydro, 2016).

Tyagi et al. (2015) studied the impact of ten Lean tools and methods in combination being; apprenticeship, employee cross-training, chief engineer, set-based concurrent engineering, trade-off curves, visual tools, check sheets, Scrum, PDCA and 5 Why's in how it impacts knowledge creation through Nonaka's (1994) SECI modes. On an overall view it was found that every Lean tools have its importance nevertheless this research shed light on three important tools to be impactful in the SECI modes which were scrum, the PDCA cycle and 5 Whys. The Lean tools provide a basis for team members to accumulate knowledge and learn from external stakeholders such as customers and vendors which is further transformed into the operational routines in part of problem-solving process.

In Zhang and Chen's (2016) study on the impact of Lean on knowledge creation in the construction industry, Concurrent engineering (CE), Last Planner System, Value Stream Mapping (VSM) and BIM supports externalization mode in the organization knowledge creation process (Nonaka, 1994). Daily huddle meeting, Last Planner System, BIM and Kanban enriches the combination 'ba' by combining knowledge gained from external routines. VSM and Kanban impacts the internalization mode when team members assimilate knowledge gained from outside their units and try to transform it to fix their problems. Their path analysis shows that the Lean tools (and social practice) impacts knowledge creation consequently Lean performance as well. The authors concluded that such a path is crucial for innovation to prosper in construction companies. Here, the Lean tools not only act as catalyst to potential absorptive capacity but also on realizing those capacity.

Netland and Powell (2016) laid out a case study on how Lean tools endorses potential and realized absorptive capacity in the Welsh Police Force that utilized Lean policing in their arrest process. The police force applied a critical audit as a technique for the arrest process and working collaboratively with Crown Prosecution Services to appropriate the criminal or unlawful charges. The critical audits functioned as force-specific feedback mechanism to highlight improvement areas. The Crown Prosecution Services information through senior management built commitment of those with access to resources to make changes to improve the process which depicts potential absorptive capacity. The external support guided the force to engage and in making using of the Lean tools and techniques to explore and solve the issues which displays the characteristics of realized absorptive capacity. The case study summarized how such as increase in the potential absorptive capacity through Lean tools and technique engagements could drive follow up improvement activities necessary for realizing those absorptive capacity (Netland & Powell, 2016).

Although many of the explanation above points towards knowledge orientation in a variety of ways (knowledge creation, sharing, management etc.), the notion of how the knowledge was developed or extracted should not be undermined. That is the ability or means of absorbing knowledge dynamically. Lean's tools and techniques provide a podium for practitioners to use them as a guideline or a parameter to do work in addition to supporting learning ability. How they intend to use the tools to suit the improvements according to their business needs and organizational routines are flexible as every firm has its own unique process controls. By having these guidelines and parameters practitioners have a high likelihood to scour for the relevant knowledge to befit into their resolutions. With the help of Lean, firms will be tempted to continuously improve and find novel approaches to their routines which prompt them in search for answers outside their custom or boundaries be it departments, headquarters, plants, subsidiaries, suppliers, clients inter alia. The findings then will be internalized and improvised to better suit their own routines or processes which they will finally put them into play as part of their best practice applications. Therefore, the following hypotheses are proposed:

H1a: LTP has a positive effect on Potential Absorptive Capacity (PACAP) (that is, external knowledge acquisition and assimilation)

H1b: LTP has a positive effect on Realized Absorptive Capacity (RACAP) (that is, external knowledge transformation and exploitation).

3.3.1.2 Lean Social Practice (LSP) and Components of Absorptive Capacity

Johnstone et al. (2011) believe that Lean could instigate new ideas and creation of knowledge through its numerous analyses like root cause and problem solving techniques that are constructive however one should note the human side to them which creates commitment, engagement, autonomous, flexibility and self-confidence.

Gong and Janssen (2015) studied Lean from the viewpoint of service innovation in the banking sector leading to formulation of a framework to analyze the benefits and risks of Lean innovation. Components of the framework which included "creating value to customer" and "flow and pull" reflected the techniques used to design processes within the bank to create value-adding process whereas "think systematically" and "continuous improvement" emphasizes on the streamline of thought to the mode of Lean where communications and management are to an internally driven value-adding scale. Using Knowledge Based View of the Firm (KBV) as the basis for the framework the authors identified that Lean is coordinated through two critical knowledge-based process which are knowledge accessing and knowledge integration (Gong & Janssen, 2015).

Similarly, Zhang and Chen (2016) studied the impact of Lean on knowledge creation and its impact towards performance in the construction industry. They examined ten Lean tools (one of which involves Human Resource Management which basically reflects social practice of Lean) on how they correlate to the SECI modes. It was found that Human Resource Management (HRM) and daily huddle meeting promotes socialization. As explained by Nonaka (1994) socialization involves interaction, the act of socializing which gains tacit elements of the knowledge. In Lean, the socialization occurs both in internal boundaries of a firm such as between improvement teams, across departments, divisions or units and externally with sister companies, branches, plants, suppliers and clientele. This circumstance allows for the process of external knowledge acquisition, assimilation, transformation and exploitation to take place.

Toyota for instance had created a network known as '*Kyohokai*' the purpose of which is for information exchange, mutual development and training between member companies and socialization (Dyer & Hatch, 2004). This platform enables the units within either Toyota, suppliers or customers to acquire and assimilate knowledge that is relevant to each of them, hence enriching their knowledge stock. This pool of knowledge acquired from external parties would enable them to utilize the relevant knowledge by transforming and exploiting it when necessary as part of their improvement regime and strategic decision making. Dyer and Nobeoka (2000) explicated a case evidence on how Toyota, where Lean stemmed from, advocated external oriented learning capability through the creation of '*Jishuken*' which stands for voluntary learning teams or voluntary study groups. Guided by Toyota, each group consist of five to seven suppliers with the purpose of assisting each other with productivity and quality improvements. This created a learning network among the stakeholders by gaining and sharing information and through external plant visits or engagements. Every year Toyota organizes a conference to congregate the Jishuken groups for sharing of the key knowledge acquired from the year's activities which allows suppliers to learn the issues that are being addressed in other groups. This permits the suppliers to recognize and acquire valuable knowledge that may trigger ideas for subsequent Jishuken projects and also as a valuable knowledge stock which suppliers could follow-up informally to make contacts and learn from each other's expertise. Toyota itself, had made subsidiary learning imperative through their Lean philosophy. For example, Toyota in the United States had the Jishuken concept replicated in 1994 which is known as Plant Development Activity (PDA) Core Groups (Dyer & Nobeoka, 2000).

These aspects of hard and soft measures lay the road to innovation through knowledge seeking process. Most solutions of Lean involve innovative outcome should it be applied appropriately and mostly involve teamwork, cross-training and anti-silo thinking as the ability to innovate germinates from the ability to share ideas and thoughts from network of people (Johnstone et al., 2011). This ability is propagated through the optimistic social practices of Lean through the aspects of motivation, engagement and disabling silos.

Danese, Romano and Boscari (2017) scrutinized the transfer process of Lean practices in multi-plant companies headquartered in Europe and made transfer of subsidiaries in the United States and China. Their research focused on the aspect of stickiness of the transfer process corresponding to influential contextual elements of Lean standards development, Lean transfer team composition, source characteristics, recipient national environment and corporate Lean program. Their research shows evidence on both facet of Lean's technical and social practice being fundamental in the transfer process where subsidiaries make importation of ideas and strategies from on another that differs in culture and company strategy. For instance, clarifications are resolved by having a shared vision and corporate program to cater a convergent view of the Lean practices, trainings are tailored to meet cultural differences to enable effective acquisition, assimilation and exploitation of information during the transformation process. This presented a flexible deployment structure for a standard Lean practice in which employees are free to adapt and seek for best practice on their own local context guided by a general sequence for the deployment and creation of a conducive social practice through active reward systems, new staff internal trainings, effectual employee assessment and the likes.

With the tools and techniques or technical practices apart, as literatures show the social practice is much akin to a Lean thinking in management for which it is also known as soft practice. What drives the practices of Lean is undeniably not the technical aspects alone but also how people are being managed to a certain extent. The social factors preside on both counts of internal and external motivations. The employees need to be appropriately rewarded for the initiatives undertaken. For the most part they need to be collectively empowered in the effort to propagate continuous improvement for the program or culture to be successful. Collective workmanship is indeed a central focus in Lean philosophy in which socialization across departments and beyond hierarchy facilitate knowledge transference. Everyone works collectively in a Lean environment where silos are exterminated enabling employees to scour information and knowledge across and beyond their boundaries. This empowers acquisition of knowledge expediently. The socialization process amongst many levels of employees also stimulates assimilating new knowledge with existing ones in order to transform them into a new best practice. Hence promotes exploiting knowledge across the organization.

The articulations above provide considerable ground that Lean, which consist of technical and social practice encourage knowledge seeking behaviors, which translates to potential absorptive capacity dimension wherein it involves, knowledge acquisition and assimilation. In part thereof, the practices also reflect the ability in using the knowledge garnered to make improvement and progresses that signifies realized absorptive capacity in which transforming and exploiting the knowledge is fundamental in reaping the benefits as expounded in many scenarios in the literatures. As such, the following hypotheses are proposed:

H2a: LSP has a positive effect on Potential Absorptive Capacity (PACAP) (that is, external knowledge acquisition and assimilation)

H2b: LSP has a positive effect on Realized Absorptive Capacity (RACAP) (that is, external knowledge transformation and exploitation).

3.3.2 Six Sigma, Potential Absorptive Capacity and Realized Absorptive Capacity

Six sigma is a process improvement methodology that emphasizes variation reduction (Hoerl, 1998; Pande et al., 2000; Schroeder et al., 2008). The essential aspects of Six Sigma as explained of their idiosyncrasies include a Structured Improvement Procedure (SIP) using the DMAIC methodology, an organized Role Structure (RS) through its belt system and a stringent Focus on Metrics (FOM) in the course of improvement endeavors. McAdam and Hazlett (2010) compile peer-reviewed studies to explain the dynamics of Six Sigma from an absorptive capacity perspective from its multidimensional view of acquisition, assimilation, transformation and exploitation of Six Sigma as a new external knowledge. They posited through Six Sigma, organizational routines enable specific technological change to be adopted, developed and to produce benefits (Lane et al., 2006). Absorptive capacity, as per Zahra and George (2002), is deemed as a set of organizational routines and processes which induces dynamic organizational capability. With Six Sigma being able to coalesce human and technical aspects through the belt system and technical trainings for process improvement projects poses a dynamic capability representation that is able to scour for source of knowledge and information internally and externally (Gowen & Tallon, 2005).

3.3.2.1 Role Structure (RS) and Components of Absorptive Capacity

Six Sigma has a parallel-meso structure (Schroeder et al., 2008) that is commonly known as the Six Sigma Belt system (Pande et al., 2000; Pyzdek, 2003) that are deemed as specialized positions (Javier Lloréns-Montes & Molina, 2006; Zu et al., 2008). This role structure provide the leadership structure a Six Sigma management should have in cultivating teamwork and culture of continuous improvement programs. Their role apart from technical project management roles will also include creating recognition and foster collective desire to learn (Choo et al., 2007a) and guiding the learning efforts (Choo et al., 2007a; Wiklund & Wiklund, 2002). De Mast (2006) explained that the formation of specialized position such as in Six Sigma allows the expansion and better utilization of existing knowledge in the organization where the leaders are seen as a focal point and source of knowledge stock. Authors have also noted that the role structure facilitates hierarchical coordination mechanism for work across multiple organizational levels to ensure better work design and coordination capabilities (Arumugam et al., 2013; Sinha & Van de Ven, 2005; Van Den Bosch et al., 1999; Zu et al., 2008).

In describing the role structure, Burton (2011) coined the term ‘Creative Stakeholdering’ where the stakeholder’s needs and actions are continuously aligned by making the improvement whereby the 'stakeholdering' could be in the manner of vertical, horizontal or lateral alignment and externally to customers and other external stakeholders. It could also mean that clients or customers may as well pose as the champions or sponsors (stakeholders) within the role structure of a Six Sigma project where their concerns are acquired and assimilated to fulfil project goals. The cross-functional nature of Six Sigma leadership allows the transmission of knowledge without borders within an organization besides being encouraged to continuously expand their proficiencies. This explains why the project leaders especially belters are encouraged to attend, seminars, conferences and industrial meetings to gain new insights and enhance their capabilities.

Arumugam, Antony and Linderman (2016) explained that having cross-functional team in Six Sigma enhances the total pool of knowledge and skills through learning among different project teams. These pool of knowledge could subsequently be used by incumbent and upcoming projects for transformation and exploitation purposes. Gutiérrez et al. (2012) claimed that the leadership of the role structure should promote beneficial learning by demonstrating and facilitating the efforts on how to absorb knowledge and putting them into use.

Yusr et al. (2012) explained using Six Sigma provides the organization with infrastructure which includes the like of role structure, which allows the process of evaluating, assimilating, integrating and using knowledge. Besides that, interaction among the cross-functional teams and different level of belters will be aligned in a way that everyone speaks of the same language as articulated by Antony and Banuelas (2002) wherein the belt system ensures everyone in the firm are speaking in the same language. Supplementing this, Gutiérrez Gutiérrez et al. (2009) demonstrated that such a teamwork is able to facilitate shared vision that fosters "homophily" within the firm which is fundamental towards augmenting absorptive capacity (Gutiérrez et al., 2012):

H3a: RS has a positive effect on Potential Absorptive Capacity (PACAP) (that is, external knowledge acquisition and assimilation)

H3b: RS has a positive effect on Realized Absorptive Capacity (RACAP) (that is, external knowledge transformation and exploitation).

3.3.2.2 Structured Improvement Procedure (SIP) and Components of Absorptive Capacity

Six Sigma projects need to undergo the DMAIC (*Define, Measure, Analyze, Improve, Control*) methodology which was established through a combination of scientific experimentation using sequential logic filters for problem solving following Mikel Harry's, the founder of Six Sigma Research Institute of Motorola University doctoral research combined with Perez-Wilson (1989) study on machine and process controls (Watson & DeYong, 2010). The method used a scientific based variable reduction thorough logical filters; recognition, classification, analysis and control (Harry, 1985). Every phase has its conceptual definition on the aspects that need to be achieved prior to moving to subsequent phases (Pande et al., 2000).

Snee (2000) defined it as a method of sequences that links improvement tools into an overall approach. It is known as a rational and systematic way of capturing and generating knowledge (Choo et al., 2007a). This is similar to artificial intelligence that programmatically copes with learning and creating knowledge. Adler et al. (1999) views this as a meta-routine, a routine to for problem-solving process. Having a structured method has a consequence on cognition-influencing mechanism that leads to learning behaviors and knowledge creation in quality improvement teams like Six Sigma (Choo et al., 2007a). The use of DMAIC methodology aids in the process of learning in project teams (Anand et al., 2010; Arumugam, Antony & Linderman, 2014; Choo et al., 2007a; Javier Lloréns-Montes & Molina, 2006; Linderman, Schroeder & Sanders, 2010).

The learning in quality improvement involves operational and conceptual learning (Kim, 1993; Mukherjee et al., 1998). As Arumugam et al. (2013) enlightened the Define and Measure phases are parallel to operational learning wherein team members acquire and assimilate the *know-what* knowledge of the project. Also, it implies that at these phases the members gather what are the problems and the severity viewed in the process under study and what is the necessity to do the projects. They explained that with knowing-what, teams explore further to get more process knowledge and information relevant to projects. This may span across various divisions, business units, subsidiaries and even customers and suppliers. This is because Six Sigma application have a tendency to extend out to customers and suppliers alike. For example, companies like 3M and GE utilize Six Sigma programs either collaboratively with their external stakeholders or partner them in their projects (Antony, 2004a; Kumar, Antony, Madu, Montgomery & Park, 2008).

This certainly allows for the enhancement of potential absorptive capacity when there is a high inflow of knowledge resources coming from these external stakeholders. The subsequent phases of Analyze, Improve and Control according to Arumugam et al. (2013) illustrates the *know-how* knowledge wherein the team engage in collective learning behavior by knowing and implementing far-reaching adaptations involving modification of processes for improved outcome. In other words, at these phases are where team members rationalize and transform the conceptual ideas gained previously into practical use by testing out pilot plans and executing new ideas for sake of improvement. The authors explained that knowing-how knowledge is transpired upon the acquisition of basic knowledge of the process and attained skills in problem solving through knowing-what learning. From the viewpoint of absorptive capacity, potential absorptive capacity of acquiring and assimilating relevant knowledge regarding the process under study precede the realized absorptive capacity where external knowledge is transformed and exploit towards resolution.

However, circumstances may exist where solutions require for more acquisition and assimilation of information and new knowledge at the later stages of Analyze, Improve and Control too. This is because solutions proposed at this stage needs to be viable and beneficial to the organization and is where creativity is enticed. Thus, teams may learn and search further for more relevant information and alternative solutions to suffice the necessity.

The dimensions of absorptive capacity have a clear path ranging from potential to realized spanning through the DMAIC phases as depicted in Figure 3.2 below:

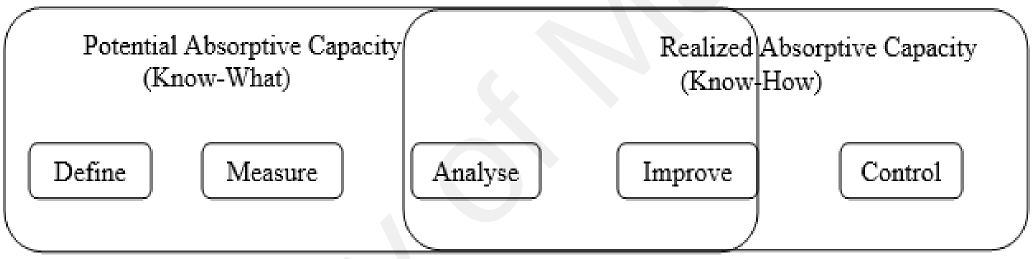


Figure 3.2: Relation of DMAIC Phases with the Dimensions of Absorptive Capacity

Source: Author

Hence, it is proposed that:

H4a: SIP has a positive effect on Potential Absorptive Capacity (PACAP) (that is, external knowledge acquisition and assimilation)

H4b: SIP has a positive effect on Realized Absorptive Capacity (RACAP) (that is, external knowledge transformation and exploitation).

3.3.2.3 Focus on Metrics (FOM) and Components of Absorptive Capacity

Six Sigma places a stringent focus on metrics in order to achieve specific and challenging goals in its improvement projects (Linderman et al., 2003). Six Sigma uses various metrics in quality and continuous improvement processes such as sigma levels, process capabilities, critical to quality metrics, defect measures such as DPMO and the likes (Breyfogle, Cupello & Meadows, 2001; Linderman et al., 2003; Pyzdek, 2003). As postulated in the literature and by practice, Six Sigma metrics are used to set improvement goals (Linderman et al., 2003; Pande et al., 2000; Zu et al., 2008). Six Sigma's improvement goals are rigorous as many in the process improvement field would concur with its renowned 10-fold improvement from the baseline performance (Linderman et al., 2003; Pande et al., 2000). Six Sigma's strategy of setting high goals is in parallel to stretch goal strategy (Choo, 2011). Stretch strategy involves creating gaps between a firm's current capabilities and the intended targets which means that current organizational members' abilities are way below than what is envisioned through the goals (Hamel & Prahalad, 1993). These targets are commonly hard to achieve goals.

Goal theory suggests that individuals with challenging goals will have higher performance than those with non-specific or "do your best goals" (Locke & Latham, 1990, 2002). This is because, goals serve as motivational mechanism that regulates human action (Locke et al., 1981). Challenging goals mobilize effort, direct attention, encourage persistence and influence strategy development (Locke & Latham, 1990; Seijts & Latham, 2005).

Challenging goals represents a sense of challenge to those who are imposed of it. Creativity literatures observe that people who feel the sense of challenge are naturally driven to be more creative and generate more ideas for solutions to a problem (Amabile, 1996; Amabile & Gryskiewicz, 1987). Choo (2011) studied how a performance and problem-driven gap of Six Sigma project experience leads to a sense of challenge through the higher goals setting it advocates which consequently influence knowledge creation in Six Sigma teams.

Linderman et al. (2003) explicated specific goals will guide team members to take more efforts pertaining to their tasks and focus on accomplishing improvement objectives. The metrics function as an evaluation tool to closely monitor the process over time and response quickly if needed (Pande & Holpp, 2002; Snee & Hoerl, 2003). Dasgupta (2003) mentioned metrics in Six Sigma can be used to measure different types of processes and teams may benchmark different process for more improvement opportunities. Linderman et al. (2006) finds that Six Sigma tools and method interacts with goals set in projects, in that increasing goals linearly improves performance in the presence of Six Sigma method.

The challenging goals set through focusing on metrics in Six Sigma enables greater effort in both components of absorptive capacity which involves learning and exploiting from it. As Linderman et al. (2003) articulated, the creation of knowledge in Six Sigma occurs through intentional learning which requires regulation of actions. Subsuming that, they mentioned that improvement goals motivate organizational members to engage in intentional learning activities which enables the creation of knowledge to resolve problems. Therefore, focusing on metrics enables learning activities as with the feature of PACAP. With focus on metrics, members of Six Sigma team are impelled towards learning activities to scour for resolution to their problems. This would involve them to acquire and assimilate knowledge that best represent their issues. Also greater effort will be spent to translate the knowledge into outcomes as required to achieve the high targets. As mentioned, challenging goals in essence would result in higher performance.

However, too high targets can truncate progress as mentioned by Linderman et al. (2003). This implies to the effort of team members' determination in getting the project done as per the goal set by the champions or customers in the Define phase of the methodology. Exploitation capabilities require efforts to convert knowledge into outcomes (Kogut & Zander, 1996). In that sense it refers to the transformation and exploitation dimensions of the RACAP which involves the transformation capabilities and creative process this component requires. Given the arguments above, the study hypothesize:

H5a: FOM has a positive effect on Potential Absorptive Capacity (PACAP) (that is, external knowledge acquisition and assimilation)

H5b: FOM has a positive effect on Realized Absorptive Capacity (RACAP) (that is, external knowledge transformation and exploitation).

3.3.3 Potential and Realized Absorptive Capacity

Potential absorptive capacity (PACAP) constitutes of external knowledge acquisition and assimilation. Whereas realized absorptive capacity (RACAP) comprises transforming and exploiting the external knowledge. Potential absorptive capacity will enable a firm to be more receptive in acquiring and assimilating external knowledge (Lane & Lubatkin, 1998; Zahra & George, 2002). With realized absorptive capacity the firm will be able to capitalize on the knowledge that has been absorbed (Zahra & George, 2002).

In distinguishing the components of absorptive capacity, Zahra and George (2002) revealed that PACAP and RACAP are distinctive but play complementary roles as they coexist at all times and fulfil necessary and insufficient condition in improving firm performance. They explained that firms may acquire and assimilate knowledge but may not have the ability to exploit them. Besides, without absorbing the knowledge first, firms could not exploit the knowledge as well, as RACAP involves transforming and exploiting the assimilated knowledge (Zahra & George, 2002). Therefore, firms with high PACAP does not necessarily mean will be superior in performance, likewise for those with a higher RACAP. Firms should store and maintain newly generated knowledge for accessibility of organization members to transform and exploit it in their operational and project necessities (Leal-Rodríguez, Roldán, Ariza-Montes & Leal-Millán, 2014).

The dichotomy between PACAP and RACAP are in lieu to the different structural properties which relates to the advantages and disadvantages in the knowledge processes (Tsang & Zahra, 2008). Cepeda-Carrion, Cegarra-Navarro and Jimenez-Jimenez (2012) explains that PACAP can be internalized by managers and selected employees who have developed relational trust, common language and confidence through their interactions. In the application of Lean Six Sigma, the organizational structure embeds of a specialized role structure which act as a strong socializing mechanism where trust and teamwork is built through continuous improvement projects.

In addition to it a common language which sometimes known as the Six Sigma language will become a norm within the organization as employees comprehend to the nature of the project undertakings which necessitates this language. RACAP on the other hand can be exhibited in rules, procedures and problem solving routines (Cepeda-Carrion et al., 2012; Nonaka, 1994). The DMAIC methodology is fundamental in transpiring the characteristics of RACAP in this context. Cepeda-Carrion et al. (2012) submits that PACAP is an important component of absorptive capacity but very little could be achieved without the traits of RACAP, implying that both components play a supplementary role towards the enhancement of firm performance outcomes. Lazaric, Longhi and Thomas (2008) claimed that the passage from PACAP to RACAP is not only a period of going beyond a simple discovery of knowledge base but a stage where competencies are integrated. Therefore, it is hypothesized:

H6: Potential Absorptive Capacity (PACAP) has a positive effect on Realized Absorptive Capacity (RACAP).

3.3.4 Mediation Effect of Components of Absorptive Capacity

This study's intention is to understand to what extent Lean Six Sigma practices influences the components of absorptive capacity. Zahra and George (2002) did mentioned that PACAP and RACAP are indeed separate but complimentary. Besides, the proponents articulated absorptive capacity in a sequential order, meaning PACAP comes first before RACAP. This means that firms could not exploit knowledge without acquiring them first. Also they believe that high PACAP does not necessarily leads to high RACAP. Given the sequential manner of these components, it motivates the study to learn and contemplate whether PACAP indeed act as a mediator between the practices of Lean Six Sigma and RACAP or are they differently associated as predicted in some literature (Cepeda-Carrion et al., 2012; Flor, Cooper & Oltra, 2017). Therefore, it is contemplated:

H7a: Potential Absorptive Capacity (PACAP) mediates the relationship between LTP and Realized Absorptive Capacity (RACAP)

H7b: Potential Absorptive Capacity (PACAP) mediates the relationship between LSP and Realized Absorptive Capacity (RACAP)

H7c: Potential Absorptive Capacity (PACAP) mediates the relationship between RS and Realized Absorptive Capacity (RACAP)

H7d: Potential Absorptive Capacity (PACAP) mediates the relationship between SIP and Realized Absorptive Capacity (RACAP)

H7e: Potential Absorptive Capacity (PACAP) mediates the relationship between FOM and Realized Absorptive Capacity (RACAP).

3.3.5 PACAP, RACAP, Innovation Performance and Sustainable Competitive Advantage

Ever since the enunciation of PACAP and RACAP by Zahra and George (2002), scholarly works had attempted to study the outcomes from the components in varying degrees.

Gebauer et al. (2012) for instance studied absorptive capacity, learning processes and combinative capabilities as determinants of strategic innovation. In turn they conceptualized the outcome as a source of competitive advantage. In another study, Minbaeva, Pedersen, Björkman, Fey and Park (2003) studied PACAP as high content of employees' ability and RACAP as high content of employees' motivation effects transfer of knowledge in MNCs subsidiaries which is seen as source of competitive advantage. Leal-Rodríguez et al. (2014) studied the effect of PACAP and RACAP in the context of relational learning and how it relates to innovation performance which is conceptualized to bring long term competitive advantage. Fosfuri and Tribó (2008) explored the antecedents of PACAP and its impact on innovation performance while conceptualizing PACAP as a source of competitive advantage. Although many research as before mentioned technically conceptualized the outcomes as per Zahra and George's (2002) view, there appears to be a dearth in conceptualizing the relationship between PACAP, RACAP, innovation performance and sustainable competitive advantage in an overt manner with empirical evidence. As per the studies mentioned, the relationship between these four paradigms is thus far in a piecemeal fashion, not to mention in particular to the perspective of Lean Six Sigma. Therefore, this study intends to overtly verify the relationship between the four in the context of Lean Six Sigma.

Zahra and George (2002) explicated that PACAP and RACAP are distinctive but complementary and coexist in developing and enhancing firm performance outcomes. Hence as a bundle of knowledge-based capabilities, they submitted the components of absorptive capacity can be a source of competitive advantage for firms. However, their demarcation clearly elucidated that PACAP and RACAP differentially contributes to sustainable competitive advantage which need to be considered meticulously.

PACAP is relative to learning capabilities through acquisition and assimilation of external knowledge. Zahra and George (2002) argues that PACAP will enable firms to continually revamp their knowledge stock and therefore be more adept in changes in the external environment. This enables them to overcome competency traps. There is two vital dimensions in being adept which are timing and cost. Being able to spot differences and learn opportunities in the market, firms could track these changes and deploy necessary capabilities at the right moment (Zahra & George, 2002). As Lei, Hitt and Bettis (1996) mentioned learning competencies are essential to the formation of sustainable competitive advantage. Lazaric et al. (2008) described firms need to mobilize energy to materialize potentialities inherent in their knowledge base in order to gain competitive advantage. From the perspective of cost, firms cost of change are likely low when they have rich knowledge and skill base (Teece et al., 1997; Zander & Kogut, 1995). Zahra and George (2002) elucidated that since capabilities are found in organization routines, as PACAP are being developed, their routines will be managed more efficiently. Hence cost of capability development tends to depreciate over time rendering firms with low sunk investment cost as firms change resource position and operational routines (Zahra & George, 2002).

Cohen and Levinthal (1990) famously coined the concept of absorptive capacity with innovation. Tsai (2001) similarly debated on how organizational unit can gain useful knowledge from other units to enhance its innovation and performance. Nevertheless, the distinction between the components of absorptive capacity enables us to view in detail how it all happens in rendering performance outcomes. Zahra and George (2002) pointed out that RACAP is the primary source of performance improvements. They expounded knowledge transformation and exploitation involves deriving new insights from the combination of existing and newly acquired knowledge subsequently incorporating into operational routines. Following Kazanjian, Drazin and Glynn (2002) assertion that firms require knowledge leveraging and skill recombination to pursue novel introduction, it was claimed that RACAP involves the process of 'bisociation' wherein firms develop new perceptual schemas through making changes in existing process. Subsequently, exploitation enables the conversion of this novelty into new products or services.

The teams of Lean Six Sigma are built of an open and supportive climate (Dahlgaard & Dahlgaard-Park, 2006; Javier Lloréns-Montes & Molina, 2006), which facilitates creativity and communication amongst the team members (Gutiérrez et al., 2012). This centers improvisational learning skills in innovation execution through transformation and exploitation capabilities. These capabilities markedly influence innovation performance of firms through product and process innovation as postulated by Zahra and George (2002).

According to Daghfous (2004) and Prajogo and Ahmed (2006), innovation is a key source of competitive advantage in the knowledge-economy era that we are in today. Innovation can create 'isolation mechanism' that safeguards profit margins thus enable capitalization of benefits for firms (Lavie, 2006). Teece (2007) explicated that innovation would render firms the ability to create and deploy capabilities that assist in the long-run business performance. Given that innovation is related to novel creation in products, services and processes, it adds value to firm's capabilities and could make external imitation difficult and therefore offer firms the ability to sustain their advantages (García-Morales, Ruiz-Moreno & Llorens-Montes., 2007). It is evident that through innovation, product, services and processes would cater the characteristics of competitive advantages in terms of value adding, cost effective, rare and non-substitutable (Carnegie & Butlin, 1993; Lee, Lee & Pennings, 2001; Livingstone et al., 1998). Herbig (1995) affirmed that innovation had become a competitive instrument in fending off inevitable decline in lieu of complacency and rigidity of status quo, maintaining that innovation is to be a key source of comparative advantage in the global market.

In the context of Lean Six Sigma philosophy, consistent improvement is fundamental. The search for knowledge is a continuous effort which involves novel exploration and exploitation activities which takes place in Lean Six Sigma projects. The consistent quest impels innovativeness to flourish by means of exploiting knowledge inherent within the firm when searching resolutions during Lean Six Sigma initiatives. Meanwhile through Lean Six Sigma projects, firms enhance its richness of knowledge bank which determines its learning capability. Adding to this is the competence level of Lean Six Sigma project team members which are the source absorptive capacity of firm. This affluence is an essential element of competitive advantage of firm from the perspective of knowledge-based view. Hence, Lean Six Sigma firms are able to relatively distinguish this facet through PACAP in attaining sustenance of competitive advantage. Authors and scholarly works have noted on aspects which foster organizational learning is regarded as a source of competitive advantage (Huber, 1996; Rindova & Fombrun, 1999; Senge, 1990; Tu et al., 2006). As Cohen and Levinthal (1990) asserted, learning capabilities (PACAP) are crucial in developing capacity to comprehend existing knowledge. Whereas problem solving skills (RACAP) represents the ability to generate new knowledge for innovation.

Given the literary explication on the differential impact of PACAP and RACAP towards innovation performance and sustainable competitive advantage, it is hereby clear that PACAP has a greater impact towards sustenance of competitive advantage following its flexibility in reconfiguring resources in addition to effective timing capability deployment at lower cost, whereas RACAP is likely to impact innovation performance by transforming and exploiting firms knowledge base in search of novelty and benefits which also converges to the contribution of competitive advantage (Zahra & George, 2002). Thus, it is posited:

H8: Potential Absorptive Capacity (PACAP) has a positive effect on Sustainable Competitive Advantage (SCA)

H9: Realized Absorptive Capacity (RACAP) has a positive effect on Innovation Performance (IP)

3.3.6 Innovation Performance and Sustainable Competitive Advantage

The resource based view explains firms within the industry are composed of heterogeneous strategic resources. The ability to manage these resources which induce value, rareness, inimitability and not easily replaced would likely sustain the competitive stance of organizations. Innovation had always been a key pillar in determining sustainability of competitive advantage in addition to being a source of competitive advantage (Prajogo & Ahmed, 2006) and a critical drive of economic performance (Urbancova, 2013). As Tushman and Nadler (1986) explicated, organization's ability to gain competitive advantage is realized through managing effectively today while simultaneously creating innovation for tomorrow. Besides technological aspects, one other crucial antecedent of innovation is the human aspect which involves the structure and culture of the organization (Prajogo & Ahmed, 2006). Research had entailed that people and organizational structures are main determinants of successful innovation (Cooper & Kleinschmidt, 1995; Zien & Buckler, 1997).

In managing innovation under the perspective of people and social practice, Prajogo and Ahmed (2006) explains the significance of developing managerial practices and actions that functions as a stimulus in inducing people to innovate through the enrichment of ideas and knowledge. Lean Six Sigma is a philosophy that underlies the notion of continuous improvement. The very essence of applying such a philosophy embeds the idea of enhancing organizational capability especially in the form of knowledge (Ang, 2015; Linderman et al., 2004) given its stance as the most strategic resource (Davenport & Prusak, 1998; Grant, 1996a, 1996b).

The market revolves around a changing customer demographics which alters the customer expectation accordingly. Thanks to technological advances, this stance had been on a rapid progression as of late. Lean Six Sigma advocates in picking of those signals or more so, magnetize a firm's ability to relate to the changing environment and improvise their existence and objectives consequently. Through Lean Six Sigma projects which are deployed to address such circumstances, firms engage in invention and innovation of products, processes and organizational changes (He, Deng, Zhan, Zu & Antony, 2015). This type of public research or research in general (Autant-Bernard, 2001; Urbancova, 2013) is known to spur innovation performance which results in realization of higher profits and market share (Calantone, Vickery & Dröge, 1995; Cooper, 1993; Griffin, 1997; Narver & Slater, 1990).

Leadership and top management support is an important role in innovation (Baker, Green, & Bean, 1986; Cooper, 1988; Lee & Na, 1994) as inciting a learning environment is imperative to shape a fertile environment or organizational culture which nurtures innovation (Jassawalla & Sashittal, 2002; Martensen, 1998; Prajogo & Ahmed, 2006). Also, empowerment and involvement is a potent determinant of innovative behavior as submitted by studies (Amabile & Gryskiewicz, 1989; Spreitzer, 1995). Lean Six Sigma is denoted as a philosophy of a top-down approach or which is driven the top management. Projects of Lean Six Sigma are those strategically driven from business plans to achieve relevant targets. Top management support stands out as a critical element in Lean Six Sigma success factors in parallel to innovation management (Abu Bakar et al., 2015; Fadly Habidin & Mohd Yusof, 2013; Lande et al., 2016; Laureani & Antony, 2012; Manville, Greatbanks, Krishnasamy & Parker, 2012). It is predominantly advocated that process improvement concepts are driven by knowledge and activities which incites learning behavior in firms (Ang, 2015; Choo et al., 2007b; Linderman et al., 2010; Schroeder et al., 2008).

Besides, the belt system which acts as a parallel-meso structure within Lean Six Sigma organizations act as a mentor system wherein different levels of specialist acts as a coach to subsequent levels in enacting knowledge exchange process. This belt system caters the involvement of employees from different levels of expertise thereby enabling cross-functional collaboration which facilitates dynamic idea generation.

It has been accepted that Lean and Six Sigma could channel innovation effectively (He et al., 2015; Nicoletti, 2015; Sony & Naik, 2012). Innovation outcomes and characteristics accomplished through Lean Six Sigma positions a firm as dynamically capable of embracing change in the market and aligning its competitive stance. The innovative outcomes that results from Lean Six Sigma projects targets to add value to customers. Meanwhile appropriating Lean Six Sigma to its fullest would allow a firm to possess a low cost advantage in the market, reaping profitability advantages. The parallel-meso structure drives proficiency or managerial capability that embrace change effectively and rather flexibly. This innovativeness is able to create newness in the company in a continuous or consistent basis especially cushioning turbulent time, thereby creating organizational features that are value adding, rare, inimitable and non-substitutable. Given innovation as a source of competitive advantage, the ability to possess such characteristics would enhance the capability of the firm to strategically manage its resources, especially knowledge. Therefore it is hypothesized;

H10: Innovation Performance (IP) achieved through Lean Six Sigma has a positive effect on Sustainable Competitive Advantage (SCA).

3.4 Summary of the Chapter

A total of nineteen hypotheses were proposed which illustrate the relationship between all the variables of the research model. This includes the relationship between Lean Six Sigma idiosyncrasies and the components of absorptive capacity, potential and realized absorptive capacity. Also, the relationship between potential and realized absorptive capacity with innovation performance and sustainable competitive advantage.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Overview of the Chapter

This chapter will discourse about the methods used to examine the research questions. The discourse will firstly be on the research design strategy which comprises a quantitative approach. The questionnaire development, data collection, analysis procedure for the survey and research setting in terms of population and sample will be discussed.

4.2 Research Design

It is a known fact especially in the field of academic research that a research can be conducted namely in three manners quantitative, qualitative and a mixed method of the two. Creswell, Klassen, Plano Clark and Smith (2011) submitted that in planning a research the aforesaid research design of quantitative, qualitative and mixed mode method should be carefully considered in making the final decision for an apt research structure. A quantitative oriented research is conducted in the essence of deductive research. Whereas on the contrary, a qualitative research has an inclination to an inductive approach to a certain extent in which research focused on theory-development is preferably to take place. The level of subjective enquiry within a qualitative research is much intense as compared to quantitative research which intends to approve a phenomenon. A mixed mode method, to simply put, is a combination of both through which the enquiries (qualitative approach) are followed by verification through objective (quantitative approach) means (Creswell, 2013; Creswell et al., 2011; Jick, 1979; Mertens, 2014).

In conjunction to Sekaran and Bougie (2003), the purpose of study also plays a part in determining research design, wherein the purpose of study could be in the form of exploratory, descriptive and causal. According to these authors, an exploratory study is conducted when not much information about a phenomenon are known or were it to even exist. Therefore, an extensive preliminary work needs to be done to search for the extent or magnitude of the problem. A descriptive study is whereby the association among variables to describe populations, events and situations are intended to be proven. This happens to identify correlations among those studied variables wherein there's intense collection of data along the process. Causal study is to determine causality in which whether or not one variable causes another or otherwise (Sekaran & Bougie, 2003). This study will be conducted using a quantitative method in an attempt to explore the path of how Lean Six Sigma leads to far reaching outcomes such as innovation and sustainable competitive advantage in organization.

4.3 Quantitative Analysis

Creswell (2013) distinguished quantitative research designs into experimental and non-experimental. Experimental research involves investigating certain outcome following specific treatments across various groups or subjects. Whereas non-experimental studies involves survey research that provides quantitative or numeric description of trends, attitudes or opinions of a sample, which results could be generalized to the relevant population (Fowler, 2008). Survey, generally includes two types. Cross-sectional, which involves collection of data at a particular point in time (Sekaran & Bougie, 2013) and longitudinal, in which the data is collected across different span of time or at multiple points in time, to analyze the change in the results over time (McKinlay, 2011). In this study, a cross-sectional survey approach was employed in order to collect data and test the hypotheses.

4.4 Survey Settings and Sampling Procedure

4.4.1 Unit of Analysis and Respondents

This study focuses on Lean Six Sigma's path towards absorptive capacity which then leads to innovation and sustainable competitive advantage. The unit of analysis for the quantitative study are firms implementing Lean Six Sigma.

As such, the respondents for the survey should be of those who have the relevant exposure and experience in the undertakings of Lean Six Sigma implementation. The projects of Lean Six Sigma are strategically oriented to the business goals, vision and mission of a company (George, 2002; Pande & Holpp, 2002). The role structure of a company adopting this philosophy is known as a parallel-meso structure in which the top of the structure will be the champions or sponsors followed by Master Black Belts, Black Belts, Green Belts and Yellow Belts (Pyzdek, 2003; Schroeder et al., 2008). Champions or Sponsors usually are represented by high-level personnel of firms like executive presidents, vice presidents, sector or department heads and the likes who understand the concept and are committed to its success (Pyzdek, 2003). Master Black Belts are somewhat as internal consultants within the firm who serves as a coach or mentor to Black Belters and at the meantime connects the business strategy of the company unto project scopes (Pande & Holpp, 2002).

Black Belters are crucial, full-time technically oriented process improvement leaders that tackle critical cross-functional projects and also serves as mentor to Green Belters (Pande & Holpp, 2002; Pyzdek, 2003). Green Belters are also project leaders but with handling confined scopes that are inter-departmental and sometimes are also known as part-time leaders (Pande & Holpp, 2002). Finally Yellow Belters form the core members of a project and consistently review the projects' progress besides being subject matter experts of the process under investigation (De Mast, 2006; Laureani & Antony, 2011).

The parallel-meso structure is a functional hierarchy that defines the roles and responsibilities of the belt system. Since the purview of this study is strategically oriented on the functioning of the firm towards innovation performance and sustainability of competitive advantage through Lean Six Sigma application, either one of the top role structure which are directly involved in the firm's business strategy through the Lean Six Sigma projects will form the respondents for this study. These are either the champions or sponsors, Master Black Belters, Black Belters or Green Belters. The Green Belter is the minimum requirement for a respondent.

This is because being project leaders at least at the Green Belt level requires them to connect the goal of the projects to the business strategy of the company which would be cascaded down through champions or sponsors, Master Black Belters and Black Belters. In other words, these four top structures most likely have sound knowledge on the firms' business strategies and its link to the Lean Six Sigma projects and how they are being administered in their company, which makes either one of them as the favored target respondents for this study. Not that Yellow Belters are insignificant, sometimes they are engaged as project leaders that are Kaizen-based and Just-Do-It oriented which at this level does not require them to relate it to business strategies. Therefore, given the framework of this study, the respondents should be at least a Green Belter.

4.4.2 Target Population and Sample

Given the profoundness of Lean Six Sigma application in the manufacturing industry, the target population for the cross-sectional survey are manufacturing firms that have implemented Lean Six Sigma in Malaysia, in particular Peninsular Malaysia. These firms supposedly have exposure and experience in the implementation of Lean Six Sigma.

Congregating the population of companies implementing Lean Six Sigma in Malaysia is rather a complex and entangled task. Furthermore, when it comes to process improvement methodologies such as Lean and Six Sigma there are no formal or private institutions or bodies that are responsible to populate firms that practice these philosophies. The rationale for this is because the decision to implement Lean Six Sigma is totally within the discretion of the firms or its top management. In addition to it, most companies had turned towards fashionable trademark by calling the philosophy in their own terms. For example, DHL's continuous improvement methodology closely resembles the Lean Six Sigma concepts but known as 'The First Choice'. Danone Group synonymously called its continuous improvement efforts as 'DaMaWay' in short for Danone Management Way (Ferrer-Bonsoms, 2012). At Nestle on a global scale they call this vision as Nestle Continuous Excellence or NCE in brief (Sjoblom & Michels-Kim, 2011). Given this complexity, a broader sampling frame is much appropriate.

Adding to the fact on why manufacturing industry were emphasized is that both Lean and Six Sigma germinated from the manufacturing industry. Therefore, the terms of this philosophy is pretty much adept in manufacturing firms compared to services. However, it should not be disregarded that services industry are also growing equally in the embracement of Lean Six Sigma. The study's initial attempt to reach for services companies using Lean Six Sigma proved to be much more complex, tedious and time consuming compared to manufacturing. One of the reasons realized in the experience was Lean Six Sigma application in many services firms that were approached seemed to be in silos, known only to certain departments or divisions. Lean Six Sigma would not work effectively in such condition as it was meant for a comprehensive business strategy. Furthermore, the target respondents should have an adept and appropriate application regime on Lean Six Sigma through which they could provide substantial response through the questionnaire, particularly related to the practices and outcomes. Therefore, in order to ensure consistency and reliability of target respondents subject to Lean Six Sigma application, it was decided to focus on manufacturing industry.

The Malaysian Productivity Corporation (MPC) is the closest formal institution or governmental body that is associated in ensuring productivity effectiveness and performance excellence. MPC collaborates with private institutions and bodies in providing training and awareness programs on Lean Six Sigma. Given this fact, the MPC was initially approached for possible list of companies practicing Lean Six Sigma. A meeting was setup with the Director of Quality and Excellence Development Division (QED) pertaining to the research intention. According to MPC, they are experiencing similar issues on their own effort to build such database on companies that are practicing Lean Six Sigma. It was mentioned that such a database will be of great assistance in measuring policy formulation and execution. However they do have a list of companies that they have provided trainings in the past which are very minimal nevertheless which they are willing to share to support this study. They also provided permission to the research in the use of MPC's good name for the purpose of identifying companies utilizing Lean Six Sigma[1].

Since Lean Six Sigma stems from a quality management paradigm, the SIRIM was subsequently approached to obtain companies listed under the ISO series predominantly ISO 9001 and ISO14001. Upon going through the list of companies under the database it was unfortunate to learn some important information are hard to obtain such as person in charge, firm size by employees and some are even inactive members within the list. However, upon discussion with two senior officials at SIRIM, it was advised to best approach the Federation of Malaysian Manufacturers[2].

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[1] A meeting on the intention of the research and a short presentation of the study was done on 19th December 2016. Dr. Rahmat Md. Ismail, the Director of Quality and Excellence Development Division consented on the hardship of collecting the list of Lean Six Sigma practicing companies which MPC themselves are finding it difficult. The MPC extended its goodwill by permitting the use of its name for data collection purpose in return for sharing the outcome of the research upon completion. An official letter dated 24th January 2017 is available in Appendix B1.

[2] The executives of SIRIM was met on 7th February 2017 on a non-appointment or an ad-hoc basis. According to them, SIRIM does not possess any database of Lean Six Sigma, for which they suggest the use of FMM who have an updated list of active manufacturers along with ISO certification from where the identification process could begin.

Federation of Malaysian Manufacturers (FMM) possess database containing primary information of manufacturing companies registered under them and are subject to updates on an annual basis. The database also offers list of companies under ISO standardization. Jain and Ahuja (2012) claimed that ISO is an enveloping management system which outlines minimum requirements to follow a standardized quality and management system. But it does not specify the details of the operationalization, the 'Know-Hows' of it. One of the key principle in the ISO standardization is continuous improvement which both Lean and Six Sigma underlines. Therefore, there is a great tendency for companies using ISO standards towards adopting philosophies like Lean and Six Sigma (Chiarini, 2011; Karthi, Devadasan & Murugesh, 2011; Khalili, Ismail & Karim, 2015; Marques, Requeijo, Saraiva & Frazao-Guerreiro, 2013).

ISO 9001 specifies clauses (previously eight now ten clauses) for the minimal requirement of standards for continuous improvement efforts wherein Lean and Six Sigma could be amicably adopted (Micklewright, 2014). Whereas Lean has been lately much associated to ISO14001 given its ability to eliminate wastages (King & Lenox, 2001a, 2001b; Yang et al., 2011). Therefore, these two universally applied ISO standards are considered as the frame for the study.

The FMM 2016 directory (47th edition) contains 2844 manufacturing companies in Malaysia out of which 1244 are ISO 9001 and 516 are ISO14001 accredited. However, upon cross checking for duplicates it seems many of the companies possess both these quality standards as these are most widely and customarily acquired. Summing up those redundancies in total there are 1311 companies using ISO 9001 and ISO14001. Given the tentative nature of Lean Six Sigma application in companies, in order to establish the population of companies using Lean Six Sigma, series of calls were made on a gradual term to these 1311 companies in addition to follow up emails and face-to-face meetings with some of the companies to learn if they are applying Lean Six Sigma. A total of 544 companies were identified to have been using Lean Six Sigma in some extent.

4.4.3 Sampling Method and Sample Size

The sampling method depends on the goal of the study. If the study intends to generalize the result into the entire population with providing statistical assertion with a representative sample, then a probability sampling is appropriate (Cooper &Schindler, 2010; Zikmund, Babin, Carr & Griffin, 2013; Bryman & Bell, 2011). But if the study intends to learn individual results or under the circumstances found that random selection is not feasible, then a non-probability sampling is an appropriate choice (Cooper &Schindler, 2010; Zikmund et al., 2013; Bryman & Bell, 2011). However, if all the elements in a field of inquiry is possibly under consideration, a complete enumeration of all the items in the 'population' is known as a census inquiry (Kothari, 2004; Sekaran & Bougie, 2013). Census inquiry, applied appropriately could reduce or possibly eliminate sampling error or bias (Lindner, Murphy & Briers, 2001).

Since the study managed to identify 544 companies practicing Lean Six Sigma, a census design was chosen involving ten states and a Federal Territory within Malaysian Peninsula. These states are Johor, Melaka, Negeri Sembilan, Selangor, Perak, Kedah, Pulau Pinang, Perlis, Terengganu, Pahang and Kuala Lumpur.

To date there are many debates on a reference or rule of thumb on administering an appropriate sample size for a study. In conducting a Structural Equation Modeling (SEM) analysis, there are no accurate and deterministic rule in estimating sample size however the absolute minimum sample size must be nonetheless greater than the number of covariance or correlations in the input data matrix (MacCallum, Browne & Sugawara, 1996). Roscoe (1975) explicates a minimum sample size of at least ten times of the variables in a study. Kline (2011) endorsed a minimum of 10 times to an ideal of 20 times of subject parameters. Roscoe (1975) in summary indicates a rule of thumb in which sample size of greater than 30 and less than 500 should be appropriate for most research. In the meantime researchers in SEM commonly propose a minimum sample size between 100 and 150 (Anderson & Gerbing, 1988; Ding, Velicer & Harlow, 1995).

In PLS-SEM, just like any other statistical techniques, the study needs to consider sample size against the background of the model and data characteristics (Hair, Hult, Ringle & Sarstedt, 2016). Hair et al. (2016) suggested the use of G*Power program which helps to identify statistical power analyses for multiple regression models. As per Cohen (1992), an effect size of 0.8 or 80% is a large enough effect for social science research and is the commonly used level of statistical power. And given the maximum number of arrows pointing at a construct in the study is six, the number of sample size required as per the model for an effect size of 0.8035 (80.35%) is 98 (refer Appendix B2). In order to compensate for non-responses and poor responses, a total of 519 surveys (excluding the 25 that was used for pilot test) was administered. The response received in final count were 125, which were above the requirement of the model of 98 to ensure the appropriate effect size.

4.5 Operationalization of Variables and Measurement Scale

The measurements used in this study were created upon extensive review from the literatures on the subject matters. As per Sekaran and Bougie (2010) and a multi-item measure is a more reliable method in measuring a variable or construct compared to a single-item measure. The measures used in this study are adapted and modified from validated measures from extant relevant studies to operationalize the constructs (Bryman & Bell, 2011). The adaptation and modification is done to ensure the measures and items are suitable to the research setting and understanding of the respondents.

Likert (1932) created a scale that could be used to measure or assess attributes of survey respondents pertaining a matter. This type of scale is desirable in most statistical operations as it enables the computation of arithmetic mean from interval-scale measures (Cooper & Schindler, 2010). The initial version of the scale created by Likert involves five-points which captures the agreement of respondents from strongly disagree to strongly agree or vice versa. There are also various types of rating scales apart from Likert scale such as numerical scale, itemized rating scale, semantic differential scale, staple scale and so forth which serves a certain purposes (Sekaran & Bougie, 2003). However, in this study the rating scale will be referred to as Likert-type. The Likert-type scales are also commonly used in empirical studies and management research alike (Zikmund et al., 2013). There has been a fair share of justifications and judgements between utilizing the 5-point and 7-point Likert type scales in research. Given the exploratory nature of this study, the researcher intends to offer clear guidelines to respondents in providing their sincere views to the questions in the questionnaire. In using a 7-point scale or more, having too many options to choose from can either frustrate or confuse respondents which can further weaken their motivation to genuinely provide their views. Similar notion had been shared in previous research which concurred that a 5-point Likert scale increased response rate and response quality in addition to reducing respondents' frustration level (Babakus & Mangold, 1992; Devlin, Dong & Brown, 1993; Sachdev & Verma, 2004). Dawes (2008) described that the 5-point scale is fairly simple for respondents to read out the complete list of scale descriptors. Likewise, the 5-point scale is readily comprehensible to respondents which enables them to express their views (Marton-Williams, 1986).

A 1-5 Likert-type scale was used in this study to measure all items in the respective constructs. Respondents were requested to read each item and descriptions carefully, understand and reflect the events or occurrences in their respective firms in order to indicate their views and extent of agreement for each question items based on the description of the scale given.

4.5.1 Lean

4.5.1.1 Lean Technical Practice (LTP)

Lean's hard practices are referred to technical and analytical tools that is used in managing improvements (Bortolotti, Boscari & Danese, 2015). Although there are plenty of tools and techniques in Lean, in order to ensure convenience for respondents, a succinct list of Lean's tools and techniques that is used commonly in Lean organizations were adapted as per Gowen III et al. (2012). The five items operationalize the construct of Lean Technical Practice (LTP) (Refer Table 4.1). Each item was measured as a 1-5 Likert scale ranging from 1 (Not Used) to 5 (Always Used).

Table 4.1: Lean Technical Practice (LTP)

No	Measurement Items
1	5S workplace organization: (Sort, Set in order [straighten], Shine, Standardize, Sustain).
2	Process Mapping (Flowchart, process map and so on)
3	Value Stream Mapping (VSM)
4	Kaizen or Kaizen Blitzes (continuous improvement events)
5	Just-in-Time (JIT) process management or inventory management

4.5.1.2 Lean Social Practice (LSP)

In Lean, practices that concern people and relations are regarded as soft practices (Bortolotti et al., 2015). Hadid et al. (2016) describe the soft practices as social bundles which they subsequently termed as Lean's social practice. Ten items adapted from the scale as per Hadid et al. (2016) for operationalizing the construct of Lean Social Practice (LSP) (Refer Table 4.2). The items include the extent in application of reward system, communication system, empowerment, involvement and commitment in continuous improvement program, having multifunctional employees, encouragement of leadership, management support, performance management system and training for continuous improvement program. Respondents were requested to identify how much effort and extent in terms of monetary, human and other resources did their firm extend on each of the activities as mentioned, as a direct consequence of implementing the practices reported in LTP. Each item was measured as a 1-5 Likert scale ranging from 1 (None) to 5 (Very Great Extent).

Table 4.2: Lean Social Practice (LSP)

No	Measurement Items
1	An appropriate reward system
2	Effective communication system
3	Employee empowerment for continuous improvement program
4	Employee commitment in continuous improvement program
5	Employee involvement in continuous improvement program
6	Having multifunctional employees for continuous improvement program
7	Encourage leadership in quality and continuous improvement program
8	Obtaining management support for continuous improvement program
9	Appropriate performance measurement system in continuous improvement program
10	Training for quality and continuous improvement program

4.5.2 Six Sigma

4.5.2.1 Role Structure (RS)

A role structure in Six Sigma refers to a systematic employee structure designated to define Six Sigma improvement specialist within a practicing organization which mainly consist of Black, Green and Yellow Belt (Pande & Holpp, 2002; Pyzdek, 2003; Zu et al., 2008). Five items were adapted from the scale of Zu et al. (2008) for operationalizing the construct of Six Sigma's Role Structure (RS) (Refer Table 4.3). The items measured the extent of practice in employing a belt structure for continuous improvement, deployment of individual employees, recognizing the depth of training and experience, providing task related training and consideration in compensation and promotion decisions. Respondents were enquired on the extent of their agreement on each item. Each item was measured as a 1-5 Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 4.3: Six Sigma Role Structure (RS)

No	Measurement Items
1	We employ a black/green belt role structure (or equivalent structure which may be called 'Six Sigma deployment structure') for continuous improvement.
2	We use a black/green belt role structure to prepare and deploy individual employees for continuous improvement programs.
3	The black/green belt role structure helps our firm to recognize the depth of employees' training and experience.
4	Our firm provides employees with task-related training so that employees who have different roles in the black/green belt role structure can obtain the necessary knowledge and skills to fulfill their job responsibilities.
5	In our firm, an employee's role in the black/green structure is considered when making compensation and promotion decisions.

4.5.2.2 Structured Improvement Procedure (SIP)

Projects carried out under the Six Sigma regime will undergo a methodology known as DMAIC which is structured, systematic and scientific towards problem solving (Choo et al., 2007b; Schroeder et al., 2008). Three items were adapted from the scale developed by Choo et al. (2007a) for operationalizing the construct of Six Sigma's Structured Improvement Procedure (SIP) (Refer Table 4.4). The items measured the extent to which the projects strictly followed the DMAIC sequence, perception that following the DMAIC was important (reverse-coded) and faithfully adhering to the DMAIC steps. Respondents were enquired on the extent of their agreement on each item. Each item was measured as a 1-5 Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 4.4: Six Sigma Structured Improvement Procedure (SIP)

No	Measurement Items
1	The project strictly followed the sequence of DMAIC steps.
2	The team felt that following the DMAIC steps was not important. *(Reversed-Coded)*
3	Each step in DMAIC was faithfully completed.

4.5.2.3 Focus on Metrics (FOM)

Six Sigma places a high emphasis in setting challenging goals which is in line to a stretch goal strategy and a strict focus on the many metrics used in handling process related activities (Choo, 2011; Linderman et al., 2003; Schroeder et al., 2008). Eight items were adapted from the scale developed by Zu et al. (2008) for operationalizing the construct of Six Sigma's Focus on Metrics (FOM) (Refer Table 4.5). The items measured the extent firms set strategic goals, has comprehensive goal-setting, convey the goals to employees, possess clear and specific goals, translates customer expectation to quality goals, connect quality performance and goals, linked with CTQ characteristics and uses systematic measures for quality related activities. Respondents were enquired on the extent of their agreement on each item. Each item was measured as a 1-5 Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 4.5: Six Sigma Focus on Metrics (FOM)

No	Measurement Items
1	Our firm sets strategic goals for quality improvement in order to improve firm financial performance.
2	Our firm has a comprehensive goal-setting process for quality.
3	Quality goals are clearly communicated to employees in our firm.
4	In our firm, quality goals are clear and specific.
5	Our firm translates customers' needs and expectation into quality goals.
6	In our firm, measures for quality performance are connected with the firm's strategic quality goals.
7	The measures for quality performance are connected with critical-to-quality (CTQ) characteristics.
8	Our firm systematically uses a set of measures (such as defects per million opportunities, sigma level, process capability indices, defects per unit, and yield) to evaluate process improvements.

4.5.3 Absorptive Capacity

4.5.3.1 Potential Absorptive Capacity (PACAP)

Potential Absorptive Capacity (PACAP) refers to the ability of a firm to be receptive to acquire and assimilate external knowledge (Lane & Lubatkin, 1998). It reflects exploratory traits such as exploratory learning (Gebauer, Worch & Truffer, 2012). Nine items were adapted from the scale of Leal-Rodríguez et al. (2014) to operationalize the construct of PACAP (Refer Table 4.6). The items measure the extent firms have frequent interactions, make visits, collect information, organize periodic special meetings, approach third parties for information, understand and analyze changing market and client demands. Respondents were queried on the extent of their agreement on each item. Each item was measured as a 1-5 Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 4.6: Potential Absorptive Capacity (PACAP)

No	Measurement Items
1	We have frequent interactions with top management and corporate headquarters to acquire new knowledge
2	Employees regularly visit other branches, units or project teams
3	We collect information through informal means (e.g., lunches with colleagues, friends, chats with trade partners)
4	Members do not visit other divisions, units or project teams *(Reversed-Coded)*
5	We periodically organize special meetings with clients, customers, suppliers or third parties to acquire new knowledge
6	Employees regularly approach third parties and external professionals such as advisers, managers or consultants
7	We are slow to recognize shifts in our market (e.g., competitors, laws and regulations, demographic changes, etc.) *(Reversed-Coded)*
8	New opportunities to serve our clients are quickly understood.
9	We quickly analyze and interpret changing client and market demands.

4.5.3.2 Realized Absorptive Capacity (RACAP)

Realized Absorptive Capacity (RACAP) refers to the firm's capacity to leverage the knowledge that has been absorbed by transforming and exploiting them into operational benefits or utilization (Zahra & George, 2002). RACAP reflects exploitative characteristics such as exploitative learning (Gebauer et al., 2012). Twelve items were adapted from the scale of Leal-Rodríguez et al. (2014) to operationalize the construct of RACAP (Refer Table 4.7). The items measure the extent firms consider changing market consequences, record and store newly acquired knowledge, swiftly recognize usefulness of new external knowledge, sharing practical experience, periodic discussion, clarity of roles and responsibilities, exploit knowledge, difficulties in implementing products and services and having a common language. Respondents were queried on the extent of their agreement on each item. Each item was measured as a 1-5 Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 4.7: Realized Absorptive Capacity (RACAP)

No	Measurement Items
1	We regularly consider the consequences of changing market demands in terms of new ways to provide services/ products.
2	Employees record and store newly acquired knowledge for future reference.
3	We quickly recognize the usefulness of new external knowledge for existing knowledge
4	Employees hardly share practical experiences *(Reversed-Coded)*
5	We work hard to seize the opportunities for our unit from new external knowledge *(Reversed-Coded)*
6	We periodically meet to discuss the consequences of market trends and new product/ services development.
7	It is clearly known how activities within our unit should be performed.
8	Clients' complaints fall on deaf ears in our unit. *(Reversed-Coded)*
9	We have a clear division of roles and responsibilities.
10	We constantly consider how to better exploit knowledge.
11	We have difficulties implementing new products and services. *(Reversed-Coded)*
12	Employees have a common language regarding our products and services.

4.5.4 Innovation Performance (IP)

Innovation performance of a firm refers to its ability to introduce new products or services, encourage new ideas for development, develop new management approaches, and adopt new improved methods (Cordero, 1990; Utterback & Abernathy, 1975). Eight items were adapted from Yusr et al. (2012) for operationalizing the construct of Innovation Performance (IP) (Refer Table 4.8). The items measured number of new products or services introduced compared to competitors, quick in bringing new products, encourage new ideas for development, increase of novelty in past years, adoption of new methods and technologies, quick to change production methods, technological competitiveness and creation of new management approaches. Respondents were enquired about the extent of their agreement on each item. Each item was measured as a 1-5 Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 4.8: Innovation Performance (IP)

No	Measurement Items
1	Number of new product/services introduction is high compared to other competitors.
2	Compared to other competitors, our company is faster in bringing new products and/or services into the market.
3	Our company encourages the new ideas presented to develop the performance.
4	Our new product/services introductions have increased over the last 5 years.
5	When we cannot solve a problem using conventional methods, we adopt and improve new methods and technologies to solve it.
6	Our company changes production methods at a great speed compared to other competitors.
7	The technological competitiveness of our company is high.
8	During the past five years, our company has developed many new management approaches.

4.5.5 Sustainable Competitive Advantage (SCA)

Sustainable Competitive Advantage (SCA) refers to firm's achievement and sustenance of economic and competitive advantage in the market through low cost advantage, greater managerial capability, better profitability and first mover advantage (Barney, 1991; Coyne, 1986; Porter, 1985). Four items were adapted from the scale of Chen, Lin and Chang (2009) to operationalize the construct of SCA (Refer Table 4.9). The items measured the extent of firms possess low cost advantages compared to competitors, better managerial capability than competitors, better profitability and first mover advantage. Respondents were enquired about the extent of having the attributes in their firm resulting from the firm's Lean Six Sigma quality program. Each item was measured as a 1-5 Likert scale ranging from 1 (None) to 5 (Very Great Extent).

Table 4.9: Sustainable Competitive Advantage (SCA)

No	Measurement Items
1	The company has the competitive advantage of low cost compared to other competitors
2	The company has better managerial capability than other competitors
3	The company's profitability is better
4	The company is the first mover in some important fields and occupies the important position

4.5.6 Summary of the Measurement Instruments

The table below portrays all the constructs in the study, where it was adapted from and the operational definition of each.

Table 4.10: Summary of the Measurements

Constructs	Source/ Authors	Operational Definition
Lean Technical Practice (LTP)	Gowen III et al. (2012)	Refers to the common technical and analytical tools and techniques of Lean's philosophy (Bortolotti et al., 2015; Hadid et al., 2016; Shah & Ward, 2007)
Lean Social Practice (LSP)	Hadid et al. (2016)	Refers to the social side or management of Lean's philosophy (Hadid et al., 2016; Shah & Ward, 2007). Concerns people and relationship (Bortolotti et al., 2015).
Six Sigma Role Structure (RS)	Zu et al. (2008)	Improvement specialist staggered according to expertise levels and receive intensive differentiated training according to their ranks i.e., Master Black Belters, Black Belters, Green Belters (He et al., 2015; Sony & Naik, 2012; Zu & Fredendall, 2009; Zu et al., 2008)
Six Sigma Structured Improvement Procedure (SIP)	Choo et al. (2007b)	A structured, systematic and scientific method of solving problems which all projects need to go through (Choo et al., 2007b; Pande & Holpp, 2002; Pyzdek, 2003; Schroeder et al., 2008)

Table 4.10: continued

Constructs	Source/ Authors	Operational Definition
Six Sigma Focus on Metrics (FOM)	Zu et al. (2008)	Goal orientation, strict focus on project goals or target and the use of metrics to monitor project progress in Six Sigma (Linderman et al., 2006; Linderman et al., 2003; Schroeder et al., 2008)
Potential Absorptive Capacity (PACAP)	Leal-Rodríguez et al. (2014)	Refers to external knowledge acquisition and assimilation (Zahra & George, 2002). Resembles exploratory traits of an organization such as exploratory learning (Gebauer et al., 2012; Limaj & Bernroider, 2017)
Realized Absorptive Capacity (RACAP)		Refers to external knowledge transformation and exploitation (Zahra & George, 2002). Resembles exploitative traits of an organization such as exploitative learning (Gebauer et al., 2012; Xia & Roper, 2008)
Innovation Performance (IP)	Yusr et al. (2012)	Firms ability to introduce new products/services, encourage new ideas for development, develop new management approaches, adopt new improved methods (Cordero, 1990; Utterback & Abernathy, 1975)
Sustainable Competitive Advantage (SCA)	Chen et al. (2009)	The achievement and sustenance of economical and competitive advantage in the market through low cost advantage, greater managerial capability, better profitability and first mover advantage (Barney, 1991; Coyne, 1986; Porter, 1985)

4.6 Survey Questionnaire Design and Pilot test

4.6.1 Survey Questionnaire Refinement

4.6.1.1 Expert Panel Review (Pre-Test)

The questionnaire was provided to an expert panel to review its content validity. The panel comprised three university lecturers in the field of Quality Management, Economics and Business and three industrial practitioners or experts in the field of process improvement reviewed the initial instrument. The panel independently evaluated each item as per the definitions given for each construct. Relevance and wording of each item, appropriateness of the scale, clarity of instruction and the design of the questionnaire were all assessed. Amendments were made in accordance to their feedback to ensure consistency in comprehension.

The panel suggested to use short and simple English language and instructions that could be easily understood. Given the many questions in the survey, the panel also recommended the use of booklet format which enable a respondent friendly questionnaire.

4.6.2 Survey Pilot Test

Prior to a comprehensive data collection, a pilot test was conducted. The purpose of the pilot test is to ensure the reliability of the study instrument (Cooper & Schindler, 2010; Sekaran & Bougie, 2010). Reliability of the instrument ascertains the set of items are consistent in measuring what is intended to be measured (Hair, Black, Babin, Anderson & Tatham, 1998; Sekaran & Bougie, 2010). The most widely used measure for reliability is the Cronbach's alpha. There are a number of guiding principle in defining the minimum requirement for reliability. Hinton, McMurra and Brownlow (2004) described a Cronbach's alpha between 0.50 and 0.75 as moderate reliability.

A total of 25 questionnaires were randomly selected and distributed from the total 544 companies identified to be practicing Lean Six Sigma. From which 15 were reverted, resulting in a response rate of 60%. Cronbach's alpha was calculated using SPSS 16 for windows. The assessment found reliability scores ranging from 0.553 to 0.940, indicating the measurement items are of satisfactory in measuring the construct of interest. Therefore, the pilot test provided assurance to content validity and internal reliability of instrument. Hence the instrument was ready for testing on a larger scale (refer Appendix B3).

4.6.3 Survey Package

The survey package included a booklet which comprise the questionnaires with a cover letter embedded at the front and a self-addressed postage-paid envelope for returning the questionnaire. The cover letter outlined the background of the research, the purpose of the questionnaire, contact information and assurance of confidentiality of the responses. The cover letter was prepared with University of Malaya's letterhead stationery. According to Dillman (2011) a letterhead stationery defines the integral connection to personalization efforts. Respondents were requested to complete and return the survey to the researcher as soonest possible before a specific deadline. The average time to complete the questionnaire was between twenty to thirty minutes. Example of the survey questionnaire and the cover letter is presented in the Appendix B4 and B5.

The questionnaire comprised of two parts. Part I involves the general profile of the firm and its Lean Six Sigma program. Part two included questions related to Lean and Six Sigma practices, absorptive capacity, the companies' level of innovation performance and sustainability of competitive advantage perceived through the application of Lean Six Sigma. Each questions were enquired in detail and appended with a scale to cater their convenience in choosing them. The last page of the booklet or survey consisted background detail of the respondents which was to be filled at their discretion. The self-addressed postage-paid envelope was provided to encourage participation in the research in addition to catering to their convenience which was hoped to increase the number of participation.

4.7 Data Collection Procedure

This section will explicate how data was gathered for the research. Data for this study as mentioned, was collected through a survey method. The instrument used for the survey was a questionnaire designed to enquire the relevant details of the research. The firm that practices Lean Six Sigma is considered as the research analysis unit. The package as explained, which included the questionnaire and a self-addressed postage-paid envelope were mailed through Malaysia Postal Service (Pos Malaysia) to 519 manufacturing firms identified from the FMM list (excluding the 25 firms used for pilot test), located in ten different states and one federal territory in Peninsular Malaysia[3]. The mail survey was the preferred option given the participants of firms' geographical proximity. It was the most convenient and cost effective way to collect the information required.

Dillman's (2011) mixed-mode survey technique was utilized in managing the self-administered survey where various modes of follow-ups were carried out to enhance survey response rate. The survey was distributed to 519 participants of Lean Six Sigma practicing companies in the end of March 2017. Given the two-week response request, the researcher made follow up contacts via email and phone calls to those who has not responded after three weeks of initial mailing of the survey. Some of the firms experienced complication in terms of not receiving the mail, lost or could not find the package. Thus a follow-up mail was done to cater their needs. Some questionnaires were personally handed by the researcher to companies that preferred such approach. As an additional effort to increase the response rate, personal visit to companies by appointment to follow up on the status of the survey was done by the researcher where possible.

4.8 Data Screening and Cleaning

The collected information was screened for missing data prior to beginning any other basic analysis like non-response bias, common method bias and validating the constructs and structural model. The normality of the data was also analyzed as per the multivariate analysis assumption (Hair et al., 1998; Kline, 2011).

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[3] East Malaysia or the Malaysian Borneo was excluded from the list given the complexity of correspondence in the survey process. Firstly, time taken to send and receive the questionnaires are relatively longer. Secondly the cost of correspondence is also higher. Thirdly, to get a hold of the relevant personnel in charge is tedious.

4.8.1 Missing Data Analysis

Missing data refers to any absent information in the survey questionnaire. The respondents may have unintentionally or intentionally failed to answer some of the questions. Missing data does have an impact to the analysis as it can affect the estimate of the mean and standard deviation (Hair et al., 1998). Tabachnick and Fidell (2007) explained that missing data can cause serious repercussions especially when the number is high and there seems to be a pattern or non-random, suggesting these features as candidate for deletion. They claimed that if the missing data are as few as 5% and pattern of missing data appears to be at random, the data set can be remedied.

4.8.2 Multivariate Normality

This study is highly exploratory in nature given the researcher's intention to learn the Lean Six Sigma's path towards innovation and competitive advantage of firms. Given the exploratory nature of the study, the data set obtained was anticipated to be of non-normal distribution. However, in order to validate the estimation, the normality of the data was evaluated as Hair et al. (2016) suggested it is still important to verify normality of data regardless of any circumstances. Hair et al. (2016) mentioned one way to assess normality is by examining two measures of distributions which are skewness and kurtosis. Skewness refers to the symmetrical distribution of the curve whereas kurtosis refers to the peakness of the distribution, whether it is too peaked or otherwise (Hair et al., 2016). If the curve from the dataset looks more asymmetrical and varying in height, it would imply to the dataset might be non-normally distributed.

A general rule of thumb, a skewness greater than +1 or -1 indicates a skewed distribution, similarly for kurtosis a value greater than +1 or -1 specify a distribution that is too peaked or too flat respectively (Hair et al., 2016). To assess normality or the multivariate skewness and kurtosis, the 'Webpower' software as recommended by Hair et al. (2016) and Cain, Zhang and Yuan (2017) was used. It is an online based statistical power analysis that could be used handily by uploading the file containing the data. The result of the analysis showed the data was not multivariate normal as the Mardia's multivariate skewness was $\beta = 22.116$, $p < 0.000$ and Mardia's multivariate kurtosis was $\beta = 122.882$, $p < 0.000$[4]. Therefore, it can be concluded that the data collected is not normally distributed and consequently supports the use of PLS-SEM technique which is amicable for non-parametric analysis.

4.9 Data Analysis Process

4.9.1 Descriptive Analysis

The descriptive statistics of the survey was first examined prior to any measurement and structural model analysis. The descriptive statistical analysis would provide the overview of the survey data which includes the profile of the firms and respondents and their characteristics in terms of Lean Six Sigma implementation. The outcome of the analysis comes in the form of frequency distribution table according to the classification portrayed in the questionnaire. The classification also portrays the response rate and business characteristics of the firms that participated, warranting the respondents represent the population of the study. The descriptive analysis was done by using IBM SPSS Statistics version 23.

4.9.2 Response Rate

A total of 519 survey questionnaires were distributed to ten states and one federal territory in Peninsular Malaysia through mail. The survey was conducted between March 2017

[4] The output of the result is available at: https://webpower.psychstat.org/models/kurtosis/results.php?url=1ba5491fa63de937d4edb95ba5c37969.

and mid-August 2017. The respondents were given two weeks to respond the questionnaire. However, it is known that it will take beyond the given time for most to reply. Therefore, the researcher set a two-month timeline from the day mails were sent out to receive the questionnaires. Ramayah (2011) mentioned that it is a norm for researchers to allow approximately two months as cut of date for returns. Accordingly, all responses returned after two months are classified as late. During the first two months a total of 77 questionnaires were received in return. In the next three months a number of follow up calls and personal visits to some companies were made by the researcher which amassed a further 65 responses. All in all, a total of 142 responses were collected. Out of the 142, 17 were incomplete which had missing data between 48% and 72%. Therefore, the 17 questionnaires were omitted from the total collection which accounts for a 24.08% response rate or 125 usable questionnaires. Ramayah (2011) revealed that the average response rate for mail survey in Malaysia is between 10-20% only. The study managed to amass a response rate that is slightly higher than the usual.

4.9.3 Response Bias

In order to ensure if any systematic differences were evident in the responses collected, the study used the non-response bias procedure based on the work of Armstrong and Overton (1977) which compares the differences between early and late responses. The responses were divided into two groups. Early responses are those who reverted within the first two months whereas late being those thereafter. Upon omission of unusable questionnaires, a total of 77 questionnaires were early and 48 were late. The early responses were compared with the late responses using an independent t-test to screen for any systematic differences for all non-demographic variables. A Chi-Square test was used to test non-response bias for demographic variables (Appendix B6).

4.9.4 Common Method Bias

The data in this study was gathered from one respondent in each of the Lean Six Sigma practicing companies. Therefore, there were no second respondent or informant who cross validates the responses. Single respondent for this study was deemed sufficient as multiple respondents or cross validation of responses in the same firm on complex social judgements can increase the random measurement error and fail to make strong assessments especially when it comes to convergent and discriminant validity (Tan, 2002). Furthermore, the cost, effort and time taken to collect second informant data is prohibitive. Thus, the study targeted Lean Six Sigma practitioners within the company ranging from champions or sponsors, Black Belters, Master Black Belters and Green Belters who are assumed to be knowledgeable in the deployment and understand the intricacies of the philosophy. This stance is supported by Cao, Vonderembse, Zhang and Ragu-Nathan (2010), who mentioned that respondents should have an overall view of a domain.

Although there are benefits of single respondent, there are equal drawbacks to it that needs consideration. Podsakoff, MacKenzie, Lee and Podsakoff (2003) claimed that data collected from single respondent may suffer from common method bias issues. To remedy the circumstances, a Harman's single-factor test was used to verify the existence of a common method bias (Harman, 1967; Podsakoff et al., 2003). Appendix B7 depicts the result of the test. The Harman's single-factor analysis was done on all items by using factor analysis. All principal constructs were entered into the principal components factor analysis and principle component analysis were used in the extraction method. An unrotated factor was selected and number of factors to be extracted was fixed to 1. The results of the analysis showed the first factor in the study that emerged explains 21.124% of the variance. It is believed that common method bias in a study exist when the emerging variance factor's percentage is higher than 50% (Eichhorn, 2014; Mat Roni, 2014;

Pallant, 2010). Given the result, it can be concluded that no substantial common method variance existed and that it is not a threat to this study.

4.10 Structural Equation Modelling (SEM)

SEM is a family of multivariate statistical techniques that is used to study the direct and indirect relationship between one or more independent latent variables (LVs) and one or more dependent LVs (Gefen, Straub & Boudreau, 2000). SEM allows the testing of a research model all together (Chin, 1998b; Gefen et al., 2000). Besides testing the hypothetical linkages of the research's structural model, SEM also evaluates the link between a variable and its respective measures. SEM offers a variety of multivariate statistical analyses such as path analysis, regression analysis, factor analysis, canonical correlation analysis, and growth curve modelling (Gefen et al., 2000; Urbach & Ahlemann, 2010).

SEM is renown in the scholarly world as a second generation of multivariate analysis (Fornell & Larcker, 1987). Chin (1998a, p. vii) expounded that SEM-based procedures cater greater flexibility for analyzing the interplay between theory and data wherein it provides the researcher the elasticity to *a) model relationships among multiple predictor and criterion variables, (b) construct unobservable LVs, (c) model errors in measurements for observed variables, and (d) statistically test a priori substantive/theoretical and measurement assumptions against empirical data*.

Under SEM, there are two main approaches which are variance-based SEM such as Partial Least Square (PLS-SEM) and covariance-based SEM (CB-SEM) (Fornell & Bookstein, 1982; Hair, Ringle & Sarstedt, 2011; Reinartz, Haenlein & Henseler, 2009; Wetzels, Odekerken-Schröder & Van Oppen, 2009). CB-SEM generates a theoretical covariance matrix by estimating a set of model parameters wherein the difference between the theoretical covariance matrix and the estimated covariance matrix is minimized (Hair et al., 2011). Whereas PLS-SEM emphasize on causal modelling approach that aims to maximize the explained variance of the dependent latent constructs (Hair et al., 2011). CB-SEM uses maximum likelihood (ML) function to minimize the differences between the sample covariance (Reinartz et al., 2009) whereas PLS-SEM uses least square estimation for single and multi-component models and for canonical correlation (Chin, 1998a).

Furthermore, when using CB-SEM the observed variables need to follow a normal distribution in addition to observation has to be independent of one another given the application of ML function. In PLS-SEM however, these restrictive assumptions underlying ML techniques are avoided and ensures against improper solution and factor indeterminacy (Fornell & Bookstein, 1982). Clearly, the objective or emphasis of both SEM approaches are different. Hence, choosing the appropriate SEM approach is vital to ensure the robustness of the estimates and results of the structural model.

4.10.1 Selecting CB-SEM or PLS-SEM

In order to select the best and appropriate statistical method, the researcher should understand and be aware of the assumptions underlying those statistical methods. (Hair et al., 2011) explained the selection between CB-SEM and PLS-SEM can be made based on several aspects such as research objective, types of measurement model specification, the modelling of structural model, data characteristics and model evaluation. Therefore, these five aspects can be used to determine which statistical approach is suitable for a study.

Firstly, on the objective of the study, CB-SEM is meant for theory testing and confirmation given that this requires demonstration of how well a theoretical model fits the observed data (Barclay, Higgins, & Thompson, 1995). CB-SEM is also commonly known as hard modelling. PLS-SEM is fitting when the objective of the study is for prediction or theory development. PLS-SEM is known as soft modelling given its ability in identifying the best prediction of relationships between variables and the focus is on maximizing the amount of covariance between LVs in order to increase the model interpretation (Sosik, Kahai & Piovoso, 2009).

CB-SEM is limited to reflective constructs as using formative constructs may lead to a situation where the explanation of the covariance of all indicators is not possible (Chin, 1998b). Handling of both reflective and formative in CB-SEM is also complicated (Urbach & Ahlemann, 2010). Conversely, PLS-SEM allows the use of reflective, formative and the combination of both constructs simultaneously in a research model (Chin, 1998a).

The use of CB-SEM is highly procedural as it requires a set of assumptions to be fulfilled prior to further analysis such as 1) data multivariate normality, 2) observation independence, and 3) variable metric uniformity (Sosik et al., 2009). PLS-SEM on the other hand does not restrict normality of data as it uses calibration mechanism that transform non-normal data in adherence to central limit theorem (Beebe, Randy & Seasholtz, 1998). PLS-SEM's emphasis is also on 'estimation' of a theoretical model versus CB-SEM which targets to identify model fits (Sosik et al., 2009).

Therefore, based on the above articulation, this study adopts PLS-SEM as the statistical method to assess the research model based on the following;

1) The focus of this study is on prediction factors related to how Lean Six Sigma could bring about innovation and sustained competitive advantage. The use of LV scores is vital in examining the underlying relationship between the LVs.

2) This study uses a considerable number of LVs and manifest variables including complex modelling which Henseler, Ringle and Sinkovics (2009) deems feasible for a PLS-SEM approach.

3) The study focuses on estimating the relationship framed in the conceptual model which result could pave theory development. In other words, the nature of this study is much attributed to exploratory.

4.10.2 Partial Least Square (PLS)

A renowned Norwegian-born econometrician, Herman Wold is the originator of PLS between 1960s and 1970s (Chin, 1998b). As abovementioned, PLS stems from a family of alternating least square algorithms that extend principal component and canonical correlation analysis (Henseler et al., 2009). The path models in PLS-SEM is usually defined using two sets of linear equations known as the measurement model and structural model (Henseler et al., 2009). The measurement model is also often known as the outer model whereas the structural model is also known as inner model (Hair et al., 2016). The outer model specifies the relationship between a LV and manifest variables (or the indicators) whereas the inner model specifies the relationship the LVs or unobserved variables.

PLS algorithm involves a sequence of regressions in terms of weight vectors (Henseler et al., 2009). Henseler et al. (2009) stated the basic stages of PLS algorithm as professed by Lohmöller (1989) as follows;

Stage 1: *Iterative estimation of latent variable scores*, consisting of a four-step iterative procedure that is repeated until convergence is obtained:

(1) Outer approximation of the latent variable scores,

(2) Estimation of the inner weights,

(3) Inner approximation of the latent variable scores, and

(4) Estimation of the outer weights.

Stage 2: Estimation of outer weights/loading and path coefficients.

Stage 3: Estimation of location parameters.

4.10.2.1 Reflective and Formative Constructs

It is known in SEM literatures that LVs or constructs can be modelled as either formative or reflective. In a reflective construct, the arrow direction points from the LV to the indicators or manifest variables. This is because reflective constructs are understood as a construct that is measuring the same underlying idea and is affected by the same underlying construct as it uses parallel measures that co-vary, which means changes in the underlying constructs may cause changes in the indicators (Jarvis, MacKenzie & Podsakoff, 2003). As such, indicators of the reflective constructs should be internally consistent given that all of them tend to be of equally valid indicators in measuring the underlying LV (Petter, Straub & Rai, 2007).

Formative constructs on the other hand refers to indicators that forms or combined to give rise to the meaning of the LV (Petter et al., 2007). This is the reason as to why the arrow direction points towards the LV from the indicators. In formative constructs, the indicators may have an impact on the underlying construct (Jarvis et al., 2003). In contrast to reflective indicators, formative indicators need not be correlated of possess high internal consistency besides any changes in the indicators may cause a change in the LV or underlying construct's definition (Jarvis et al., 2003). In reflective constructs the indicators assume high correlation between each other as it represents similar dimension of the underlying construct but the formative construct is represented by various dimensions as explained by its indicators (Chin, 1998b; Gefen et al., 2000). Figure 4.1 represents the expression between reflective and formative constructs.

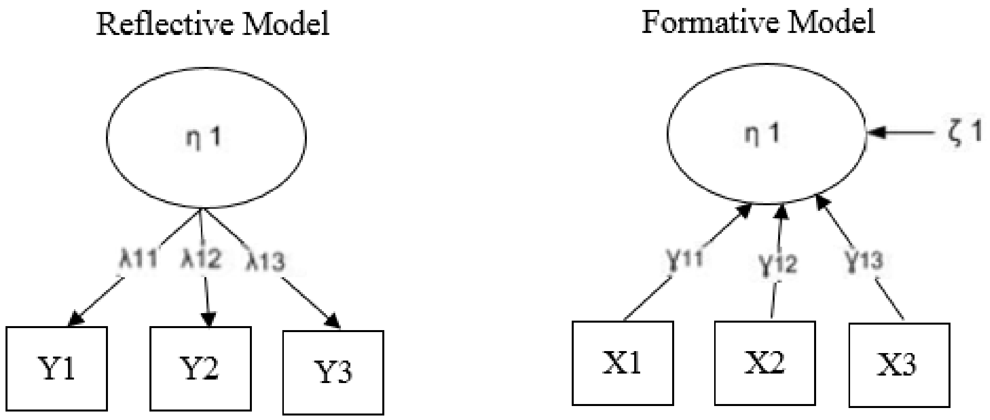


Figure 4.1: Reflective and Formative Constructs

Source: Petter et al. (2007)

For reflective constructs, it is appropriate to assess the loadings of each indicators as they represent the correlation between the indicators and the component scores (Gefen et al., 2000). As for formative constructs, assessment and interpretation should be based on weights as each indicator provides important information towards the formation of the component (Chin, 1998b).

In this study, all LVs are modelled as reflective measures as per the adoption from previous literatures. The causality flow of each LV are based on the prior knowledge gathered from past studies that was done during literature review. Henseler et al. (2009) appealed that using prior studies and knowledge in determining the causality flow is a potent approach towards avoiding measurement model misspecification.

4.10.3 Evaluating Measurement and Structural Models using Partial Least Square

This study will be using a two-step approach in evaluating the: 1) measurement (outer) and 2) structural (inner) model (Hair et al., 2016). The purpose of such an approach is to ensure that both outer and inner model fulfill the quality criteria for empirical work

(Urbach & Ahlemann, 2010). The following subsections discuss the guidelines used in assessing the outer and inner models of this study.

4.10.4 Measurement Model

Validation of reflective measurement model requires attention on four fronts; internal consistency, indicator reliability, convergent validity and discriminant validity (Hair et al., 2016; Lewis, Templeton & Byrd, 2005; Straub, Boudreau & Gefen, 2004).

4.10.4.1 Internal Consistency

Internal consistency is traditionally validated by using Cronbach's Alpha (CA). A high CA value implies that indicators have the same meaning as it provides estimate for reliability based on indicator inter-correlations (Cronbach, 1971). There are a number of guiding principle in defining the minimum requirement for reliability. The most prominent or generally used measure of CA value is between 0.6 and 0.7 as advocated by Hair et al. (1998). However, Hinton et al. (2004, p. 363) described a CA value between 0.50 and 0.75 is generally accepted as indicating a moderately reliable scale. Hair et al. (2016, p. 101) enlightened CA is "*sensitive to the number of items in the scale and generally tends to underestimates the internal consistency reliability*". Furthermore, Hair et al. (2016, p. 101) went on to explain that PLS-SEM "*prioritizes the indicators according to their individual reliability*". Given the limitation and requirement respectively, they suggested the use of Composite Reliability (CR) as a measure of internal consistency reliability which is deemed to be technically more appropriate as it takes into account the different outer loadings of the indicator variables (Hair et al. 2016). Chin (1998b) also supported the use of CR as internal consistency in PLS. Essentially, CA and CR measures the same thing but CR takes into consideration the different loadings each indicator has. CA assumes tau equivalency among the measures and assume all indicators are equally weighted, for which CA is subject to severe underestimation of the internal consistency reliability (Chin, 1998b; Werts, Linn & Jöreskog, 1974). According to Hair et al. (2016) a CR value of 0.60 to 0.70 are acceptable in exploratory research whereas in advanced stages values between 0.70 and 0.90 can be regarded as satisfactory.

4.10.4.2 Indicator Reliability

Indicator reliability refers to the extent to which a set of variable is consistently measuring what is intended to be measured (Urbach & Ahlemann, 2010). The size of the outer loading is often referred to as the indicator reliability and Hair et al. (2016) suggested it should be 0.70 or 0.708 to be specific as it implies to 50% of the variance explained of the indicator in reference to communality. It is said that all the items combined should at least be able to explained 50% of the meaning of the construct. However, Hair et al. (2016) went on to elaborate that the elimination of indicators should be performed with caution and fair judgement. It was mentioned when indicator loadings are between 0.40 to 0.70, indicators should be considered for removal only when the deletion leads to increase in Average Variance Extracted (AVE) or the CR above the threshold value. Another consideration the authors mentioned is to the extent the removal may impact the content validity of the construct.

4.10.4.3 Convergent Validity

According to Urbach and Ahlemann (2010), convergent validity refers to the extent each items converge in explaining a construct compared to items measuring different constructs. In PLS-SEM, convergent validity is measured through Average Variance Extracted (AVE). It is corroborated that convergent validity suffices when AVE achieves at least a value of 0.5 (Fornell & Larcker, 1981).

4.10.4.4 Discriminant Validity

Discriminant validity explains how discriminate or different are measures of a construct compared to other measures of some other constructs. In contrast to convergent validity, discriminant validity aims to test items do not unintentionally measure some other constructs other than of its own (Urbach & Ahlemann, 2010). Two most commonly used discriminant validity are cross loadings (Chin, 1998b) and Fornell-Larcker's criterion (Fornell & Larcker, 1981).

Cross loading is done by correlating each of LV's component scores with all other items. When each indicator's loading is higher for its designated construct compared to all other constructs, than it can be said that the items are discriminately measuring the intended construct and all other items are not interchangeable (Chin, 1998a). For Fornell-Larcker's criterion, the square root of the AVE of each construct should be higher than its highest correlation with any other construct AVE (Hair et al., 2016).

Nevertheless, there has been recent criticism of the Fornell-Larcker's criterion. Henseler, Ringle and Sarstedt (2015) elucidated that it does not reliably detect the lack of discriminant validity in common research situations. Alternatively, Henseler et al. (2015) proposed a much stable approach to assess discriminant validity in the form of heterotrait-monotrait ratio of correlations (HTMT), which they went on to demonstrate its superior performance through a Monte Carlo simulation study. There are two decision rules in the assessment of discriminant validity. If the HTMT value is greater than $HTMT_{0.85}$ value of 0.85 (Kline, 2011), or $HTMT_{0.90}$ value of 0.90 (Gold, Malhotra & Segars, 2001) then this indicates issues of discriminant validity.

4.10.5 Structural Model

Once the measurement model has been evaluated and validated as per necessary decision rules, the analysis will then proceed to structural model analysis. Assessment of the structural model will help the researcher to validate the hypothesized relationship of the research model through the support of data (Urbach & Ahlemann, 2010). Hair et al. (2016) puts forth the assessment of the structural model which involves path coefficient, coefficient of determination (R^2), effect size (f^2) and predictive relevance (Q^2). In order to assess for potential collinearity issue within the structural model, Variance Inflation Factor (VIF) is also assessed accordingly.

4.10.5.1 Path Coefficient

Path coefficient is used to examine the relationship between to LVs. The researcher should look for the value of path coefficient, algebraic sign, magnitude and significance. Path coefficients have standardized values between -1 and +1. The larger the number is towards the value of 1, the stronger the relationship is. The positive and negative signs represent how the LVs are related (negative or positive relationship). Huber, Herrmann, Meyer, Vogel and Vollhardt (2008) claims that path coefficients should be at least 0.100 to account for an impact on the LVs and should be significant.

With reference to statistical significance, Hair et al. (2016) explains when an empirical t-value is larger than the critical value, we conclude that the coefficient is statistically significant at a certain significance level. Generally, there are two types of tailed t-test, one-tailed and two-tailed. They explained that commonly used critical values for two-tailed test are 1.65 (significance level = 10%), 1.96 (significance level = 5%), and 2.57 (significance level = 1%). Whereas for one-tailed test are 1.282 (significance level = 10%), 1.645 (significance level = 5%), and 2.33 (significance level = 1%) (Hair et al., 2016). They also clarified that when the research is exploratory in nature it is normal to assume a significance level of 10%. Additionally, the choice between one-tailed and two-tailed test depends on the objective of the study. Scholars have stressed on the conditions of using the two types of test. According to Cho and Abe (2013, p. 1262) and Churchill and Iacobucci (2002, p.660), a one-tail testing should be used for directional research hypotheses and a two-tailed testing for non-directional hypotheses. Given the nature of the hypotheses in this study, which intends to examine the positive effect of the said variables, the study will take into account a significance level of 10%, 5% and 1% based on a one-tailed test with the exception of mediation test. This is because mediation analysis will be carried out using Preacher and Hayes' (2004, 2008) bootstrapping method recommended by Hair et al. (2016). The bootstrapping method will utilize Bias-Corrected Confidence Interval at 95% from the bootstrapping results. This will yield an upper and lower level of the indirect effect which technically refers to two-tail test. Therefore, for mediation analysis a two-tailed test will be used (Preacher & Hayes, 2004).

4.10.5.2 Coefficient of Determination (R^2)

The R^2 refers to the variance explained by the LVs relationship. The R^2 explains the exogenous latent variables' combined effects on the endogenous latent variable (Hair et al., 2016). The R^2 ranges from 0 to 1. The higher the value, the higher the predictive accuracy. To date, there happens to be no one commonly accepted or universal guideline on R^2 value. A standard prescription that explains a substantial, moderate and weak R^2 values vary across different scholars. Cohen (1988, p. 413-414) claims an R^2 value of 0.26 as substantial, 0.13 as moderate and 0.02 as weak. According to Chin (1998b, p. 323), an R^2 value of 0.67 is considered substantial, 0.33 as moderate and 0.19 and lower are considered weak. Whereas, Hair et al. (2011, p. 145) describe R^2 values of 0.75, 0.50 and 0.25 as substantial, moderate and weak respectively. In this study, Chin's (1998b) version of the descriptions on R^2 values will be considered as a guideline as it stands somewhere in between the aforesaid variants.

4.10.5.3 Variance Inflation Factor (VIF)

One of the important elements in assessing structural model is the possible multicollinearity issue with multiple independent variables. Multicollinearity can cause a number of complication to the research model amongst are: produce parameter estimates of the "incorrect sign" and of implausible magnitude; create situations in which small changes in the data produce wide swings in parameter estimates; and, in truly extreme cases, prevent the numerical solution of a model (Belsley, Kuh & Welsch, 1980; Greene, 2003). The VIF is defined as the reciprocal of the tolerance, which is computed from the differences of R^2 (Hair et al., 2016), as follows:

$$VIF = \frac{1}{1 - R^2}$$

The common threshold value for VIF is to be below 5 as cited commonly in scholarly works from Hair et al. (2011). This means there is no multicollinearity issue found in the research model. However, in recent scholarly works, a much stringent critical threshold value is being reported as posited by Diamantopoulos and Siguaw (2000) at 3.33 and below.

4.10.5.4 Effect Size (f^2)

The f^2 is known as the effect size. It implies to the changes in the R^2 when a specified exogenous construct is omitted from the model and how substantive of an impact it could have on the endogenous variable (Hair et al., 2016). The formula for effect size is as follows:

$$f^2 = \frac{R^2 included - R^2 excluded}{1 - R^2 included}$$

An f^2 value of 0.02 represents small effect, 0.15 is a medium effect whereas 0.35 is considered as a large effect (Cohen, 1988).

4.10.5.5 Predictive Relevance (Q^2)

Besides R^2, there's been an increase of importance in current research to assess Stone-Geisser's Q^2 value (Geisser, 1974; Stone, 1974). Q^2 is an indicator of the model's out-of-sample predictive power or predictive relevance (Hair et al., 2016). It means to say if the model has predictive relevance, it could accurately predict data not used in the estimation model. The blindfolding technique is used to assess Q^2 for a specified omission distance (D). Blindfolding is a sample reuse technique that omits every dth data point in the endogenous construct's indicators and estimates the parameters with the remaining data points (Chin, 1998b; Henseler et al., 2009; Tenenhaus, Vinzi, Chatelin & Lauro, 2005). A Q^2 value greater than zero means the model has predictive relevance for a certain endogenous construct (Fornell & Cha, 1994; Hair et al., 2016).

Besides, Hair et al. (2016) also explicated similar to the relative measure of effect size, the effect size of the predictive relevance, q^2 is computed through the following equation:

$$q^2 = \frac{Q^2 included - Q^2 excluded}{1 - Q^2 included}$$

A q^2 value of 0.02, 0.15 and 0.35 indicate that an exogenous construct has a small, medium, or large predictive relevance, respectively, for a certain endogenous construct (Hair et al., 2016).

4.10.6 Mediation Assessment

When it comes to mediation, the traditionally sought after test is referred to Baron and Kenny's (1986) mediation analysis. Past literatures had made it customary to adopt their approach in analyzing mediating variable. However, this approach had been a subject to criticism as of late. Amongst the critics include that a mediation may still work even the direct path between X and Y are not significant (Pardo & Román, 2013). Besides, the method lacked potency wherein the initial significant path between X and Y could be overlooked (Collins, Graham & Flaherty, 1998; James, Mulaik & Brett, 2006; MacKinnon, Lockwood, Hoffman, West & Sheets, 2002; Shrout & Bolger, 2002; Zhao, Lynch Jr & Chen, 2010).

Another test of mediation comes in the form of Sobel (1982). The Sobel test compares the direct relationship between the independent variable and the dependent variable with the indirect relationship between the independent variable and dependent variable that includes the mediation construct (Helm, Eggert & Garnefeld, 2010). However, the Sobel test is not consistent with PLS-SEM method as it assumes normal distribution and in addition, multiplication of two normally distributed coefficient in the test, results in a non-normal distribution of their product (Hair et al., 2016). Therefore, Hair et al. (2016) recommends Preacher and Hayes (2004, 2008) bootstrapping method which is a non-parametric resampling test. The bootstrapping of the indirect effect yields higher levels of statistical power compared with the Sobel test according to Hair et al. (2016).

In reality, there are various types of mediation models. As per this study's research model, it is one without a direct effect (Malhotra, Singhal, Shang & Ployhart, 2014), as it is postulated that the practices of Lean Six Sigma effects the components of absorptive capacity. And the components of absorptive capacity influences innovation performance and sustainable competitive advantage.

Therefore the indirect effects are calculated manually by multiplying both paths' coefficient and divided by each effect's standard error to obtain the t-statistics. Also, the product of the path coefficients will be evaluated using Bias-Corrected Confidence Interval at 95% from the bootstrapping results. Ideally, the t-value should be significant and the 95% confidence interval of the indirect effect between lower level and upper level should not straddle a zero value in between (Preacher & Hayes, 2004, 2008). Given the lower and upper level of the 95% confidence interval, the critical t-value will be 1.96. This would imply the mediation exist in the model otherwise there is no mediation in existence. It should also be noted that the use of "full" and "partial" mediation have been debated as Rucker, Preacher, Tormala and Petty (2011) explained it is subject to dependence on sample size.

Zhao et al. (2010) explained Baron and Kenny's classification of "full", "partial" and "no" mediation is somewhat coarse and misleading, given the reliance on a test of the total effect of X on Y. Instead, they developed a typology on different types of mediation: (a) *complementary mediation* whereby both the indirect effect and the direct effect exist and are in the same direction, (b) *competitive mediation* whereby both the indirect effect and the direct effect exist and are in opposite directions, (c) *indirect-only mediation* whereby the indirect effect exists but there is no direct effect, (d) *direct-only non-mediation* whereby a direct effect exist but there are no indirect effects, and (e) *no-effect non-mediation* whereby neither direct or indirect effects exist (Zhao et al., 2010, p. 200).

4.10.7 Importance-Performance Matrix (IPMA)

Importance Performance Matrix Analysis (IPMA) was first introduced by Martilla and James (1977). The IPMA extends standard PLS-SEM reporting by considering average values of latent variable scores (Fornell, Johnson, Anderson, Cha and Bryant, 1996; Hock, Ringle & Sarstedt, 2010; Kristensen, Martensen & Gronholdt, 2000). The idea of this method is to identify the importance of various attributes, and the relative performance of these attributes in evaluating comparative advantage (Siew & Chin, 1991). Hair et al. (2016) mentioned that IPMA contrasts structural model's total effects on a specific target construct with the average latent variable scores of this construct's predecessors. As they mentioned that the goal is to identify predecessors that have a relatively high importance for the target construct.

There are two dimensions in the IPMA, the x-axis depicts importance whereas the y-axis explains performance of a particular variable or construct. The readings from the x and y-axis would suggest which variables are important and which variables possess higher performance (Matzler, Bailom, Hinterhuber, Renzl & Pichler, 2004). After running the IPMA, the values in the path coefficient represents the unstandardized total effects, which is the relative importance of an exogenous construct towards the target construct. The IPMA also provides a performance value for each latent variable in the model which is positioned within each construct in place of R^2. These scores refers to the average value of the latent variables scores which ranges between 0 to 100, in which the closer to 100 means the greater the performance of the particular construct (Hair et al., 2016; Ringle & Sarstedt, 2016).

The focus in reading the IPMA is on the lower right area of the importance-performance map as those constructs reflect high importance but lower performance. This means that these constructs have high potentials for improvement (Ringle & Sarstedt, 2016). Subject to all other factors remain constant, a one-unit point increase in an exogenous construct at the mentioned area, would increase the performance of the target endogenous construct by the value of the exogenous construct's total effect on the endogenous construct. This analysis could also be extended until the indicator level (Ringle & Sarstedt, 2016).

In this study the IPMA will be used as a complementing method to augment the findings' analysis through a meaningful pictorial description although the use of it does not associate to any objectives of the study. Through this analysis, the relevant aspects that possess greater importance and higher performance can be identified for further course of managerial actions and decisions in order to improve certain target construct.

Hence, the IPMA will function as an additional mechanism to examine the importance and performance of Lean Six Sigma practices towards the components of absorptive capacity which in turn influences organizational outcomes in the form of innovation performance and sustainable competitive advantage.

4.11 Summary of the Chapter

This chapter discussed about the research design strategy and methodology employed in the study which consist of quantitative methods. The approaches used to develop the research instrument were explained. Issues with regards to measurement are identified and PLS-SEM is introduced as the quantitative data analysis technique. The summary of the measurement and structural model criterion used in this study is shown in Table 4.11. Besides, preliminary details of the survey were also reported. The following chapter will elucidate data analysis and results of the survey findings.

Table 4.11: Summary of Measurement and Structural Model Criterion

Measurement Model Criterion		
Assessments	**Criterion**	**References**
Internal Consistency	Composite Reliability > 0.70.	Hair et al. (2016)
Indicator Reliability	Outer loadings > 0.70. Value between 0.4 and 0.7 should only be removed if it increases AVE otherwise should be retained.	Hair et al. (2016)
Convergent Reliability	Average Variance Extracted (AVE) > 0.50.	Fornell & Larcker (1981)
Discriminant Validity:		
Cross Loadings	Each indicator's loading is higher for its designated construct compared to all other constructs and all other items are not interchangeable.	Chin (1998a)
Fornell-Larcker	The square root of the AVE of each construct should be higher than its highest correlation with any other construct AVE.	Fornell & Larcker (1981)
HTMT	HTMT ratio of correlations < 0.85 HTMT ratio of correlations < 0.90	Kline (2011) Gold et al. (2001)

Table 4.11: continued

Structural Model Criterion		
Assessments	**Criteria**	**References**
Path Coefficient	At least 0.100 to account for an impact on the LVs and should be significant.	Huber et al. (2008)
Critical Value	Direct Effects (one-tailed test): 1.28 (significance level = 10%) 1.65 (significance level = 5%) 2.33 (significance level = 1%) Indirect Effects (two-tailed test): 1.96 (significance level = 5%)	Hair et al. (2016) Preacher and Hayes (2004, 2008)
Coefficient of Determination (R^2)	$R^2 = 0.67$ → substantial $R^2 = 0.33$ → moderate $R^2 < 0.19$ → weak	Chin (1998b)
Effect Size (f^2)	$f^2 = 0.02$ → Small $f^2 = 0.15$ → Medium $f^2 = 0.35$ → Large	Cohen (1988).
Predictive Relevance (Q^2)	$q^2 = 0.02$ → Small $q^2 = 0.15$ → Medium $q^2 = 0.35$ → Large	Hair et al. (2016)
Variance Inflation Factor (VIF)	VIF < 5 VIF < 3.33	Hair et al. (2011) Diamantopoulos and Siguaw (2000)
Mediation Analysis	T-value > 1.96 and Bias-Corrected 95% Confidence Interval (lower and upper level) should not straddle a zero value in between.	Preacher and Hayes (2004, 2008)

CHAPTER 5: DATA ANALYSIS AND FINDINGS

5.1 Overview of the Chapter

This chapter presents the data analysis and findings from the survey. In the following sections the sample description and respondents' characteristics will be discussed. Thereafter non-response bias results will be presented followed by measurement and structural model analysis. First, the measurement model will be assessed through validity and reliability. Then, the structural model will be evaluated and validated. The chapter ends with the analysis and results of hypothesis testing.

5.2 Sample Description and Response Rate

5.2.1 Response Rate

A total of 142 responses were collected. Out of the 142, 17 were omitted due to incompletion and missing data. Table 5.1 displays the responses received accordingly.

Table 5.1: Questionnaire Distribution

Remarks	Total
Total Questionnaires distributed to the respondents	519
Complete questionnaires returned	142
Returned questionnaires (unusable)	17
Questionnaire not returned	377
Questionnaire usable	125
Overall response rate	27.36%
Usable response rate	24.08%

The final response rate for the survey was 24.08%, which was 125 usable questionnaires. Although a census approach was used, the final list of respondents was also found to be of close proportion to the characteristics of firms found in the original list hence sampling bias was not deemed to be an issue. The next section discusses the characteristics of the respondents.

5.2.2 Profile of Firms and Respondents

The 125 firms were classified according to industry sub-sectors, number of employees, firm ownership, firm type, duration in business, duration of Lean Six Sigma implementation, methodology used, average annual savings from Lean Six Sigma projects and respondents' qualification in Lean Six Sigma. The background of respondents are exhibited in Table 5.2. As before mentioned, only manufacturing industry was involved in this study given the complexity in identifying firms that implement Lean Six Sigma in services or other industry. Of those companies, 56% are employed with more than 1000 workers. Sub-sector wise, Transport Equipment and other Manufacturers and Electrical and Electronics seemed to be the major contributor with 35.20% and 29.60% respectively, followed by Non-Metallic Mineral Products, Basic Metal and Fabricated Metal Products (17.60%).

From the total respondents, 54.40% of the firms are MNC-owned, 40% are Malaysian owned and 5.60% are government-based organization. Most of the firms are private organization with 91.20% of the total proportion and majority of the firms (74.40%) have been in business for more than 15 years. Around 49.60% of the firms have been using Lean Six Sigma for more than 8 years and 38.40% had been using it between six to eight years. This explains that majority of the responding firms are experienced practitioners of Lean Six Sigma.

Table 5.2: Respondents' Demographic Profile

Characteristics	Categories	Overall	
		Frequency	Percentage (%)
Industry	Manufacturing	100	100.00
Sub-Sectors	Petroleum, Chemical, Rubber and Plastic	7	5.60
	Electrical and Electronics	37	29.60
	Food, Beverages and Tobacco	15	12.00
	Non-Metallic Mineral Products, Basic Metal and Fabricated Metal Products	22	17.60
	Transport Equipment and other Manufacturers	44	35.20
	Wood Products, Furniture, Paper Products and Printing	0	0.00
	Textile, Wearing Apparels and Leather	0	0.00
Number of Employees	Less than 100	10	8.00
	100 - 250	15	12.00
	251 - 500	14	11.20
	501 - 1000	16	12.80
	More than 1000	70	56.00
Firm Ownership	MNC	68	54.40
	Malaysian Owned	50	40.00
	Government Linked Company	7	5.60
Firm Type	Public Listed (Berhad)	11	8.80
	Private Limited (Sdn. Bhd.)	114	91.20
Duration in Business	Less than 5 years	3	2.40
	6 - 10 years	20	16.00
	11 - 15 years	9	7.20
	More than 15 years	93	74.40
Duration of Lean Six Sigma Implementation	2 - 3 years	7	5.60
	4 - 5 years	8	6.40
	6 - 8 years	48	38.40
	More than 8 years	62	49.60
Methodology used	DMAIC	35	28.00
	PDCA	19	15.20
	DMAIC and DFSS	9	7.20
	DMAIC and PDCA	62	49.60
Average Annual Savings from Lean Six Sigma Projects	Less than $ 50,000	19	15.20
	$ 50,000 - $ 100,000	22	17.60
	$ 100,000 - $ 150,000	12	9.60
	$ 150,000 - $ 200,000	13	10.40
	More than $ 200,000	59	47.20

Table 5.2: continued

Characteristics	Categories	Overall	
		Frequency	Percentage (%)
Lean Six Sigma Qualification	Black Belt	43	34.40
	Master Black Belt	17	13.60
	Green Belt	41	32.80
	Champion/ Sponsor	24	19.20

The distribution also indicates that almost half of the Lean Six Sigma practicing firms (49.60%) utilizes DMAIC and PDCA methodology in their process improvement endeavor. Lean commonly uses the PDCA cycle whereas Six Sigma is known for the DMAIC cycle. Therefore, firms are noticed to be applying both methodology interchangeably in the application of Lean Six Sigma. Out of the total, almost half (47.20%) of the firms claim to benefit more than $200,000 in average annual savings generated from Lean Six Sigma projects. 17.60% claim to be yielding between $50,000 and $100,000 and 19 firms are benefiting less than $50,000 from Lean Six Sigma projects. Of the 125 firms, 34.40% of the respondents were Lean Six Sigma Black Belters, followed by Green Belters with 32.80%. There were twenty four Champions or sponsors and seventeen Master Black Belters comprising the remaining distribution of the respondents.

5.2.3 Response Bias

The non-response bias was done to ensure no systematic differences exist between late and early responses. The results are as per Table 5.3 (for detail refer to Appendix B6). Based on the result shown in the table, there was no significant difference between early and late respondents for non-demographic variables.

Table 5.3: Independent T-Test for Early and Late Responses for Non-Demographic Variables

Group		Mean	Std. Deviation	*t*-value	Sig. (2-tailed)
Lean Technical Practice (LTP)	Early Responses	18.961	2.976	-0.915	.362
	Late Responses	19.458	2.924		
Lean Social Practice (LSP)	Early Responses	38.234	5.640	0.527	.599
	Late Responses	37.646	6.686		
Role Structure (RS)	Early Responses	18.701	2.938	0.868	.387
	Late Responses	18.188	3.630		
Structured Improvement Procedure (SIP)	Early Responses	12.701	1.514	-0.210	.834
	Late Responses	12.771	2.185		
Focus on Metrics (FOM)	Early Responses	31.857	3.398	1.202	.232
	Late Responses	30.917	5.355		
Potential Absorptive Capacity (PACAP)	Early Responses	35.455	4.015	-0.390	.697
	Late Responses	35.771	4.973		
Realized Absorptive Capacity (RACAP)	Early Responses	47.351	3.637	0.211	.833
	Late Responses	47.188	4.992		
Innovation Performance (IP)	Early Responses	29.909	3.874	0.017	.986
	Late Responses	29.896	4.581		
Sustainable Competitive Advantage (SCA)	Early Responses	14.714	2.470	-0.885	.378
	Late Responses	15.146	2.925		

Furthermore, a non-response bias for demographic variables were also conducted using chi-square test which included profile of sample firms and respondents. To assess the demographic profiles, the indicators of response bias of chi-square and p-value were used to test the level of difference of each category of the respondent's profile. The p-value should be more than 0.05 (p-value > 0.05) to be concluded that the respondents and the company's profiles are free from response bias. Table 5.4 displays the results for non-response bias test for the demographic variables.

Table 5.4: Chi-square Test for Differences between Early and Late Responses

Characteristics	Categories	Early Responses (Freq.)	Late Responses (Freq.)	Chi-Square ($\chi2$) Value (*p*-value)	*df*	Asymp. Sig. (2-sided)
Industry sub-sectors	Petroleum, Chemical, Rubber and Plastic	3	4	1.465	4	.833
	Electrical and Electronics	23	14			
	Food, Beverages and Tobacco	9	6			
	Non-Metallic Mineral Products, Basic Metal and Fabricated Metal Products	13	9			
	Transport Equipment and other Manufacturers	29	15			
Number of Employees	Less than 100	4	6	2.947	4	.567
	100 - 250	10	5			
	251 - 500	10	4			
	501 - 1000	9	7			
	More than 1000	44	26			
Firm Ownership	MNC	46	22	2.331	2	.312
	Malaysian Owned	27	23			
	Government Linked Company	4	3			
Firm Type	Public Listed (Berhad)	7	4	0.021	1	.884
	Private Limited (Sdn.Bhd.)	70	44			
Duration in Business	Less than 5 years	3	0	5.065	3	.167
	6 - 10 years	12	8			
	11 - 15 years	3	6			
	More than 15 years	59	34			
Duration of Lean Six Sigma Implementation	2 - 3 years	4	3	0.134	3	.987
	4 - 5 years	5	3			
	6 - 8 years	29	19			
	More than 8 years	39	23			
Methodology used	DMAIC	21	14	1.146	3	.766
	PDCA	11	8			
	DMAIC and DFSS	7	2			
	DMAIC and PDCA	38	24			
Average Annual Savings from Lean Six Sigma Projects	Less than $ 50,000	11	8	4.734	4	.316
	$ 50,000 - $ 100,000	10	12			
	$ 100,000 - $ 150,000	9	3			
	$ 150,000 - $ 200,000	7	6			
	More than $ 200,000	40	19			

Table 5.4: Continued

Characteristics	Categories	Early Responses (Freq.)	Late Responses (Freq.)	Chi-Square ($\chi 2$) Value (p-value)	*df*	Asymp. Sig. (2-sided)
Lean Six Sigma Qualification	Black Belt	32	11	5.608	3	.132
	Master Black Belt	8	9			
	Green Belt	22	19			
	Champion/ Sponsor	15	9			

Note: Significant differences (p < 0.05)

Based on Table 5.3 and 5.4, the results portrayed no significant difference in the non-demographic and demographic variables amongst the respondents. In summary, there was not enough evidence to claim that early and late responses had a response bias issue for the overall enquiries. Therefore, it can be concluded that non-response bias was not a problem in this study.

5.3 Measurement Model Assessment

The research model in this study is evaluated using a partial least square technique (PLS). Hence, Smart PLS 3 software version 3.2.6 was utilized (Ringle, Wende & Becker, 2015) for measurement and structural model assessment and validation. The technique utilized will be able to assist the researcher in assessing the psychometric properties of the measurement model and estimates the parameter of the structural model. As per discussion in Chapter 4, the validity and reliability of the measurement model are assessed based on indicator reliability, internal consistency reliability, convergent validity and discriminant validity.

5.3.1 Indicator Reliability

Table 5.5 below portrays the descriptive statistics of the constructs' items. Indicator reliability is measured through the value of the items' loadings. A value of at least 0.7

and significant is said to be satisfactory. However values between 0.4 and 0.7 should be assessed carefully. If the removal of the items contributes to the achievement of AVE and CR above the threshold value, it is desirable to do so (Hair et al., 2016). The items with asterisk marks were dropped due to poor loading which correspondingly improved the convergent and reliability of the constructs.

Table 5.5: Descriptive Statistics

Constructs	Item	Mean	Std. Dev.	Loadings	T-Statistics
Lean Technical Practice (LTP)	LTP1*	4.424	0.775	0.421	2.274
	LTP2*	4.272	0.766	0.422	1.986
	LTP3	3.200	1.078	0.653	3.690
	LTP4	4.040	0.945	0.672	3.809
	LTP5	3.216	1.229	0.744	3.186
Lean Social Practice (LSP)	LSP1*	3.568	1.138	0.608	7.539
	LSP2	3.688	0.787	0.650	9.474
	LSP3	3.832	0.811	0.686	10.218
	LSP4	3.840	0.817	0.716	13.112
	LSP5	3.816	0.807	0.694	11.277
	LSP6	3.600	0.916	0.692	11.168
	LSP7	3.920	0.867	0.743	13.153
	LSP8	3.992	0.828	0.726	15.070
	LSP9	3.760	0.856	0.750	17.208
	LSP10	3.992	0.808	0.751	14.116
Role Structure (RS)	RS1	3.824	1.017	0.696	8.796
	RS2	3.792	0.883	0.756	10.919
	RS3	3.688	0.797	0.688	5.790
	RS4	3.832	0.820	0.687	8.064
	RS5*	3.368	1.125	0.614	5.783
Structured Improvement Procedure (SIP)	SIP1	4.280	0.736	0.854	15.783
	SIP2	4.328	0.716	0.760	11.004
	SIP3	4.120	0.714	0.864	29.251
Focus on Metrics (FOM)	FOM1*	4.048	0.739	0.587	3.722
	FOM2	3.864	0.846	0.564	3.602
	FOM3	4.040	0.700	0.756	11.707
	FOM4	4.112	0.698	0.735	13.614
	FOM5	3.888	0.844	0.626	5.663
	FOM6	3.968	0.832	0.719	6.970
	FOM7	3.832	0.887	0.689	7.603
	FOM8*	3.744	0.991	0.541	5.147

Table 5.5: continued

Constructs	Item	Mean	Std. Dev.	Loadings	T-Statistics
Potential Absorptive Capacity (PACAP)	PACAP1*	4.080	0.679	0.565	7.146
	PACAP2	3.840	0.893	0.732	12.409
	PACAP3*	3.752	0.726	0.524	5.416
	PACAP4	4.208	0.796	0.669	7.995
	PACAP5*	3.960	0.766	0.608	5.015
	PACAP6*	3.808	0.895	0.593	6.663
	PACAP7	4.016	0.924	0.629	7.660
	PACAP8	3.968	0.647	0.684	9.785
	PACAP9	3.944	0.626	0.624	5.941
Realized Absorptive Capacity (RACAP)	RACAP1	3.976	0.575	0.568	5.622
	RACAP2*	3.928	0.611	0.568	6.167
	RACAP3*	3.912	0.696	0.520	5.009
	RACAP4*	4.024	0.808	0.368	2.530
	RACAP5*	3.640	1.027	0.287	2.688
	RACAP6*	3.896	0.749	0.599	8.223
	RACAP7	4.088	0.596	0.656	6.433
	RACAP8*	4.376	0.668	0.296	2.314
	RACAP9	4.168	0.471	0.539	5.044
	RACAP10	4.048	0.633	0.671	7.876
	RACAP11*	3.904	0.766	0.365	3.511
	RACAP12*	3.328	1.176	0.241	1.991
Innovation Performance (IP)	IP1*	3.680	0.947	0.525	5.223
	IP2	3.648	0.900	0.724	10.044
	IP3	3.944	0.733	0.610	6.853
	IP4*	3.680	0.725	0.405	2.757
	IP5*	3.936	0.704	0.588	5.906
	IP6	3.512	0.939	0.692	11.195
	IP7	3.568	0.901	0.689	9.874
	IP8	3.936	0.859	0.648	9.588
Sustainable Competitive Advantage (SCA)	SCA1	3.664	0.888	0.659	8.175
	SCA2	3.808	0.759	0.848	23.605
	SCA3	3.792	0.910	0.798	15.744
	SCA4	3.616	0.982	0.695	10.296

**Items dropped due to poor loading. Eliminating them improved AVE and CR values above the required threshold value.*

The lower bound of the outer loading value of the items is 0.539 with the upper bound being 0.864. All items are significant at the level of 0.01 as per reflected by the T-statistic values in the table.

5.3.2 Internal Consistency Reliability

A measurement model is considered to be of satisfactory when the composite reliability (CR) of each construct exceeds the threshold value of 0.7 in general. Hair et al. (2016) explained a CR value between 0.60 and 0.70 are acceptable in exploratory research and in advanced stages values between 0.70 and 0.90 can be regarded as satisfactory.

Table 5.6: Internal Consistency Reliability Statistics

Constructs	Item	Loadings	AVE	CR	Cronbach
Lean Technical Practice (LTP)	LTP3	0.659	0.501	0.749	0.514
	LTP4	0.672			
	LTP5	0.785			
Lean Social Practice (LSP)	LSP2	0.626	0.515	0.905	0.882
	LSP3	0.693			
	LSP4	0.726			
	LSP5	0.712			
	LSP6	0.702			
	LSP7	0.745			
	LSP8	0.732			
	LSP9	0.752			
	LSP10	0.761			
Role Structure (RS)	RS1	0.687	0.516	0.810	0.688
	RS2	0.763			
	RS3	0.714			
	RS4	0.706			
Structured Improvement Procedure (SIP)	SIP1	0.856	0.684	0.866	0.770
	SIP2	0.757			
	SIP3	0.864			
Focus on Metrics (FOM)	FOM2	0.618	0.509	0.861	0.808
	FOM3	0.794			
	FOM4	0.745			
	FOM5	0.687			
	FOM6	0.745			
	FOM7	0.679			
Potential Absorptive Capacity (PACAP)	PACAP2	0.722	0.514	0.841	0.764
	PACAP4	0.653			
	PACAP7	0.720			
	PACAP8	0.764			
	PACAP9	0.720			

Table 5.6: Continued

Constructs	Item	Loadings	AVE	CR	Cronbach
Realized Absorptive Capacity (RACAP)	RACAP1	0.616	0.517	0.809	0.687
	RACAP7	0.769			
	RACAP9	0.686			
	RACAP10	0.790			
Innovation Performance (IP)	IP2	0.712	0.506	0.836	0.756
	IP3	0.644			
	IP6	0.729			
	IP7	0.749			
	IP8	0.718			
Sustainable Competitive Advantage (SCA)	SCA1	0.644	0.568	0.839	0.743
	SCA2	0.842			
	SCA3	0.800			
	SCA4	0.713			

Based on Table 5.6 above, all the constructs CR values exceeds the 0.7 level. The CR values ranges between 0.749 and 0.905. Hence, the analysis indicates the use of the items represents the constructs which has satisfactory internal consistency reliability. Besides, the Cronbach alpha value also achieves the reasonable threshold between 0.50 and 0.75 as Hinton et al. (2004) described to be of moderate reliability.

5.3.3 Convergent Validity

In order to assess and validate convergent validity of the research model, the average variance extracted (AVE) value is examined. Convergent validity is said to be achieved when the AVE has a value of at least 0.5 or more. Based on Table 6.6, the AVE value ranges between 0.501 and 0.684, which are above the threshold value as stated. This corroborates that the study's measurement model demonstrated an adequate convergent validity.

5.3.4 Discriminant Validity

This study's measurement model's discriminant validity is assessed using three measures as delineated in chapter 3: 1) cross loadings 2) Fornell and Larcker's (1981) criterion and 3) heterotrait-monotrait ratio of correlations (HTMT) as suggested by Henseler et al. (2015). A measurement model is said to be of discriminant validity when 1) the indicators' loadings are higher against their respective construct compared to other constructs; 2) the square root of the AVE exceeds the correlations between the measure and all other measures; and 3) the HTMT value is greater than $HTMT_{0.85}$ value of 0.85 (Kline, 2011), or $HTMT_{0.90}$ value of 0.90 (Gold et al., 2001).

5.3.4.1 Cross Loadings

Table 5.7 show the output of cross loadings between constructs and indicators. It shows that all measurement items loaded higher against their respective intended latent variable compared to other variables. Besides that, the result also demonstrated that the loading of each block is higher than any other block in the same rows and columns. Thus, cross loadings does not seem to be an issue in this study.

Table 5.7: The Cross Loading Output Using Smart PLS

	FOM	IP	LSP	LTP	PACAP	RACAP	RS	SCA	SIP
FOM2	**0.618**	0.086	0.35	0.245	0.035	0.317	0.233	0.045	0.119
FOM3	**0.794**	0.262	0.397	0.279	0.218	0.349	0.272	0.189	0.347
FOM4	**0.745**	0.228	0.459	0.277	0.14	0.35	0.312	0.077	0.392
FOM5	**0.687**	0.051	0.332	0.133	0.075	0.175	0.194	0.033	0.19
FOM6	**0.745**	0.236	0.398	0.296	0.165	0.363	0.245	0.197	0.307
FOM7	**0.679**	0.244	0.378	0.318	0.094	0.314	0.362	0.153	0.25
IP2	0.128	**0.712**	0.18	0.291	0.43	0.28	0.174	0.398	0.43
IP3	0.208	**0.644**	0.321	0.231	0.35	0.331	0.211	0.348	0.392
IP6	0.136	**0.729**	0.158	0.127	0.439	0.341	0.186	0.429	0.302
IP7	0.332	**0.749**	0.265	0.194	0.405	0.351	0.307	0.379	0.47
IP8	0.189	**0.718**	0.333	0.042	0.478	0.354	0.289	0.454	0.303
LSP2	0.375	0.198	**0.626**	0.403	0.232	0.311	0.232	0.36	0.337
LSP3	0.449	0.251	**0.693**	0.391	0.293	0.26	0.27	0.169	0.263

Table 5.7: continued

	FOM	IP	LSP	LTP	PACAP	RACAP	RS	SCA	SIP
LSP4	0.383	0.245	**0.726**	0.343	0.249	0.377	0.287	0.203	0.351
LSP5	0.351	0.274	**0.712**	0.29	0.27	0.344	0.262	0.227	0.311
LSP6	0.398	0.266	**0.702**	0.305	0.299	0.352	0.202	0.309	0.223
LSP7	0.454	0.338	**0.745**	0.223	0.252	0.348	0.305	0.247	0.236
LSP8	0.429	0.282	**0.732**	0.239	0.207	0.417	0.358	0.317	0.235
LSP9	0.401	0.214	**0.752**	0.35	0.326	0.37	0.33	0.364	0.327
LSP10	0.279	0.213	**0.761**	0.271	0.254	0.31	0.279	0.264	0.204
LTP3	0.183	0.127	0.268	**0.659**	0.129	0.246	0.232	0.273	0.168
LTP4	0.44	0.118	0.455	**0.672**	0.133	0.205	0.238	0.156	0.327
LTP5	0.219	0.24	0.248	**0.785**	0.31	0.227	0.209	0.185	0.231
PACAP2	0.153	0.394	0.256	0.254	**0.722**	0.325	0.299	0.461	0.409
PACAP4	0.119	0.404	0.22	0.06	**0.653**	0.222	0.238	0.29	0.446
PACAP7	0.048	0.353	0.242	0.164	**0.720**	0.203	0.196	0.414	0.371
PACAP8	0.168	0.484	0.295	0.28	**0.764**	0.413	0.193	0.365	0.36
PACAP9	0.152	0.486	0.302	0.247	**0.720**	0.376	0.308	0.418	0.4
RACAP1	0.296	0.298	0.216	0.119	0.196	**0.616**	0.378	0.308	0.089
RACAP7	0.351	0.398	0.425	0.236	0.351	**0.769**	0.462	0.377	0.44
RACAP9	0.383	0.223	0.356	0.29	0.288	**0.686**	0.189	0.214	0.306
RACAP10	0.282	0.396	0.362	0.261	0.395	**0.790**	0.253	0.405	0.291
RS1	0.223	0.138	0.274	0.231	0.3	0.269	**0.687**	0.222	0.269
RS2	0.258	0.249	0.272	0.204	0.298	0.274	**0.763**	0.308	0.346
RS3	0.274	0.206	0.278	0.149	0.149	0.332	**0.714**	0.243	0.26
RS4	0.332	0.332	0.299	0.292	0.241	0.414	**0.706**	0.316	0.346
SCA1	0.181	0.298	0.255	0.299	0.38	0.407	0.344	**0.644**	0.362
SCA2	0.161	0.504	0.356	0.157	0.466	0.429	0.321	**0.842**	0.401
SCA3	0.176	0.450	0.298	0.164	0.416	0.383	0.346	**0.800**	0.369
SCA4	0.019	0.433	0.238	0.272	0.388	0.179	0.156	**0.713**	0.273
SIP1	0.323	0.427	0.323	0.276	0.43	0.357	0.371	0.414	**0.856**
SIP2	0.358	0.354	0.344	0.325	0.324	0.362	0.387	0.333	**0.757**
SIP3	0.304	0.512	0.302	0.241	0.581	0.311	0.325	0.402	**0.864**

5.3.4.2 Fornell and Larcker's Criterion

Table 5.8 represents the Fornell and Larcker's criterion assessment using the square root of AVE. Based on the results, it is clear that all off-diagonal elements are lower than the square roots of AVE (bolded on the diagonal). Thus, it can be concluded that the Fornell and Larcker's criterion is satisfactory.

Table 5.8: Discriminate Validity of Constructs

	FOM	IP	LSP	LTP	PACAP	RACAP	RS	SCA	SIP
FOM	**0.714**								
IP	0.279	**0.711**							
LSP	0.546	0.354	**0.718**						
LTP	0.374	0.241	0.434	**0.708**					
PACAP	0.182	0.594	0.369	0.289	**0.717**				
RACAP	0.452	0.467	0.482	0.317	0.437	**0.719**			
RS	0.383	0.330	0.393	0.313	0.348	0.455	**0.718**		
SCA	0.176	0.567	0.384	0.284	0.548	0.462	0.383	**0.754**	
SIP	0.392	0.528	0.386	0.332	0.552	0.410	0.430	0.465	**0.827**

Note: Diagonals represent the square root of AVE while the other entries represent the squared correlations.

5.3.4.3 HTMT Criterion

Discriminant validity is said to be of an issue when the values surpass 0.85 or 0.90. The value of 0.85 is a stringent criteria than the 0.90 value. Given the results reported in Table 5.9, all the values amongst the constructs are lower than the stricter value of HTMT$_{0.85}$. Therefore, it indicates that discriminant validity of this measurement model is ascertained and proves of no issue.

Table 5.9: Discriminant Validity (HTMT Ratio)

	FOM	**IP**	**LSP**	**LTP**	**PACAP**	**RACAP**	**RS**	**SCA**	**SIP**
FOM									
IP	0.346								
LSP	0.640	0.433							
LTP	0.593	0.397	0.678						
PACAP	0.229	0.775	0.447	0.423					
RACAP	0.591	0.634	0.604	0.527	0.581				
RS	0.499	0.443	0.501	0.521	0.470	0.640			
SCA	0.247	0.745	0.469	0.482	0.722	0.645	0.536		
SIP	0.480	0.690	0.473	0.551	0.704	0.547	0.592	0.615	

5.4 Structural Model Assessment

The measurement model has been assessed and validated. As mentioned in Chapter 4, the structural model assessment will involve path coefficient, coefficient of determination (R^2), variance inflation factor (VIF), effect size (f^2) and predictive relevance (Q^2). These assessment will be able to validate the relationships as hypothesized in the research model.

5.4.1 Coefficient of Determination (R^2)

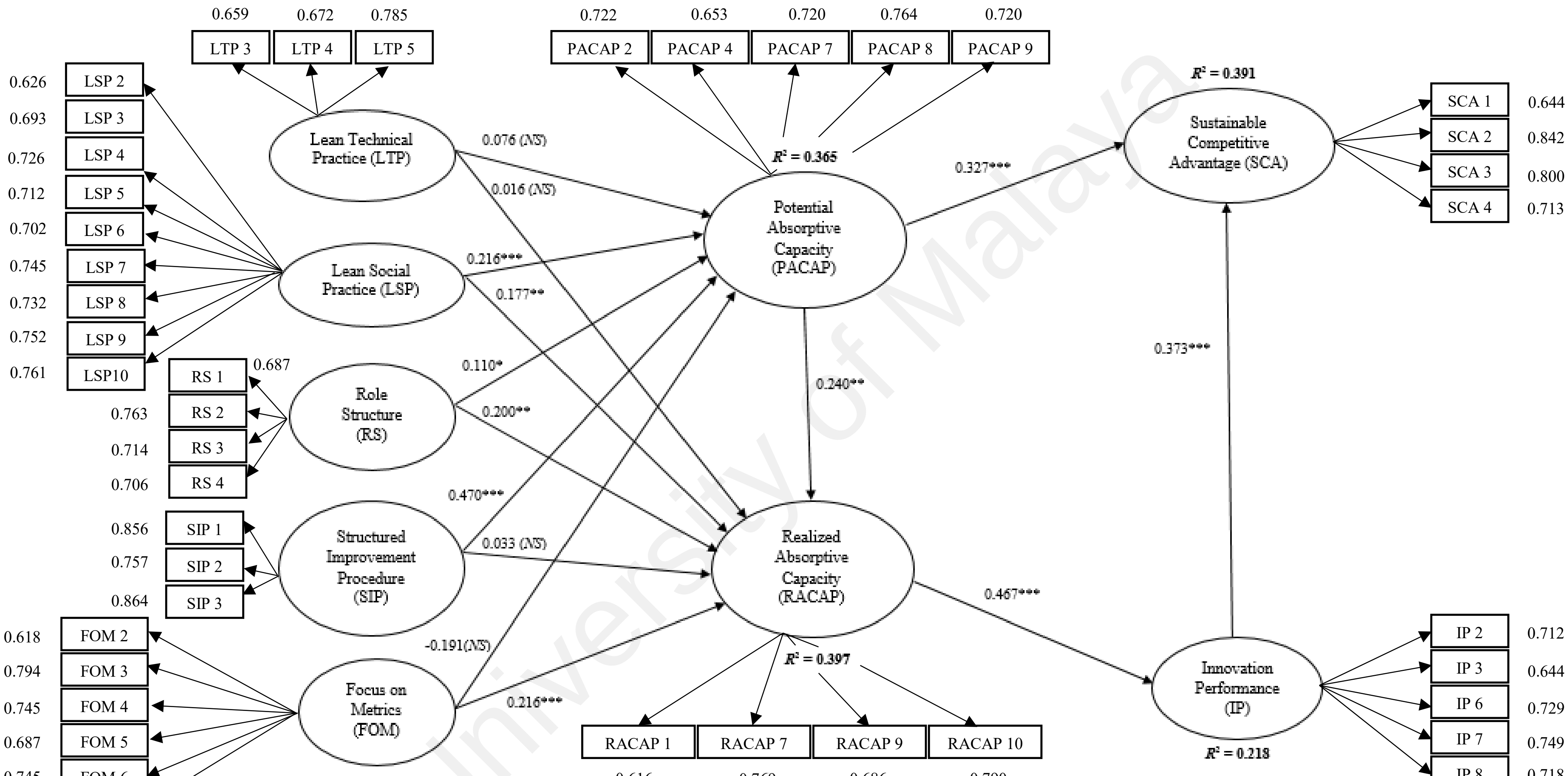
The R^2 value elucidates the amount of variance in the dependent variables explained by the independent variables. It implies that a larger value of R^2 increases the predictive ability of the structural model. In this study, the PLS Algorithm function is used to obtain the R^2 values. The SmartPLS bootstrapping function is used to gain the t-statistic values. For bootstrapping, the generally recommended sample size of 5000 (n=5000) is used (Hair et al., 2016). The result of the structural model is presented in Figure 5.1.

Referring to Figure 5.1, potential absorptive capacity (PACAP) and innovation performance (IP) are able to explain 39.1% of the variance in Sustainable Competitive Advantage (SCA). Realized absorptive capacity (RACAP) is able to explain 21.8% of the variance in IP. The idiosyncrasies of Lean, the technical (LTP) and social (LSP) practice and Six Sigma's role structure (RS), structured improvement procedure (SIP) and focus on metrics (FM) together explain 36.5% of the variance in PACAP. These idiosyncrasies (LTP, LSP, RS, SIP and FOM) along with PACAP explain 39.7% of the variance in RACAP.

5.4.2 Path Coefficients

Each path connecting two latent variables in the structural model represents a hypothesis. Based on the results analyzed in the structural model, the study will be able to confirm or disconfirm the respective hypothesis in validating them. Besides, the researcher will also be able to recognize the strength of the relationship between dependent and independent variables.

The SmartPLS algorithm will be able to display the relationships between dependent and independent variables. But in order to examine the significance level, the bootstrapping function is used to generate the t-statistics for all the paths. The t-statistics output determines the significance level of each relationship.



* p<0.1
** p<0.05
*** p<0.01

NS Not Significant

Figure 5.1: Results of Structural Equation Modeling

Table 5.10: Path Coefficients, T- Statistics, Significance Level for all Hypothesized Paths

Independent Constructs	Dependent Construct	Path Coefficient (β)	T – statistics	Significance Level (p-values)
PACAP →	Sustainable Competitive Advantage (SCA) $R^2 = 0.391$	0.327	3.434	0.000
IP →		0.373	3.456	0.000
RACAP →	Innovation Performance (IP) $R^2 = 0.218$	0.467	4.775	0.000
LTP →	Potential Absorptive Capacity (PACAP) $R^2 = 0.365$	0.076	0.819	NS
LSP →		0.216	2.478	0.007
RS →		0.110	1.308	0.096
SIP →		0.470	4.849	0.000
FOM →		-0.191	1.957	0.025
LTP →	Realized Absorptive Capacity (RACAP) $R^2 = 0.397$	0.016	0.184	NS
LSP →		0.177	1.747	0.040
RS →		0.200	1.718	0.043
SIP →		0.033	0.285	NS
FOM →		0.216	2.571	0.005
PACAP →		0.240	2.019	0.022

Table 5.10 displays the path coefficients, t-statistics and p-values for all the hypothesized paths. The acceptance and rejection of the proposed hypothesis is determined using the results obtained from the path assessment. Next, testing of the proposed hypotheses are discussed after considering multicollinearity issues.

5.4.3 Variance Inflation Factor (VIF)

A high VIF value indicates a multicollinearity problem in the structural model. It implies that independent variables within the research model are highly correlated which brings complications as reported in Chapter 4. Referring to the VIF values obtained from the analysis in Table 5.12, which ranges from 1.000 and 1.731, all the values are clearly below 5 and even lower from the stringent threshold of 3.33 (Diamantopoulos & Siguaw, 2000). It can be concluded that the structural model is free from multicollinearity issue and that it is not a cause for concern.

5.4.4 Hypotheses Testing

Validation of the proposed hypothesis is done by assessing the path coefficient between two latent variables. Path coefficient values need to be at least 0.1 to account for a certain impact (Wetzels et al., 2009). The path coefficient assessment shows that all the hypotheses are supported except for H1a, H1b, H4b, H5a, H7a, H7b, H7c and H7e (Refer Table 5.11). From the analysis, the supported hypotheses are significant at least at the level of 0.1 (10%), have expected sign directions (i.e., positive or negative) and has a path coefficient (β) value ranging from 0.110 to 0.470. Table 5.11 shows the summary of the hypotheses testing and the respective results.

Table 5.11: Summary of Hypothesis Testing

Hypothesis Statement		Result
H1a	Lean Technical Practice (LTP) has a positive effect on Potential Absorptive Capacity (PACAP)	Not Supported
H2a	Lean Social Practice (LSP) has a positive effect on Potential Absorptive Capacity (PACAP)	Supported
H3a	Role Structure (RS) has a positive effect on Potential Absorptive Capacity (PACAP)	Supported
H4a	Structured Improvement Procedure (SIP) has a positive effect on Potential Absorptive Capacity (PACAP)	Supported
H5a	Focus on Metrics (FOM) has a positive effect on Potential Absorptive Capacity (PACAP)	Not Supported
H1b	Lean Technical Practice (LTP) has a positive effect on Realized Absorptive Capacity (RACAP)	Not Supported
H2b	Lean Social Practice (LSP) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported
H3b	Role Structure (RS) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported
H4b	Structured Improvement Procedure (SIP) has a positive effect on Realized Absorptive Capacity (RACAP)	Not Supported
H5b	Focus on Metrics (FOM) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported
H6	Potential Absorptive Capacity (PACAP) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported

Table 5.11: Continued

Hypothesis Statement		Result
H7a	Potential Absorptive Capacity (PACAP) mediates the relationship between LTP and Realized Absorptive Capacity (RACAP)	Not Supported
H7b	Potential Absorptive Capacity (PACAP) mediates the relationship between LSP and Realized Absorptive Capacity (RACAP)	Not Supported
H7c	Potential Absorptive Capacity (PACAP) mediates the relationship between RS and Realized Absorptive Capacity (RACAP)	Not Supported
H7d	Potential Absorptive Capacity (PACAP) mediates the relationship between SIP and Realized Absorptive Capacity (RACAP)	Supported
H7e	Potential Absorptive Capacity (PACAP) mediates the relationship between FOM and Realized Absorptive Capacity (RACAP)	Not Supported
H8	Potential Absorptive Capacity (PACAP) has a positive effect on Sustainable Competitive Advantage (SCA)	Supported
H9	Realized Absorptive Capacity (RACAP) has a positive effect on Innovation Performance (IP)	Supported
H10	Innovation Performance (IP) has a positive effect on Sustainable Competitive Advantage (SCA)	Supported

Based on the analysis of the output, it shows that LTP does not have a positive effect on PACAP (β=0.076, t=0.819, not significant). LTP also does not seem to have a positive effect on RACAP (β=0.016, t=0.184, not significant). As a result, hypothesis H1a and hypothesis H1b are not supported.

LSP has a positive effect on PACAP (β=0.216, t=2.478, $p<0.01$). LSP also positively effects RACAP (β=0.177, t=1.747, $p<0.05$). As a result, hypothesis H2a and hypothesis H2b are supported.

RS has a positive effect on PACAP (β=0.110, t=1.308, $p<0.1$) and on RACAP (β=0.200, t=1.718, $p<0.05$). SIP has a positive effect on PACAP (β=0.470, t=4.849, $p<0.01$). However, SIP does not seem to have a positive effect on RACAP (β=0.033, t=0.285, not significant). As a result, hypothesis H3a, H3b and H4a are supported meanwhile hypothesis H4b is not supported.

Also, FOM has a negative effect on PACAP (β= -0.191, t=1.957, not significant). However, FOM has a positive effect on RACAP (β=0.216, t=2.571, $p<0.01$). Therefore, hypothesis H5a is not supported however hypothesis H5b is supported.

From the analysis, it is also evident that PACAP has a positive effect on RACAP (β=0.240, t=2.019, $p<0.05$). Hence, hypothesis H6 is supported. Furthermore, RACAP has a positive effect on IP (β=0.467, t=4.775, $p<0.01$), meanwhile PACAP has a positive effect on SCA (β=0.327, t=3.434, $p<0.01$). IP also has a positive effect on SCA (β=0.373, t=3.456, $p<0.01$). As a result, hypothesis H8, H9 and hypothesis H10 are supported.

5.4.5 Effect Size (f^2)

The effect size of f^2 refers to the change in the R^2 when a specified exogenous construct is omitted from the model and how substantive of an impact the omitted construct could have on the endogenous constructs (Hair et al., 2016). The f^2 value of 0.02, 0.15, and 0.35 represents small, medium and large effects respectively (Cohen, 1988).

Table 5.12 shows the summary of effect sizes of all the hypothesized relationship in the research model. According to the results of the analysis, there are seven relationships with small effect sizes (H2a, H2b, H3a, H3b, H5b, H6 and H8). Three of the relationships have medium effect sizes (H4a, H9 and H10) meanwhile the rest can be considered as absent of effect size.

5.4.6 Predictive Relevance (Q^2)

The Q^2 value explains the predictive relevance of the research model. In other words how accurately could the model predict data not used in the estimation model. If the value is greater than zero, it means the research model possess predictive relevance (Fornell & Cha, 1994; Hair et al., 2016). The Q^2 value is acquired through the blindfolding procedure for a specified omission distance (*D*) (Hair et al., 2016). The distance chosen for this study is 7. The Q^2 values for the endogenous constructs in the research model are as reported in Table 5.12. Given all the Q^2 values are greater than zero which ranges from 0.096 to 0.198, it can be concluded that the research model has sufficient predictive relevance. All the endogenous constructs of the research model has a medium effect size (q^2) of predictive relevance except for IP which has a small effect size of predictive relevance.

Table 5.12: Effect Size and Predictive Relevance of the Research Model

Hypothesis	Relationship	t-values	Decision	R^2	f^2	VIF	Q^2
H1a	LTP → PACAP	0.819 (NS)	Not Supported	0.365	0.007	1.321	0.167
H2a	LSP → PACAP	2.478***	Supported		0.045	1.643	
H3a	RS → PACAP	1.308*	Supported		0.014	1.370	
H4a	SIP → PACAP	4.849***	Supported		0.252	1.383	
H5a	FOM → PACAP	1.957	Not Supported		0.037	1.569	
H1b	LTP → RACAP	0.184 (NS)	Not Supported	0.397	0.000	1.330	0.153
H2b	LSP → RACAP	1.747**	Supported		0.030	1.716	
H3b	RS → RACAP	1.718**	Supported		0.048	1.389	
H4b	SIP → RACAP	0.285 (NS)	Not Supported		0.001	1.731	
H5b	FOM → RACAP	2.571***	Supported		0.048	1.626	
H6	PACAP → RACAP	2.019**	Supported		0.061	1.574	
H9	RACAP → IP	4.775***	Supported	0.218	0.280	1.000	0.096
H8	PACAP → SCA	3.434***	Supported	0.391	0.113	1.546	0.198
H10	IP → SCA	3.456***	Supported		0.148	1.546	

5.4.7 Test of Mediation

Testing of mediation in the research is done following Preacher and Hayes (2004; 2008) method of bootstrapping. The indirect effects are calculated manually by multiplying relevant paths' coefficient. The t-value should be significant and the Bias-Corrected Confidence Interval on the lower and upper level should not straddle between 0. If this is not satisfied, it means there is no mediation effect otherwise there is. Table 5.13 shows the result of the mediation analysis of PACAP.

In the assessment of PACAP as a mediator, it is observed that the indirect effect was significant at 5% significance level between SIP and RACAP (β=0.113, t=2.051). The mediation is evident given the bootstrap confidence interval, CI: [LL=0.005, UL=0.221] did not straddle a zero in between. It can be concluded that PACAP mediates the relationship between the practice of SIP and RACAP therefore H7d is supported. The rest of the hypotheses were not significant and the bootstrap confidence interval did not straddled a zero in between as per the result obtained and displayed in Table 5.13. Therefore all the other hypotheses (H7a, H7b, H7c, and H7e) are not supported accordingly.

Table 5.13: Mediation of PACAP

Hypothesis	Relationship	Std. Beta	Std. Error	t-values	Decision	Bootstrapped Confidence Interval	
						95% LL	95% UL
H7a	LTP → PACAP → RACAP	0.018	0.0293	0.624	Not Supported	-0.039	0.076
H7b	LSP → PACAP → RACAP	0.052	0.0403	1.285	Not Supported	-0.027	0.131
H7c	RS → PACAP → RACAP	0.026	0.0334	0.790	Not Supported	-0.039	0.092
H7d	SIP → PACAP → RACAP	0.113	0.0550	2.051*	Supported	0.005	0.221
H7e	FOM → PACAP → RACAP	-0.046	0.0343	-1.335	Not Supported	-0.113	0.021

Note: *p<0.05 (t-value > 1.96). A two-tailed test is used for mediation assessment.

Table 5.14: IPMA: Total Effect and Performance Values Based on Target Constructs

Construct	Importance (PACAP)	Importance (RACAP)	Importance (SCA)	Importance (IP)	Performance
FOM	-0.183	0.124	-0.038	0.087	74.332
IP	-	-	0.402	-	68.366
LSP	0.195	0.157	0.122	0.110	70.681
LTP	0.053	0.018	0.026	0.013	61.760
PACAP	-	0.183	0.451	0.127	74.604
RACAP	-	-	0.280	0.697	76.887
RS	0.095	0.149	0.080	0.104	69.658
SIP	0.424	0.100	0.197	0.070	80.779

Note: Performance value for SCA is 68.339

5.4.8 Importance-Performance Matrix (IPMA)

The IPMA in this study will be used as an augmentation to analysis' findings to identify relevant variables that are of utmost importance to a key target construct. This study focuses on the extent Lean Six Sigma practices effect the dual components of absorptive capacity, PACAP and RACAP. Following that, the study also intends to highlight how these components resulting from the practices bring about innovation performance and sustainable competitive advantage. As such, the key target construct in this context is dissected into four; potential absorptive capacity (PACAP), realized absorptive capacity (RACAP), innovation performance (IP) and sustainable competitive advantage (SCA). The reason being, it is intended to discover which practices of Lean Six Sigma have substantial effect on PACAP and RACAP. Further, how do these importance convey to the outcome of IP and SCA. The following analysis will be based on figures of each target construct and Table 5.14 displays the performance of each construct and total effect (unstandardized) values based on each target construct as in parentheses.

Figure 5.2 portrays the graphical representation of IPMA result for target construct PACAP. Based on Table 5.14 and the Figure 5.2, it can be explained that SIP is the most important practice with a total effect of 0.424 followed by LSP (0.195) and RS (0.095).

As for RACAP (as shown in Figure 5.3), it is not surprising that the most important variable to its impact being PACAP. However, in the context of Lean Six Sigma practices, the most important practice would be LSP with a total effect of 0.157. Which means increase of performance in LSP by a unit from 70.681 to 71.68 will render an improvement in the performance of RACAP by 0.157 points. Subsequent improvement of one-unit in the performance of RS and FOM would yield an increase in the performance of RACAP by 0.149 and 0.124 points respectively, making the practices as the second and third most important practice of Lean Six Sigma to trigger RACAP positively.

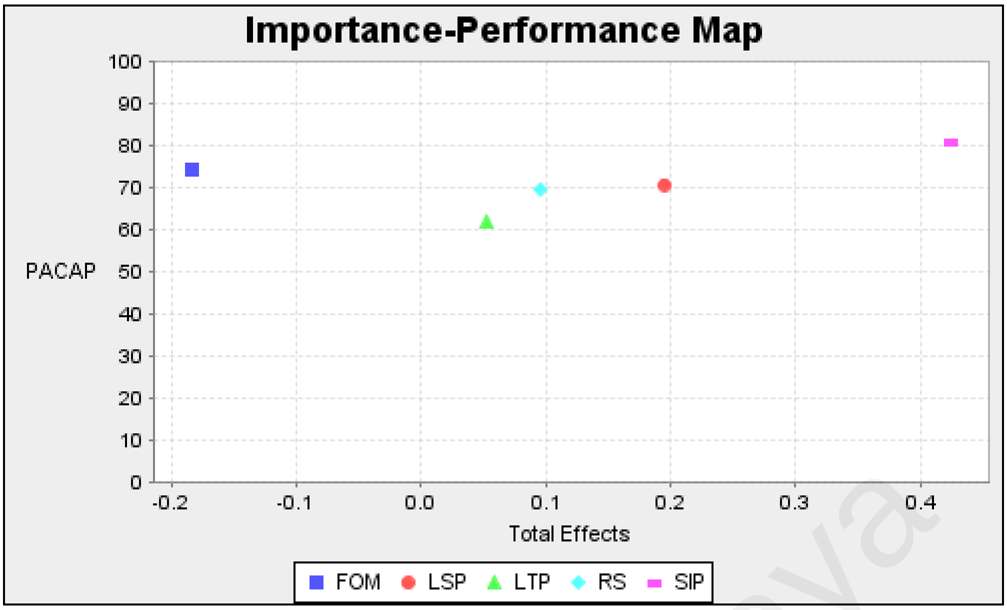


Figure 5.2: IPMA Target Construct Potential Absorptive Capacity (PACAP)

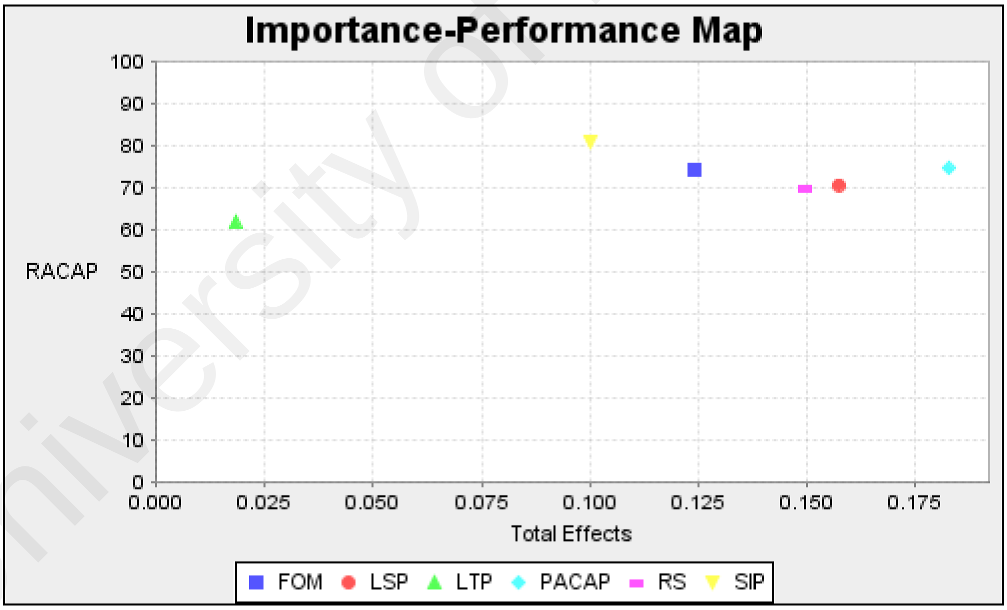


Figure 5.3: IPMA Target Construct Realized Absorptive Capacity (RACAP)

The most important construct for IP is without a doubt RACAP (0.697) given its significant impact on the variable following which is PACAP (0.127) (Refer Figure 5.4). This means, when RACAP's performance increases by one-unit from 76.887 to 77.887, the performance IP improves by 0.697 points. A similar one-unit increase on PACAP on the other hand, influences an increase in IP by 0.127 point from 68.366 to 68.493.

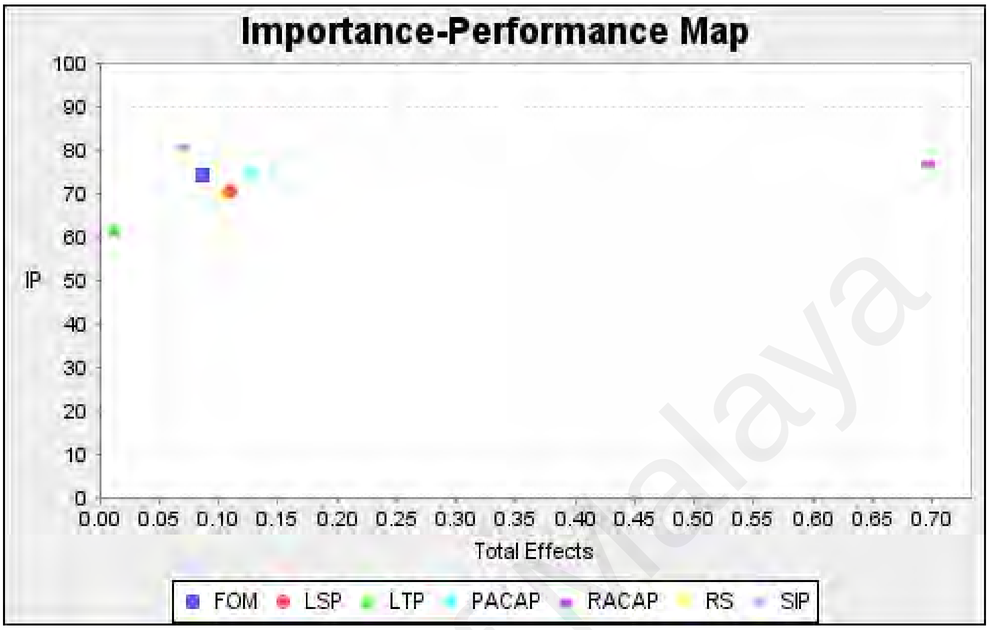


Figure 5.4: IPMA Target Construct Innovation Performance (IP)

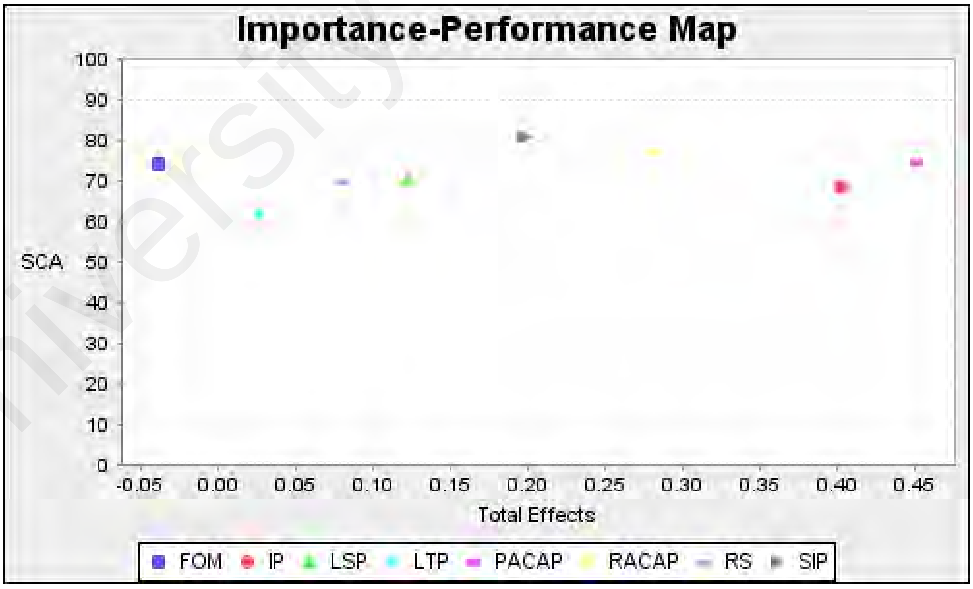


Figure 5.5: IPMA Target Construct Sustainable Competitive Advantage (SCA)

As per Figure 5.5, the most influential construct for SCA is PACAP (0.451) followed by IP (0.402) and RACAP (0.280). A one-unit increase in the performance of PACAP, IP and RACAP will increase the performance of SCA from 68.339 to 68.790, 68.741, and 68.619 respectively.

5.5 Summary of the Chapter

The SmartPLS statistical software is used to investigate the positive effects of Lean Six Sigma practices on the components of absorptive capacity and how do the components' effect lead on to innovation performance and sustainable competitive advantage. A number of observation can be made from the analysis of the structural and measurement model of the study.

The measurement model demonstrated satisfactory of reliability, validity, convergent and discriminant measures. In terms of internal consistency, all the constructs have composite reliability value of more than the threshold value of 0.7. All item loadings were above 0.50 and was significant at 0.01 level. Convergent measures of AVE showed more than 0.50 for all constructs and all manifest variables loaded on its respective latent variable which established discriminant validity of the model.

The structural model also demonstrated satisfactory result. The R^2 value is substantial with a value of 39.1%. This demonstrated a considerable explanatory power. Besides from that, eleven out of fourteen proposed direct paths within the structural model are supported. Meanwhile only one indirect relationship was found to be significant. The relationships have a β value greater than 0.10 and are significant at least at 10% level. The next chapter discourses the summary of the main findings and the discussion of the research's theoretical constructs corresponding to the results obtained.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Overview of Chapter

This chapter provides a summary of the hypotheses and the discussions to the relevant findings obtained in the preceding chapter of survey finding analyses. The discussions of the hypotheses are based on the research questions this study intends to answer. In doing so, rightful explanation to the findings from existing literature will be discoursed. Thereafter, managerial and theoretical implications will be discussed in the next chapter before proceeding to limitation of the study and direction for future research perceived from the research. This chapter ends with concluding remarks about the study.

6.2 Main Findings

Based on the research findings, three of Lean Six Sigma practices (LSP, RS, SIP) were found to be positively and significantly related to PACAP. As for RACAP, LSP, RS and FOM deemed to be positively and significantly related to it. The results found no evidence of Lean's technical practices or tools and techniques to be influencing either of the absorptive capacity's components. Meanwhile, SIP was found to be non-significant towards RACAP, however the relationship was mediated by PACAP. Whereas FOM was negatively related to PACAP as opposed to what was hypothesized.

The research found the components of absorptive capacity to be significantly related wherein PACAP has a positive impact towards RACAP. The study also managed to detail out the significant relationship of these components towards its relevant outcomes of innovation performance and sustainable competitive advantage. The result displayed PACAP to be significantly related to SCA whereas RACAP had a significant influence towards innovation. Innovation in turn had a positive significance towards SCA.

Table 6.1 below exhibits the summary of the research hypotheses and its results corresponding to the research questions. Eleven hypotheses (H2a, H2b, H3a, H3b, H4a, H5b, H6, H7d, H8, H9, H10) out of 19 hypotheses of the research were supported.

Table 6.1: Summary of the Research Questions, Objectives and Hypotheses

Research Questions, Objectives and Hypotheses Statement		Result
Research Question 1: What are the practices of Lean Six Sigma (LTP, LSP, RS, SIP and FOM) that have positive effect on the components of absorptive capacity, Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP)?		
Research Objective 1: To examine the positive effects of Lean Six Sigma's practices (LTP, LSP, RS, SIP and FOM) on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP).		
H1a	Lean Technical Practice (LTP) has a positive effect on Potential Absorptive Capacity (PACAP)	Not Supported
H2a	Lean Social Practice (LSP) has a positive effect on Potential Absorptive Capacity (PACAP)	Supported
H3a	Role Structure (RS) has a positive effect on Potential Absorptive Capacity (PACAP)	Supported
H4a	Structured Improvement Procedure (SIP) has a positive effect on Potential Absorptive Capacity (PACAP)	Supported
H5a	Focus on Metrics (FOM) has a positive effect on Potential Absorptive Capacity (PACAP)	Not Supported
H1b	Lean Technical Practice (LTP) has a positive effect on Realized Absorptive Capacity (RACAP)	Not Supported
H2b	Lean Social Practice (LSP) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported
H3b	Role Structure (RS) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported
H4b	Structured Improvement Procedure (SIP) has a positive effect on Realized Absorptive Capacity (RACAP)	Not Supported
H5b	Focus on Metrics (FOM) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported
Research Question 2: What is the relationship between Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) under the context of Lean Six Sigma application?		
Research Objective 2: To investigate the relationship of Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) under the context of Lean Six Sigma application.		
H6	Potential Absorptive Capacity (PACAP) has a positive effect on Realized Absorptive Capacity (RACAP)	Supported

Table 6.1: continued

Research Questions, Objectives and Hypotheses Statement		Result
Research Question 3: Does Potential Absorptive Capacity (PACAP) mediates the relationship between the practices of Lean Six Sigma (LTP, LSP, RS, SIP, FOM) and Realized Absorptive Capacity (RACAP)?		
Research Objective 3: To analyze the mediating role of Potential Absorptive Capacity (PACAP) between Lean Six Sigma practices (LTP, LSP, RS, SIP, FOM) and Realized Absorptive Capacity (RACAP).		
H7a	Potential Absorptive Capacity (PACAP) mediates the relationship between LTP and Realized Absorptive Capacity (RACAP)	Not Supported
H7b	Potential Absorptive Capacity (PACAP) mediates the relationship between LSP and Realized Absorptive Capacity (RACAP)	Not Supported
H7c	Potential Absorptive Capacity (PACAP) mediates the relationship between RS and Realized Absorptive Capacity (RACAP)	Not Supported
H7d	Potential Absorptive Capacity (PACAP) mediates the relationship between SIP and Realized Absorptive Capacity (RACAP)	Supported
H7e	Potential Absorptive Capacity (PACAP) mediates the relationship between FOM and Realized Absorptive Capacity (RACAP)	Not Supported
Research Question 4: What are the relationships between Potential Absorptive Capacity (PACAP), Realized Absorptive Capacity (RACAP), innovation performance and sustainable competitive advantage in the context of Lean Six Sigma?		
Research Objective 4: To evaluate the relationships between Potential Absorptive Capacity (PACAP), Realized Absorptive Capacity (RACAP), innovation performance and sustainable competitive advantage in Lean Six Sigma firms.		
H8	Potential Absorptive Capacity (PACAP) has a positive effect on Sustainable Competitive Advantage (SCA)	Supported
H9	Realized Absorptive Capacity (RACAP) has a positive effect on Innovation Performance (IP)	Supported
H10	Innovation Performance (IP) has a positive effect on Sustainable Competitive Advantage (SCA)	Supported

6.3 Discussion

In this section, the findings from the analyses will be deliberated with relevance to each research objective.

6.3.1 Research Objective 1: To examine the positive effects of Lean Six Sigma's practices (LTP, LSP, RS, SIP, FOM) on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP).

6.3.1.1 Lean Technical Practice's (LTP) Effect on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP)

Lean's Technical Practice (LTP), or the tools and techniques of Lean was found to be non-significant towards both components of absorptive capacity (PACAP: $\beta=0.076$, $t=0.819$, not significant, RACAP: $\beta=0.016$, $t=0.184$, not significant). This finding contradicts with previous studies' findings such as Stanica and Peydro's (2016) wherein they found implementation of the cross-training employee lean tool will have a positive effect on the knowledge transfer processes in the organizations, which reflects the traits of absorptive capacity. As Tsai (2001) puts it knowledge creation and absorptive capacity plays a relative role since the fundamental of creation, transference or absorption of knowledge involves learning orientation. Zhang and Chen (2016) found Lean tools to be vital in the creation of knowledge. Tyagi et al. (2015) believes that Lean tools are crucial in the creation of dynamic knowledge that involves internal and external interaction amongst organizational members. They proposed ten Lean tools to assist the absorption of tacit and explicit knowledge from within the organization and externally. Although these studies denotes the importance of Lean tools influence on knowledge creation, the findings of this study indicates otherwise in the context of absorptive capacity.

The results obtained may be in line to the notion by Anand et al. (2009) that operational Lean tools is a minimum but not sufficient condition for the development of Lean practices as Lean infrastructure. Another possible explanation to this may be as per the study by Assen (2016) who scrutinized Lean's tools and infrastructural practice's impact towards process improvement, customer effectiveness and financial performance. The result of his study revealed in contrast to common outcomes whereby the use of Lean tools did not directly impact process improvement performance, customer effectiveness or financial performance. In fact, Lean tools were impactful towards Lean's infrastructural practices (social practices) which in turn was significantly related to the outcomes mentioned. Thus, his findings stated that Lean tools did not have a direct effect towards the outcome but through the mediating variable of infrastructural practice of Lean.

The items used in operationalizing the construct was adopted from past literature which outlines the commonly used tools in the industrial world and Lean companies in particular. Furthermore, these low number of items were chosen to facilitate the convenience of respondents who may detract in answering genuinely given a long list of tools which require them to identify each of it one by one in their organizational context. Besides, Lean's tools and techniques had also been conceptualized in bundles of practices in some research. Shah and Ward (2003) is renowned to have bundled the tools of Lean into four; Just in Time (JIT), Total Quality Management (TQM), Total Preventive Maintenance (TPM) and Human Resource Management (HRM) which consist of 22 tools and techniques. Cua, McKone and Schroeder (2001) found high performing plants commonly use bundles of tools or practice that are TQM, JIT and TPM oriented. However, Hadid et al. (2016) in identifying the interaction of technical and social practices of Lean, classified 23 practices of Lean tools into four factors; process factor, physical structure factor, customer value factor and error prevention factor. In this study, measurement of Lean tools were adopted from Gowen III et al. (2012) involves five commonly utilized tools in Lean organizations regardless of industry. The classification of commonly used tools and techniques of Lean in the manufacturing and services industry into bundles of practice may have an alternate outcome towards the components of absorptive capacity which is an avenue for future research.

6.3.1.2 Lean Social Practice's (LSP) Effect on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP)

Lean Social Practice (LSP) is found to be statistically significant in influencing PACAP and RACAP positively (PACAP: $\beta=0.216$, $t=2.478$, $p<0.01$, RACAP: $\beta=0.177$, $t=1.747$, $p<0.05$). The soft practice of Lean is in fact the essential factor in realizing absorptive capacity. As mentioned by Bortolotti et al. (2015) mostly studies in Lean only focuses on the technical aspects which are basically the tools and techniques. However, their study clarifies the eminence of the social aspect of Lean, the soft practices which encapsulate the people and human relation. Studies have revealed that the social aspect of Lean is equally imperative as the technical aspect in sustaining the Lean culture, especially in the long run (Hines et al., 2004; Taylor, Taylor & McSweeney, 2013).

The findings of this study provides empirical evidence on which side of Lean contributively leads to PACAP and RACAP. This is in line with previous studies' findings where soft practices of Lean were found to allow companies to gain competitive advantage over competitors through utilizing its resources, namely human resources (Fotopoulos & Psomas, 2009; Liker & Rother, 2011; Shah & Ward, 2007). This study augments those findings by adding in the crucial insight of how it occurs through the components of absorptive capacity.

The measurements in this study are from Hadid et al. (2016) which consist of human and motivation factor. Lean emphasizes the optimum utilization of human from the perspective of teamwork, appropriate training, performance and reward system, motivation and stakeholder (customer and supplier) engagements (Mamat & Rahman, 2015; Womack et al., 1990). Scholars had stressed the essence of Lean being in more of organizational culture (Emiliani & Emiliani, 2013; Liker, 2004; Saurin, Marodin & Ribeiro, 2011; Snyder, Ingelsson & Bäckström, 2016; Turesky & Connell, 2010). A Lean induced working culture and environment has the propensity to infuse motivation when configured appropriately (Cheser, 1998; De Treville & Antonakis, 2006; Graban, 2011; Holbeche & Mayo, 2009).

A performance management system such as Lean's is also conducive towards people's motivation (Atkinson, 2010). Vidal's (2007) work reflects the eminence of Lean in empowering workers by involving them through teamwork in continuous improvement efforts which consequently induces job satisfaction. Motivated employees would want to contribute to organizational effectiveness, thus energies the learning ability within them (Liao, Fei & Chen, 2007). Tian and Soo (2015) studied the relativeness of intrinsic and extrinsic motivation towards absorptive capacity through self-determination theory and found the superior effect of intrinsic motivation towards PACAP as it breeds perceptions of organizational commitment to learning. In addition, the authors found that RACAP to be mediating the relationship between PACAP and creativity performance.

The finding is in parallel to this study's path analysis where PACAP positively influences RACAP, which in turn significantly predicts innovation performance which is gained through creativity. Similar findings was also reported by Popaitoon and Popaitoon (2016) in project team's motivation towards knowledge absorptive capacity. Their result showed intrinsic motivation can accelerate the influence of project team's potential knowledge absorptive capacity whereas motivational forces could reinforce project performance enhancement of knowledge utilization in the form of realized absorptive capacity (Popaitoon & Popaitoon, 2016). Minbaeva et al. (2003) work emphasized the element of employee's ability and motivation being substantial aspects of firm's absorptive capacity. This echoes the importance of training and reward system the Lean system accentuates on.

One other important facet in the social network of Lean is the customer and supplier relationship. The fundamentals of Lean propagate enhancing the proficiency of the entire value chain of an organization which extends from suppliers to customers. It is where the involvement of external stakeholders becomes pivotal in eliminating waste in the supply chain (Abdulmalek & Rajgopal, 2007; Rother & Shook, 1999), hence engendering the stream of "Lean Supply Chain" activities (Bozarth, Handfield & Chandiran, 2008; Lamming, 1996; Myerson, 2012; Wee & Wu, 2009; Wincel, 2003). The Lean approach facilitates a consultant-partner approach amongst the stakeholders of the organization (MacDuffie & Helper, 1997).

This characteristics of engaging stakeholders of the organizations together could be seen from the originator of the Lean philosophy, Toyota. Toyota lay emphasis on 'Kyohokai', a network which purpose is for information exchange, mutual development and training between member companies and socialization (Dyer & Hatch, 2004). Apart from that, it also advocates voluntary learning groups amongst stakeholders known as 'Jishuken' (Dyer & Nobeoka, 2000). Without a doubt, such network creates a pool of knowledge for members of the Lean network to draw upon in making improvement in their respective organizations (Cousins & Menguc, 2006; Dombrowski et al., 2012; Dyer & Nobeoka, 2000; Lawson, Petersen, Cousins & Handfield, 2009).

The resultant of these activities in Lean necessitates teamwork, having multifunctional employees, cross functional groups, eliciting ideas for process improvement from all levels of employees, motivated work tasks and the likes (Womack et al., 1990). Such traits most notably is acquainted to coordination and socialization characteristics. Coordination capabilities include the likes of cross-functional interfaces, participation in decision making, and job rotation (Galbraith, 1973; Henderson & Cockburn, 1994; Van Den Bosch et al., 1999). A Lean organization that has a knack of bringing together different sources of expertise tends to increase lateral interaction between the functional areas and components of knowledge. Gupta and Govindarajan (2000) spell out such cross-functional interfaces enable knowledge exchange. With this cross-functional interfaces, organization or the cross functional team is able to discuss differences, interpret issues and build understanding about new external knowledge (Daft & Lengel, 1986). The social network of Lean requires the participation of all relevant members in decision making while engaged in improvement activities.

Cohen and Levinthal (1990) explain that participation increases the range of prospective "receptors" in the organization's environment, which Aldrich and Herker (1977) believe filters and facilitates new external knowledge acquisition and assimilation. These characteristics enable a Lean organization to draw upon PACAP. Camerer and Vepsalainen (1988) and Volberda (1999) describe socialization capabilities enable creation of broad and tacitly understood rules for appropriate actions. The social network Lean caters involves an organization's interaction between customer-supplier relationship from which the tacit understandings could be spawned and transformed into knowledge that could resolute a matter at hand which benefits the network as a whole.

Adler and Kwon (2002) elucidate that socialization could spur strong social norms and beliefs which in turn enhance commitment and compliance by exploiting new external knowledge from members of the network. The socialization mechanism facilitates organizational relationships, improved communications, problem solving and knowledge exchange between relevant parties (Cousins & Menguc, 2006). As such it germinates the RACAP capabilities of the Lean organization. Fynes and Ainamo's (1998) work supplements these facts as they articulate how Lean's cross-organizational architecture creates a learning environment for the exploitation benefit amongst its supply chains.

6.3.1.3 Role Structure's (RS) Effect on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP)

Moving on to the practices of Six Sigma, role structure (RS) or commonly known as the belt system was found to be positively related to PACAP ($\beta=0.110$, $t=1.308$, $p<0.1$) and RACAP ($\beta=0.200$, $t=1.718$, $p<0.05$). This findings extends the line of contribution as similar to Gutiérrez et al. (2012) in establishing a positive relationship between mechanisms for integrating workers and absorptive capacity. Nevertheless, Gutiérrez et al. (2012) study had a gap in which they could not say whether the lateral communication mechanisms influence the first phase of absorptive capacity (PACAP) or the last phase (RACAP). This study led to the discovery of those answers, wherein the results showed RS positively influences both phases of absorptive capacity. This finding establishes an important research contribution. Six Sigma caters specialization roles in process improvement through its belt structure which comprises namely of champions, Master Black Belts, Black Belts, Green Belts and Yellow belts (Pande & Holpp, 2002; Pyzdek, 2003; Schroeder et al., 2008).

The RS acts as a hierarchical coordination mechanism for quality improvement work across multiple organizational levels (Sinha & Van de Ven, 2005). As Schroeder et al. (2008) outlined, champions will be involved in the Define phase but more of supporting role in the following phase, whereas process owners will be involved in the control phase and supports the phases prior to it. Whereas Black and Green belter who are project leaders along with Yellow belters whom form the project team members will always be involved throughout the DMAIC phases. Hence, the RS involves teamwork and concentrated coordination. Six Sigma teams are cross-functional and interdepartmental teams with coordination mechanisms that facilitate the exchange of knowledge between units (Gutiérrez et al., 2012). The RS of Six Sigma brings together a diverse range of knowledge from the expertise across the belts within the organization (Anand et al., 2010;

Hoerl, Montgomery, Lawson & Molnau, 2001; Linderman et al., 2004; Pyzdek, 2003), hence amassing the pool of knowledge for project utilization. These characteristics spell out two important capabilities required in Six Sigma's infrastructural team, cross-functional coordination and socialization. Jansen et al. (2005) ratified that cross-functional interfaces largely affects PACAP meanwhile socialization capabilities involving connectedness of the team and socialization tactics mainly influences RACAP. This study's finding on the practice of Six Sigma's RS further corroborates it.

The project leaders (namely Black and Green Belters) in addition to leading the projects also subsumes coaching roles to the team members and subordinate belt structures (Pande et al., 2000; Schroeder et al., 2008). This allows project team members to assimilate and transform knowledge learnt from their coaches to be utilized in Six Sigma project execution. In addition to this, Lenox and King's (2004) explication of "managers can develop absorptive capacity by directly providing information to agents in the organization" accentuates Six Sigma's approach in making resources available to assist in the development of absorptive capacity (Choo et al., 2007a). Gutiérrez et al. (2012) illuminate Six Sigma positions are dynamic for teamwork which also crafts a shared vision, both of which are crucial towards the development of absorptive capacity (Gutiérrez Gutiérrez et al., 2009).

Given the fact that absorptive capacity can take place within the organization, Cohen and Levinthal (1990) made it clear on the role of knowledge diversity playing a crucial role in the building of an organization's absorptive capacity. They elucidated diverse background provides a more robust basis for learning as it increases the prospect of incoming information in relation to prior knowledge of organizational members. The belters are generally experts from within the organization and information infused to project team members will be of relative importance which the members are able to conceive.

In this role-based infrastructure that Six Sigma provides, communication becomes extensive in the accumulation and assimilation of knowledge within subunits of the organization. A Six Sigma team allows the creation, capturing, storing, sharing and utilization of information in the DMAIC phases (Park et al., 2009). Communication systems such as in this context may rely on specialized actors to transfer information from the environment who stands in the interface between firms and external environment or between subunits within the firm (Cohen & Levinthal, 1990). Allen (1977) and Tushman (1977) calls this role as “gatekeeping” or “boundary-spanning” roles. Daft (2001) submits that boundary-spanning roles can break down barriers which disrupts problem understanding. The belters who are strongly linked to internal and external environment are mostly effective at boundary spanning roles (Druskat & Wheeler, 2003; Tushman & Scanlan, 1981).

Schroeder et al. (2008) exemplified how Six Sigma Black Belters as high level project leaders reports to senior management in this boundary-spanning roles. This paves the opportunity for the belters to obtain and utilize useful internal or external knowledge in their problem solving activities besides conveyance of their expertise during coaching their subordinate roles. Besides Hoerl et al. (2001) enlightened that Six Sigma project leaders are trained in the use of practices for collecting, combining, and synthesizing the knowledge of team members for use in process improvements. These attributes foster PACAP (collecting and combining knowledge) and RACAP (synthesize and use knowledge). Through this expertise of the project leadership, the belters also works in creating recognition and foster the collective desire to learn among team members (Choo et al., 2007a; Wiklund & Wiklund, 2002).

Such communication is an exemplar towards exploration and boundary spanning activities (Manev & Stevenson, 2001), which influences PACAP. GE created a boundaryless organization in an effort to allow information acquisition and utilization for the convenience of Six Sigma projects through its Work-Out program (Ulrich, Kerr & Ashkenas, 2002). Schroeder et al. (2008) explain that Six Sigma creates a parallel-meso structure that involves sturdy decision making process in the improvement efforts. The structure emulates what Burton (2011) coined as 'Creative Stakeholdering' wherein the stakeholder's needs and actions are continuously aligned by making the improvement. Structure, as per Tushman and Nadler (1978) stores and reflect knowledge about the organization's perception of the environment. Consequently, structure strongly corresponds to an organization's problem-solving behaviors (Burns & Stalker, 1981; Thompson, 1967). Dahlgaard and Dahlgaard-Park (2006) and Javier Lloréns-Montes and Molina (2006) describe Six Sigma teams as being open and supportive climate, which structures have positive repercussions for absorptive capacity to flourish (Tu et al., 2006). Evidence on these articulations are significantly reflective towards the composition of PACAP and RACAP through the role structure of Six Sigma.

6.3.1.4 Structured Improvement Procedure's (SIP) Effect on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP)

The findings of this study revealed Structured Improvement Procedure (SIP) of Six Sigma positively influences PACAP ($\beta=0.470$, $t=4.849$, $p<0.01$). Parallel to theoretical view where PACAP is commingled with learning abilities (Kim, 1995; Zahra & George, 2002), this findings is in line with previous study by Choo et al. (2007a) which found Six Sigma's structured method contributes significantly to learning behaviors. The SIP of Six Sigma is viewed as a "metaroutine", which functions as a process to change other processes (Choo et al., 2007a; Grant, 1996a; Nelson & Winter, 1982). Adler et al. (1999) enlightened learning behaviors can be achieved through systemized metaroutines, which can maintain efficiency and flexibility in problem solving processes. The DMAIC phases of Six Sigma, which explains the idea behind SIP, is a structured metaroutine which handles problem solving projects through a scientific approach (Arnheiter & Maleyeff, 2005; De Mast & Lokkerbol, 2012; Linderman et al., 2003). Besides, Six Sigma project team is characterized by an open and supportive climate (Javier Lloréns-Montes & Molina, 2006) wherein team members are always encouraged to voice out their concerns and opinions and try out new things which creates a psychologically safe environment without the fears of being punished. Edmondson's (1999) renown research propagates the idea of team's psychological safety is associated with learning behaviors. This explains the positive linkage between SIP and PACAP which attributes largely associates to learning features of the absorptive capacity. Todorova and Durisin (2007) asserted absorptive capacity is not static but evolves through learning processes.

While many explanations of Six Sigma's DMAIC methodology pointed towards variance reduction (Choo et al., 2007a; Schroeder et al., 2008), this study found evidence that the structured method does in fact incite exploration in the context of absorptive capacity, which is through PACAP. Besides DMAIC, Six Sigma also involves DFSS (Design for Six Sigma) in which the DMADV (Define, Measure, Analyze, Design, and Verify) methodology is used to innovate new processes or products (Linderman et al., 2003; Schroeder et al., 2008). This finding is in line to justification provided by Hwang, Lee and Seo (2017) wherein they found evidence of Six Sigma's structured method impacting exploration and exploitation traits as a means of creative process prior to influencing performance. According to Levinthal and March (1993), exploration is attributed to the search of new knowledge. As Schroeder et al. (2008) puts it, Six Sigma project team members utilize variety of problem-solving tools and techniques along with their creativity to solve unexpected and unfamiliar problem (Hwang et al., 2017).

Although Six Sigma uses a structured methodology to solve problems, Six Sigma projects, if done appropriately would involve frequent improvisation and brainstorming activities. These activities possess traits of increased variability and uncertainty which induces exploratory innovation activities (Sutton & Hargadon, 1996). Schroeder et al. (2008) acquiesced Six Sigma's emergent structure creates a context which enables problem exploration within the organization.

The essence of Six Sigma activities is to solve problems which are translated into projects. Therefore, it can be accepted that Six Sigma is a form of problem-based learning (Savolainen & Haikonen, 2007; Scally & Donaldson, 1998) in addition to project-based learning (Kanigolla, Cudney, Corns & Samaranayake, 2014; Snee, 2000). Besides, Chermers and Cronin (2015) submitted that the structure (DMAIC) of Six Sigma implementation bodes well with Kolb's experiential learning cycle (Kolb, 1993) as it involves learning by doing (Easton & Rosenzweig, 2012). Experiential learning mostly takes place in the Improve and Control phase of DMAIC, where solutions will be put to test in improving problem at hand and sustaining the improvements thereafter. As Werder (2015) explains, in a problem-based learning and project-based learning, the problem situation is well structured but as for project-based learning the solution space has a higher degree of freedom wherein creative solutions are possible. Thus, it can be reasoned that a Six Sigma project entails an explorative learning environment. Rummel, Mavrikis, Wiedmann, Loibl, Mazziotti and Holmes (2016) verified that combining exploratory learning with structured practice has significant contribution in fostering robust fractions of knowledge involving conceptual and procedural knowledge. Furthermore, scholars had also highlighted the ability of experiential learning in promoting exploration activities in addition to exploitation (De Freitas & Neumann, 2009; Holmqvist, 2004).

Gebauer et al. (2012) explicated PACAP is related to exploratory learning whereas RACAP is associated with exploitative learning. However, the depiction of learning behaviors of the authors in Choo et al. (2007a) is found to be in contrast to this study's findings. Choo et al. (2007a) classified structured method as variance reducing or exploitative mechanism. In this study, interestingly there were no evidence of SIP influencing RACAP (β=0.033, t=0.285, not significant). Instead, SIP favors the exploratory learning portion of the absorptive capacity. Interestingly, this leads to the mediation test carried out to enlighten the relationship of PACAP and RACAP. As per Table 5.13, the analysis reveals that PACAP mediates the relationship between SIP and RACAP (β=0.113, t=2.051). No other practices of Lean and Six Sigma was found to be having such relationship.

This corroborates the explanation in the hypothesis that in the context of absorptive capacity, SIP influences RACAP through PACAP. In the Define, Measure and Analyze phase, team members are engaged in learning and acquiring more information of the project. Upon gathering those information, execution plans will follow through to put the solutions in place. This also proves that the DMAIC structure fosters the components of absorptive capacity, PACAP and RACAP in a systematic and sequential manner. This finding where, under the conditions of absorptive capacity, SIP to have the traits of exploration through PACAP and its indirect effect on RACAP is a vital and novel contribution to the process improvement literature where many explanations in prior articles denote only on the variance reducing characteristics of Six Sigma's structured methodology.

6.3.1.5 Focus on Metrics' (FOM) Effect on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP)

This study also highlighted the effect of Focus on Metrics (FOM) in Six Sigma on the components of absorptive capacity. The outcomes of the analysis revealed a rather interesting finding yet a significant contribution to this study. FOM seem to be positively and significantly effectual on RACAP (β=0.216, t=2.571, $p<0.01$). Nevertheless it was not a synonymous case as anticipated since FOM was found to be non-significant and most surprisingly, negatively related to PACAP (β= -0.191, t=1.957, not significant).

From the viewpoint of FOM-RACAP relationship, this finding supplements the workings of Linderman et al. (2006) and Linderman et al. (2003). Six Sigma is an interactive methodology in which it has a high focus on metrics and goals. This trait in particular induces motivation for members of the project team and the organization's employees to make more effort, be more persistent and intensify their focus and attention on relevant activities to accomplish the goals (Linderman et al., 2003; Zu et al., 2008). As Locke and Latham (1990) articulated, the higher or challenging the goals are, performance achievement could follow a positively parallel pattern provided the goals are not too unrealistic or outlandish (Linderman et al., 2006).

Breyfogle III (2003) and Hamel (2000) mentioned that stretch goals approach creates a motivation and impel project team members to "out-of-the-box" thinking. Choo's (2011) study on stretch goal strategy in relation to Six Sigma application augments this explication. His findings revealed that the synergy of problem-driven and performance-driven gap positively influences a sense of challenge or challenging goals. This in turn, according to the author, influences innovation and knowledge creation. This articulation is supported by the findings of this study in which FOM, which has a positive effect on RACAP, will consequently reflect the increase of innovation performance of the organization. Being able to track performance of process and project through the metrics in Six Sigma, Eisenhardt (1985) calls this as a cybernetic process for monitoring and rewarding performance which will propel the intention and ability of team members to do more.

The motivation imparted through this process will account for individuals' intensity, direction and persistence towards achieving the challenging goal (Robbins, 1997). Process improvement efforts such as Six Sigma, echoes the improvement of a rational system (Scott, 1987) which regulate knowledge and motivation (Linderman et al., 2003). Linderman et al. (2003) believes that Six Sigma engenders intentional learning, which requires regulation of actions by team members. He argues that goals act as the regulator of human actions by motivating their actions.

However, from the viewpoint of PACAP, the case is the opposite of from what was first anticipated. It is realized that the type of learning capability infused through focus on metrics may differ as it is much oriented towards exploitative features. It is elucidated that a mechanistic structure with tightly coupled connections foster exploitative learning (Burns & Stalker, 1961; Hansen et al., 2001; Rowley et al., 2000; Weick & Westley, 1999). In this case, a strict focus on metrics may be essential towards RACAP where rigorous efforts are placed in transformation and exploitation of knowledge to identify solutions to ensure target is met. In the expense of realizing the target, the importance of potential absorptive capacity (acquisition and assimilation of knowledge) is forsaken. March (1991) explained exploiters gain efficiency based on current competencies leading to success and therefore further exploitation.

Arumugam et al. (2016) studied on the interplay between structured method, challenging goals and knowledge in Six Sigma projects. They discovered that structured method and challenging goals can compensate for one another. Generally, the structured method or DMAIC methodology is very rarely disregarded in the implementation of Six Sigma projects. Metrics are also an inherent nature of Six Sigma. But the focus of both aspects unto the component of absorptive capacity may differ just as this study's findings portray. Gutiérrez et al. (2012) claimed that setting of challenging goals will align employees' attention and motivation, therefore enabling the creation of knowledge and learning ability which develops absorptive capacity. However, it was not explained how it works between the components of absorptive capacity which this study is set out to do so. Imposing challenging targets or goals do encourage learning ability and knowledge creation as posited but on varying modes among the components of absorptive capacity.

Six Sigma projects are time bound with generally between 4 to 6 months on average (Caldwell et al., 2009). Focus on metrics, although it allows for knowledge search but in a way truncates them to an exploitative nature. Focusing on metrics in Six Sigma projects which are time bound confines the process of exploring for new knowledges externally held. In order to achieve the targets, teams may only focus on refining and improving existing knowledge (known as familiarity trap), focus only on those knowledges that is reliable and predictable (known as maturity trap) and explore only the knowledge near to the issue being studied (known as propinquity trap) (Ahuja & Morris Lampert, 2001). Hence transforming and exploiting knowledge becomes a priority more than to acquire and assimilate new ones. In other words, exploitative learning (realized absorptive capacity) becomes at the expense of exploration learning (potential absorptive capacity). This articulation may account for the incumbent debate in scholarly literatures where it has been argued that process improvement endeavors only brings exploitation and trims exploration (March, 1991; Parast, 2011). This facet may prove vital in explaining which proportion of process improvement undertakings accounts for exploitation and exploration features.

Given the differing dimensions of absorptive capacity consisting dual elements of potential and realized that drives different intentional outcomes, it is evident in this context that FOM relates more positively on the latter and conversely on the former. Yet again, this proves to be a substantial finding of the study.

6.3.1.6 Summary: Lean Six Sigma Practices and the Components of Absorptive Capacity

The discussion provides prove to the fact of dual components of absorptive capacity (PACAP and RACAP) having differential path to the outcome of an organization (Zahra & George, 2002). As such, it is imperative to discover which of the practices are productive towards the components which will pave the way for managerial or practical assistance.

The importance-performance map (IPMA) for key target construct of PACAP in Figure 5.2 displays the Six Sigma's methodology, SIP as the most influential aspect followed by social practice of Lean (LSP) and Six Sigma's role structure (RS). A significant rise on PACAP in turn would have a considerable improvement in SCA as portrayed by Figure 5.5. This rationalizes the importance of having a structured methodology in place in an organization, in particular to continuous improvement efforts. A structured approach caters a systematic enhancement in knowledge accumulation of an organization which it could leverage to make its resources to be more valuable and hard for competitors to emulate. This structure, as exemplified should be assisted by a judicious social practice which marks respect for the people within the organization and value their competencies. By having a systematic role structure such as the belt system in Six Sigma, it allows for organized coordination which impels a common language across employees.

Figure 5.3 on the other hand portrays the IPMA for key target construct of RACAP. Besides PACAP being a significant influence on RACAP (given that both components play complementary role), the most important aspect for RACAP is the social aspect (LSP), role structure (RS) and emphasis on goals and metrics (FOM). These aspects would affect RACAP considerably which in turn influences IP as exhibited in Figure 5.4. In contrast to PACAP, RACAP's primary influence comes from LSP which implies in order to trigger transformation and exploitation of external information into meaningful results, firm need to inculcate a strong sense of internal and external motivation that values its people or that connects the human touch in what it does. A systematic role structure (RS) would then appendage a mentoring role of key personnel in the organization, as they possess crucial business information and could guide the information transformation and exploitation process. The challenging goals act as a focal element for members of the organization or project team of Lean Six Sigma to achieve novelty by exploiting information they gained from improvement activities. As discoursed, a sense of challenge is imposed when high goals are set in Lean Six Sigma projects which is customary, therefore propelling team members to enterprise innovative outcomes.

6.3.2 **Research Objective 2:** To investigate the relationship of Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) under the context of Lean Six Sigma application.

This study found potential absorptive capacity (PACAP) is positively related to realized absorptive capacity (RACAP) ($\beta=0.240$, $t=2.019$, $p<0.05$) in the context of Lean Six Sigma application. This finding ratifies the theoretical argument by Zahra and George (2002) that PACAP and RACAP are separate but play a complementary role. Scholars have also noted on the corresponding roles played by the two components which reflects the functionality of absorptive capacity (Cepeda-Carrion et al., 2012; Fosfuri & Tribó, 2008; Leal-Rodríguez et al., 2014).

PACAP refers to personal internal processes such as reflection, intuition and interpretation meanwhile RACAP is the efficiency of capitalizing externally absorbed knowledge (Cepeda-Carrion et al., 2012). As Zahra and George (2002) expressed, with a high PACAP it does not necessarily mean a firm possesses higher performance unless it has the ability to capitalize on the knowledge that was captured (RACAP). The functioning of PACAP and RACAP involves three important mechanism which endow a proper and smooth transition of the former to the latter component of absorptive capacity.

Activation triggers refer to events that prompt a firm to respond to internal or external stimuli such as performance failures, customer complaints, change of market demand and etcetera (Walsh & Ungson, 1991). The proponents argue, activation triggers will influence the increase of PACAP that influences the locus of search pertaining to a matter. Lean Six Sigma involves making changes and improvements through projects which tackles organizational matters such as performance issues, market fluctuation, internal inconsistencies and the likes. These events would trigger the need to engage into projects with an effort to resolve the matters. Most companies initiate Lean Six Sigma projects to respond to either internal or external stimuli. Consequently, the project team members will embark on a mission to expend efforts to find necessary information towards a resolution, which involves the enhancement of PACAP.

Firms knowledge sharing and integration mostly are stifled by structural, cognitive, behavioral and political barriers (David, 1985; Foster, 1988; Garud & Nayyar, 1994; Garvin, 1993). Social integration mechanisms including formal and informal ones fosters knowledge sharing and assimilation. In Lean Six Sigma, socialization is one important facet that is innately cultivated within the culture of the organization where project team members scour for knowledge internally and externally of their departments, suppliers and customers (Ang, 2015). The systematic structure of DMAIC provides a formal mechanism for social integration where it helps to facilitate the distribution of information within the firm and gather interpretations and identify trends and along the way creating connectedness within the organization (Zahra & George, 2002). The mediation of PACAP between SIP and RACAP proves substantial in explaining the systematic social integration mechanism.

The rate at which PACAP is being transformed to RACAP is what Zahra and George (2002) calls as efficiency factor. A low efficiency factor would imply that firms have varying ability in capturing new knowledge and creating value from it therefore resulting in a break in the link between PACAP and RACAP. This would mean the firm is unable to reap the optimal essence of absorptive capacity given the difference in its capabilities. Social integration mechanism imparts a high efficiency factor in which it coordinates a smooth transition of the capabilities from PACAP to RACAP in achieving optimal essence of absorptive capacity.

Upon this study's empirical validation it can be said that Lean Six Sigma enables the activation trigger and efficiency factor in addition to fostering a social integration mechanism within the organization which in turn empowers project teams to achieve a balance between what they are able to do and learn (PACAP) and what they could finally put into practice (RACAP). In other words, Lean Six Sigma facilitates the optimal transformation of PACAP into RACAP.

6.3.3 **Research Objective 3:** To analyze the mediating role of Potential Absorptive Capacity (PACAP) between Lean Six Sigma practices (LTP, LSP, RS, SIP, FOM) and Realized Absorptive Capacity (RACAP).

As per Table 5.13, the analysis reveals that only one relationship seem to be mediated by PACAP which is the relationship between SIP and RACAP ($\beta=0.113$, $t=2.051$). No other practices of Lean and Six Sigma was found to be having such relationship. This brings to the understanding that, with exception to SIP, all other idiosyncrasies of Lean Six Sigma are distinctly related to PACAP and RACAP. This explains SIP of Six Sigma accommodates a sequential effect throughout the DMAIC structure which begins with an exploration characteristics and progressively moves into exploitation mode.

The Define phase is where the nature of the problem will be explored thoroughly, scrutinizing its severity and assessing its quantum to the business, organization or clients in order to justify the purpose of a Lean Six Sigma project. Subsequent exploration will come in the form of how big of a goal the project requires to turn around the situation. This would involve exploring the voice of customers, voice of stakeholders or business and also the voice of the process. Accurate goals mostly would not be available at this time of the project which is why the champions or sponsors would exercise a stretch goal strategy to rake a sense of challenge to project teams. This also signifies an exploration on the capability of the project teams to achieve dramatic turn arounds to a problem. In Measure phase, the capability of the process performing to the goals set at Define phase will be explored. This is done to view how far the process is from achieving the objective of the project or organization. Besides, factors that contributes to the problem defined in the project will also be explored and compiled in this phase using root cause analysis techniques. An exploration of the risks inherent in the process will also be carried out through the concept of FMEA (Failure Mode and Effect Analysis).

These factors will be analyzed in greater detail moving into the Analyze phase with the use of statistics or data analysis. The condition to explore here consist of identifying how many of the factors listed in the preceding phase will be vital-few. Meaning, focusing on crucial few factors that has a large impact towards the problem would render greater outcome to the project's objective. Once the vital or critical few factors are identified, solution options for each of the factors will be explored. Usually, multiple solutions will be congregated for every factors as the degree of influence every solution have may differ. This requires the project team to evaluate and explore the rigor and viability of every solution. Once the best of option in the solutions have been discovered, the solution will be verified through pilot test.

Given the satisfaction of the results thereon, the exploitation of the results into practice will begin through planning for a comprehensive implementation, a training plan for the stakeholders involved in the process and a communication plan to inform the organization of the changes that will be taking place. The final phase, Control, involves the process of ensuring the improvement is consistent and standardized overtime. This is where the exploitation practice ensues. Given the nature of some projects, exploitation process could also begin from Analyze phase once the vital factors are filtered out of the process so as to focus on exploiting the important elements that has a large influence on the process (Breyfogle III, 2003; George, 2002, 2003; Pande et al., 2000; Pande et al., 2002; Pyzdek, 2003; Pyzdek & Keller, 2014).

The evolution of explorative and exploitative capabilities through the SIP of Six Sigma explains the phenomenon in which PACAP and RACAP transpires in a sequential manner as discovered in the result of this study. The phenomenon that unfold bodes to the articulation of Arumugam et al. (2013) wherein they mentioned the DMAIC phases begins with 'Know-What' knowledge through Define and Measure phase. In order to know what the problem is or what the factors are that is relevant to a problem at hand, it requires project team members to explore the possibilities. Analyze, Improve and Control phases signifies a 'Know-How' knowledge which prescribes knowing how to solve the issue by means of exploiting the 'know-what' knowledge from the preceding process.

This provides genuine prove of organization's ability to trigger exploration and exploitation capabilities through Lean Six Sigma projects. Hwang et al.'s (2017) research explain the gravity of this findings wherein the structured improvement procedure had a significant influence on both exploration and exploitation. However, the novelty of this finding comes from the enlightenment of SIP influences exploitation through exploration which is culminated from the viewpoint of absorptive capacity. As explained in research question one under SIP, this finding provides a novel contribution to the body of knowledge in the process management literature.

6.3.4 **Research Objective 4:** To evaluate the relationship between Potential Absorptive Capacity (PACAP), Realized Absorptive Capacity (RACAP), innovation performance and sustainable competitive advantage in Lean Six Sigma firms.

Absorptive capacity is the ability of a firm to recognize external knowledge and use it to the benefit of progression. As theorist advocate it as a trait that is largely attributed to innovativeness with a subsequent influence on competitive advantage (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Tsai, 2001; Zahra & George, 2002). Since innovation is established as a key source of competitive advantage (Daghfous, 2004; Prajogo & Ahmed, 2006), numerous articles studying the concept of absorptive capacity had linked its outcome towards innovation and classify the theoretical framework as a source of competitive advantage (Ali & Park, 2016; Cepeda-Carrion et al., 2012; Flor et al., 2017; Fosfuri & Tribó, 2008; Leal-Rodríguez et al., 2014; Rangus & Slavec, 2017; Scaringella, Miles & Truong, 2017). There happens to be a dearth of study which immaculately justify how absorptive capacity is related to both innovation and sustainable competitive advantage (Chen et al., 2009; Riikkinen, Kauppi & Salm, 2017).

Also, there seems to be a gap in the scholarly work which empirically justifies the differential outcome of PACAP and RACAP as per advocated in theory and how it connects to altogether. This study does that in the context of Lean Six Sigma. The study finds PACAP to be a significant predictor of sustainable competitive advantage (SCA) ($\beta=0.327$, $t=3.434$, $p<0.01$) whereas RACAP predicts innovation performance (IP) of firms employing Lean Six Sigma ($\beta=0.467$, $t=4.775$, $p<0.01$). IP in turn leads to SCA ($\beta=0.373$, $t=3.456$, $p<0.01$).

Scarcely has there been any study indicating such findings. Yet understanding this is imperative which would direct managerial capabilities within a firm. The findings of this study corroborates the theoretical argument of Zahra and George (2002). The fundamentals of absorptive capacity intends to break firms out of homogeneity, hence provides a character of heterogeneity which could gain competitive advantage. Matusik and Hill (1998) imply a firm that can create, manage and exploit knowledge possess the advantage to gain competitiveness. Lean Six Sigma as advocated in scholarly research in the past is much attributed to creation and management of knowledge (Anand et al., 2010; Ang, 2015; Gowen III et al., 2008; Linderman et al., 2010; Schroeder et al., 2008). Therefore, Lean Six Sigma's function in a firm which advocates effective use of knowledge creates a bundle of knowledge-based capabilities.

With PACAP accredited to learning capabilities (Lei et al., 1996), Lean Six Sigma firms will possess the ability to track changes in their industries effectively and facilitate the deployment of necessary capabilities. Zahra and George (2002) also implied the more developed PACAP of a firm is, it has the probability to reduce sunk investments, as firms could manage its routines and capabilities more effectively. Besides the traits of Lean Six Sigma infusing learning capabilities, one of the focus elements in improvement projects is also to reduce cost or enhance revenue to expand the profit margin. In the midst of engaging in this, a firm gains experience to manage its processes more effectively. In other words, firms gain strategic flexibility in managing their resources (Zahra & George, 2002).

This learning mechanism induced by Lean Six Sigma allows firms to learn the conditions of the market be it fluctuation, changing trends, customer necessities and the likes which allows them to align their business strategies and deploy necessary resources to fit the business needs through improvement projects. Being able to know the changes in the market firms comprehend how it could maneuver its resources strategically. This reduces the cost of change. This means the firms need not invest in trainings, new equipment, changes in layouts and R&D every time the market undergoes a change. Also, the sooner the firms comprehend or learn those changes provides opportunity for first mover advantage, or timing of the deployment of the resources becomes capably effective. The flexibility the firms have allows them to capitalize on the emerging opportunities in the market which backs first mover advantage (Ferrier, Smith and Grimm, 1999; Raff, 2000). This capability is without a doubt is valuable to a firm and allows to bring values to market demand and displays distinctive strength. Thus, Lean Six Sigma generates PACAP of a firm which contributes towards the sustaining of competitive advantage.

RACAP on the other hand involves leveraging or capitalizing on the knowledge gained by exploiting it into operationalization. The transformation and exploitation dimension as Zahra and George (2002) mentioned involves a 'bisociation' process where firms develop new schema which when converted into physicality, yields an innovative outcome. The knowledge accumulated and assimilated through Lean Six Sigma projects with explicit and tacit information gained from suppliers and customers facilitate firms to transform those knowledge into viable and operational mode. In the effort to justify contend in the market, firms are prompted to spur novelty through its enriched knowledge base by generation of products and services that are truly inventive and able to distinguish the presence in incumbent market condition. This idea is supplemented by the works of Antony et al. (2016) where Lean Six Sigma spurs the creation of novel concepts which brings about process innovation, incremental innovation and ultimately innovation capability. Their findings also suggest radical innovation is equally potential as incremental innovation provided a pertinent structure and framework for problem solving.

The relationship between IP and SCA was found to be positively significant ($\beta=0.373$, $t=3.456$, $p<0.01$). Lavie (2006) asserted innovation would create an isolation mechanism that can separate a firm from the other which is reflected in terms of profit margins and other benefits that allows the firm a competitive edge. This creates a capability which when deployed constructively supports long run business performance (Teece, 2007). And the success of this innovation will protect their imitability features resulting in sustained competitive advantage of the firm (García-Morales et al., 2007). Lean Six Sigma firms are constantly engaged in projects which drive the business strategy. Constant touch on innovation capability and performance through those projects allow firms to possess inventive ability through the products and service it provides in the market in accordance to business cycles.

Being able to provide solutions subject to uniqueness will survive firms of heavy competition. Besides product and services innovation, the study by He et al. (2015) implies Six Sigma could also bring about process and administration innovation. According to Galli and Kaviani (2018), organizations must be willing to change corporate culture, empower employees and hire trained personnel to kindle the genuine benefits of Lean Six Sigma. The knack to constantly align organizational processes or routines to fit this innovative capability will ensure firms to stay afloat in competitive oscillation. Competition in the market namely resides in the idea of offering better service, faster, relatively cheaper and with greater quality and reliability. According to Tidd, Bessant and Pavitt (2005), innovation centered in these aspects has long been seen as a source of competitive advantage. For instance, Citibank developed a strong market position when it first offered the automated telling machinery (ATM) service which resulted from the back of process innovation.

Lean Six Sigma characterizes projects which focus on inventing solutions catered to enhance quality of services rendered and increasing customer or stakeholder satisfaction, reducing cycle time or lead time in producing products or providing services with greater quality and reliability additionally at a lower cost (George, 2002). Therefore innovation of processes ascertains the sustenance of competitive advantage in Lean Six Sigma firms.

Moreover, the crucial characteristics that shapes a fertile ground or a culture of the organization susceptible to innovation are innately equipped in Lean Six Sigma's idiosyncrasies. The projects of Lean Six Sigma infuses a learning environment through problem solving activities where research becomes a necessity towards resolution. As Autant-Bernard (2001) puts it, research is a necessary locus for innovation. In enduring project activities, team members, involving cross functional employees are empowered to possess a certain degree of autonomy when enacting solution implementation. This infuses self-efficaciousness which leads to innovative behavior as suggested by Spreitzer (1995). Besides, cross functional teamwork, being one of the foundation of Lean Six Sigma projects stimulates creativity as it imposes an effective channel of communication (Kanter, 1983; Prajogo & Ahmed, 2006). Lean Six Sigma emphasizes on the effective management of intellectual capital which is of essence for organizational innovation infrastructure (Leonard-Barton, 1995).

The concept and application of Lean Six Sigma emphasizes a strong reference to the voice of customer. Given this reciprocity Lean Six Sigma embeds, a firm could establish a strong relationship between market performance and products or services. New products that is aligned to market demand ensures maintaining market shares and improved profitability in addition to possibilities of low cost advantages as Lean Six Sigma considers a prudent yet effective cost structure. Constant changes of non-price factors, such as modification of existing products or services to meet the market demand would yield a considerable growth through Lean Six Sigma projects besides providing an opportunity to substitute outdated products or services through the means of upgrading them. By focusing on processes, which is the predominant idea behind Lean Six Sigma projects intends to accelerate products or services into the market by means of shortening the production time. This positions firm in a first mover advantage which could possibly yield exponential profitability. The articulation of the traits above stands as a foundation in Tidd et al. (2005) which outlines how innovation is decisive in sustaining competitive advantage (Urbancova, 2013).

Consistent freshness and improvement recognized and accomplished by Lean Six Sigma firms on a consistent basis provides a cushioning mechanism especially at times of turbulence and tribulations, thereby forming organizational context that are dynamic in characteristic. Since it is widely deliberated and accepted that innovation is a source of competitive advantage, the ability to possess the aforesaid characteristics would enhance the capability of the firm to strategically manage its resources to drive strategic paths, which can be used either as an offensive strategy intended to compete vigorously and improve market shares or opening up of new markets (Lowe, 1995). Lean Six Sigma allows a firm to possess value adding qualities which distinguishes itself and makes it difficult for those firms truant of the said traits to imitate or substitute, therefore allowing the sustenance of competitive positioning in the market.

Lean Six Sigma firms are predominantly motivated to do things better and emphasize a way of doing things that makes them look unique and different from the rest of the players in the market. Through projects, Lean Six Sigma tend to continuously look for innovative changes that could benefit the company and infuse an innovative culture throughout. Many Fortune 500 companies like General Electric, Caterpillar, Ingersoll-Rand and Xerox are standing examples of this trait who enjoyed significant innovativeness and competitive advantage (George & George, 2003). Further, this finding justifies the argument of a number of scholars who acclaimed of process improvement concepts like Lean Six Sigma promote innovation capabilities and resulting competitive advantages (Antony et al., 2016; Arnheiter & Maleyeff, 2005; Azis & Osada, 2010; Bisgaard, Redman Thomas, Tartarone, Jones & Kessels, 2008; Hoerl & Gardner, 2010; Maleyeff et al., 2012).

6.3.4.1 Further Analyses

(a) ***Potential Absorptive Capacity's Effect on Innovation Performance and Realized Absorptive Capacity's Effect on Sustainable Competitive Advantage (PACAP-IP & RACAP-SCA)***

In addition to what was found as significant relationship and as hypothesized, the findings led to contemplate the possible effects of PACAP on IP and RACAP on SCA. Appendix C shows the path analysis of this contemplation which turns out to be significant. PACAP was found to be positively and significantly related to IP (β=0.485, t=4.229, $p<0.01$) meanwhile RACAP was also positively and significantly related to SCA (β=0.212, t=2.205, $p<0.05$).

The finding of PACAP positively influencing IP supplements the findings of Fosfuri and Tribó (2008) and Leal-Rodríguez et al. (2014). This findings however adds to the body of knowledge which contrast Zahra and George's (2002) theoretical notion. It was found that PACAP is also a vital predictor of innovation as subsumed by the said authors above. Lean Six Sigma projects which enable the acquisition and assimilation of external knowledge allows for invention which is related to conceptual novelty where new concepts would be generated to be applied in business context. The conceptual novelty would then be a regulator in the creation of instrumental novelty where it acts as a source of innovation (Beckenbach & Daskalakis, 2003). As Leal-Rodríguez et al. (2014) explains, innovative efforts are a result of firm's engagement and investment in knowledge.

This also supports elucidation of several author who acclaimed innovation is a resultant of acquisition of external knowledge (Hamberg, 1963; March & Simon, 1958; Mueller, 1962). The prospect of organizations to fuel innovation is contingent upon previous accumulation of knowledge that they have absorbed (Fiol, 1996). Lean Six

Sigma projects can be seen as source of knowledge base which facilitates and enhances the ability of firm's novelty and inventions. Thus, Lean Six Sigma generates PACAP of a firm which contributes towards the sustaining of competitive advantage and innovation performance of firms which embraced it.

The finding of RACAP related to SCA is in parallel to that of Xu, Chen, Kwon and Fang (2009) wherein they found RACAP accounts substantially in the contribution towards competitive advantage. The ability to capitalize on the knowledge base of the organization is a vital competency in this current competitive business environment. The knowledge based view of the firm postulates knowledge as a key resource of the firm which determines the competitive advantage it holds (Davenport & Prusak, 1998; Grant, 1996b; Kogut & Zander, 1996). Exploiting this advantage without a doubt enables the sustainment of the firm's competitive advantage. As mentioned above, Lean Six Sigma which works through projects, facilitates the acquisition and assimilation of knowledge. As the projects necessitate viable solutions which could enhance the firm's competitiveness, the knowledge obtained would be capitalized by transforming and exploiting them to meet this necessity. The capability of a firm to make incremental changes in its characteristics according to the changes in the market through improvising its routines enables a character that is hard to imitate and substitute by competing firms thus enhancing its competitiveness.

The effects of PACAP on SCA and IP appears to be larger than the effects of RACAP on both outcomes. This leads to a revelation that Lean Six Sigma relatively has a greater impact on SCA and IP through PACAP than RACAP, even though RACAP significantly does effect SCA and IP as well. However, this significance comes at a cost where RS was found to be no longer in significance given the path of PACAP and IP. This warrants further investigation for such difference which future studies could focus on learning the interlinkage between RS, PACAP and IP.

It needs to be emphasized that both PACAP and RACAP has to be dealt or managed simultaneously as both components tend to coexist. Focusing one at the expense of another does not necessarily brings efficacy, as per this study's discourse it prevents the optimization of absorptive capacity of the firm.

(b) ***Mediation of Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) between Lean Six Sigma Practices, Innovation Performance (IP) and Sustainable Competitive Advantage (SCA)***

The intention of this study is to explore how does Lean Six Sigma, through its idiosyncrasies influence the components of absorptive capacity (PACAP and RACAP). Given this influence from Lean Six Sigma, how do the capabilities generated via PACAP and RACAP stimulates innovation and sustainable competitive advantage. In light of this, the study explores the proposition of Lean Six Sigma acting as an antecedent which triggers dynamic capabilities, which are in turn responsible to incite far reaching performance outcomes in innovation and competitive advantage. Therefore, the nature of this study is oriented towards an antecedent-outcome based study.

However, one could possibly wonder, the likelihood of the two intermediate variables posing as a mediating variable. If one were to do a mediational analysis as such, one way to do it is by generating a second-order construct for absorptive capacity, consisting of PACAP and RACAP. Nonetheless, the mediation analysis of absorptive capacity had been attempted before as delineated in literature review. And furthermore, the intention of this study, as abovementioned, is to understand how does the internal mechanism, innards or components of both Lean Six Sigma and absorptive capacity interact towards unfolding overarching performance outcomes. Which means, the study is centered towards main effects or direct paths. Adding to this, literature support for the individual components (idiosyncrasies of Lean Six Sigma (LTP, LSP, RS, SIP, FOM) and components of absorptive capacity (PACAP and RACAP) on a possible mediation towards an outcome are scarce to non-existent. This may also be because not many studies in the past have intensely characterized or scrutinized Lean Six Sigma's practices or idiosyncrasies in the manner it was done in this study. Additionally, neither have they looked into the components of absorptive capacity (PACAP and RACAP).

Nevertheless, in the interest of research and academic curiosity, a multiple mediation analysis was carried out in the midst of contemplating its possibilities. As per the results displayed in Appendix C2, all the possible mediation relationships came out as non-significant, with the exception of the relationship between SIP, PACAP and SCA. This significance may be in lieu to the high beta coefficient values on its proposed directions. To make sense on the significance of this single path relative to the whole research framework is cumbersome. Hence, these findings virtually verify the stance of the research on exemplifying the main effects of the theoretical framework. In other words, this justifies the proposition of the research that Lean Six Sigma acts as a potent antecedent in stimulating capabilities that are dynamic and ambidextrous, which is explained through the direct paths toward PACAP and RACAP. These capabilities accounts for the responsibility in kindling far reaching effects in organizations in the form of innovation and sustainability in competitive advantage.

6.4 Summary of Findings

The result of the findings revealed that LTP was not a significant factor in influencing components of absorptive capacity. The social practice of Lean however explains the contribution of Lean towards the components of absorptive capacity. Synonymous traits in Six Sigma, was found in the form of RS which influences both PACAP and RACAP. However, an interesting and considerable contribution to the body of knowledge in the process improvement literature is garnered through the findings where it was discovered the SIP of Six Sigma induces PACAP which in turn mediates the relationship between the structured method and RACAP. The essence of this finding's importance is due to extant literatures which largely believe, the structured method tends to be exploitative in nature or variance reducing (Choo, 2011; Choo et al., 2007b; Parast, 2011). This study provides empirical justification that in the context of absorptive capacity, it in fact influences a more explorative trait. Besides, the debate between exploitative and explorative in the process management literature could yield the explanation as to which portion of Lean Six Sigma or process improvement practice drives both features. It was found that the practice of FOM enterprises exploitative learning activities as opposed to what was initially hypothesized. This proves to be a novel contribution of the study as well.

Jansen et al. (2005) provided some enlightenment on how PACAP and RACAP could be managed differently. Their findings portrayed coordination capabilities which involves cross-functional interfaces, participation in decision making, and job rotation to be significant towards PACAP. Socialization capabilities such as connectedness and socialization tactics primarily influence RACAP. Their study proved that antecedents matters when it comes to managing absorptive capacity of an organization. This study provides ample support through empirical evidence on how Lean Six Sigma acts as a source and form of dynamic capability which assists in the development and management of absorptive capacity. This in turn leads to overarching performance outcomes in the context of IP and SCA. Although there are comparable explanations to the forms of combinative capabilities as per Jansen et al. (2005), the effects of Lean Six Sigma towards the components of absorptive capacity are different.

This study found LSP and RS as a form of socialization approach driving organization's PACAP and RACAP. One of the reason for such socialization in Lean Six Sigma that trigger PACAP as opposed to Jansen and authors' (2005) findings is that the teams are more open and have a supportive climate which could nurture absorptive capacity comprehensively (Javier Lloréns-Montes & Molina, 2006; Tu et al., 2006). As a result, enduring in process improvement activities team members are open to explore opportunities by challenging status quo instead of accepting status quo. RS also act as a coordination capability which involves cross-functional interfaces, participation in decision making, and job rotation through the belt structure. A Six Sigma organization would possess a customized parallel-meso structure involving improvement specialist.

The improvement specialist would hold positions in the form of belt system that defines their expertise and allows for cross-functional project undertakings. Under the project team, members are encouraged to participate by giving ideas and resolutions in making improvements. Every member within the project would later be potential members of other improvement efforts depending on the need of the project. As such the expertise tends to get rotated which enhances every project team's absorptive capacity since it provides a job design for Six Sigma personnel (Zhang, Hill & Gilbreath, 2011).

The SIP of Six Sigma could be denoted as a systems capability which methodologically enhances internal capability and strategic flexibility through PACAP. The DMAIC structure enhances explorative learning capabilities as discovered in the findings. It would pave opportunities in exploitation activities at the subsequent phases or as the phase moves on. This explains the mediating function of PACAP between SIP and RACAP. The FOM of Six Sigma brings about connectedness within team members to transpire critical goals through RACAP. As Linderman et al. (2003) puts it, team members are dedicated to a focal point through the targeted improvement levels set which prompts them to exploit opportunities by doing things that gets them to the target. Thus, it could be implied that Lean Six Sigma endows improvisation in common combinative capabilities which drives the relevant components of absorptive capacity.

The Lean Six Sigma philosophy triggers absorptive capacity from different angles. The use of specific practices of Lean Six Sigma, as ones delineated in this research, aid the learning process and transmission of knowledge throughout the organization. During project execution, individual knowledge are gathered and synthesized into team-level knowledge which is consequently exploited for operational and organizational benefit (Antony, Gupta, Sunder & Gijo, 2018). Ultimately it leads to the attainment of a dynamic capability which influences the nature and sustainability of firms' competitive advantage (Zahra & George, 2002). However it has to be noted that not all Lean Six Sigma practicing companies have been able to achieve success (Jeyaraman & Kee Teo, 2010). And to go beyond mediocre performance outcomes (such as operational and organizational performance per se), firms need to view the philosophy from a theoretical lens in how it could improvise combinative capabilities which dynamically enhances its knowledge base to bring about success on a sustainable level in accordance to the hypercompetitive environment businesses are in today.

Besides a central discovery realized through this study is the fact that Lean Six Sigma is potent in fostering explorative (PACAP) and exploitative (RACAP) traits which is fundamental for organizations to be ambidextrous. Scholars emphasized that ambidextrous organizations are capable of exploiting their existing competencies meanwhile exploring new opportunities (Bodwell & Chermack, 2010; Datta, 2011; Lubatkin, Simsek, Ling & Veig, 2006; March, 1991; O'Reilly & Tushman, 2008). Although scholars had discoursed on the potential of continuous improvement philosophies like Lean Six Sigma in fostering ambidextrous organization (Choo et al., 2007a; Jugulum & Samuel, 2010; Schroeder et al., 2008), empirical justification which supports the statement are limited.

This study provides tangible justifications as to how Lean Six Sigma could foster ambidextrous organization through the traits of absorptive capacity. Different idiosyncrasies or practices of Lean Six Sigma proves to have different impact on the components of absorptive capacity. Firms could act more organically when coming up with new ideas for change and improvement by employing SIP, LSP and RS and more mechanistically when implementing those ideas by adhering to LSP, FOM and RS (Schroeder et al., 2008).

Hypothesized findings revealed PACAP significantly influences SCA whereas RACAP relates significantly to IP which consequently associates to SCA. These results are consistent as per theoretical argument. However, additional contemplation in the study also portrayed PACAP and RACAP appear to have synonymous significant impact on the existing paths of innovation and sustainable competitive advantage respectively. Given the similarity of effect by both components, one could question why is it then important to perceive these components differently? The rationale on this lies in the explanation by Zahra and George where both PACAP and RACAP coexist and works together. Because in order to realize the full extent of absorptive capacity a firm needs both components.

A firm which is able to learn and accumulate external knowledge is still able to attain innovation and sustained competitive advantage. A firm which is able to transform and exploit knowledge is also able to attain innovation and sustained competitive advantage. However the inexistence of either one may result in a handicapped capacity to fully realize absorptive capacity. In other words a firm which is able to learn and enrich its knowledge base but is inefficient in the ability to realize the affluence it has, and a firm which is efficiently capable of capitalizing on its knowledge pool but is of less competent in its ability to learn from external stimuli would only be entitled to a half-hearted efficacy in realizing innovation and sustained competitive advantage.

Besides this fact, as discoursed in literature and portrayed through the findings of this study, it takes differentiated capabilities, or practices in this study's context to trigger the components of absorptive capacity. Dealing with those prudently would maximize the outcomes PACAP and RACAP consequently influence. PACAP is influenced by SIP, LSP and RS whereas RACAP is influenced by LSP, RS and FOM. The difference on the impact of Lean Six Sigma practices on the components of absorptive capacity is in fact only one, where SIP accounts for the influence on PACAP where FOM relates to RACAP. However, SIP's influence on RACAP is mediated by PACAP is one novel findings which justifies the need for both components in realizing absorptive capacity. One other novelty in the findings is FOM is attributed to exploitative learning as explicated by its positively significant relationship with RACAP meanwhile negatively related to explorative activities in the context of PACAP. This may emerge as an important insight which explains the characteristics of process improvement practices that are exploitative and explorative in manner.

Competent in maneuvering improvement continuously, Lean Six Sigma provides a cushioning mechanism especially at times of turbulence and tribulations, corresponding in the formation of an organizational context that is dynamic in characteristic. Moreover, crucial characteristics that shapes a fertile environment for a culture that is susceptible to innovation are innately equipped in Lean Six Sigma's idiosyncrasies such as learning, leadership and top management support, employee empowerment and involvement, cross functional collaboration and the likes. This enables Lean Six Sigma firms to manage resources strategically meanwhile enduring strategic paths which positions them in a level of distinction within the market and complicating the ability of firms that are truant of Lean Six Sigma characteristics to imitate such competencies.

Therefore appropriating the use of Lean Six Sigma, organization could strike a balance between exploitative mechanisms and explorative necessities according to the business objectives, therefore creating an organic structure which is deemed to be a substantial predictor of innovation and competitive advantage alike (Prajogo & Ahmed, 2006;

Reigle, 2001; Thibodeaux & Faden, 1994). These ambidextrous capability leads to sustainable performance outcomes through innovation and competitive advantage.

CHAPTER 7: IMPLICATIONS, RECOMMENDATIONS AND CONCLUSION

7.1 Overview of Chapter

This chapter begins with a summary of the previous six chapters. It is then followed by sections that are dedicated to managerial and theoretical implications. Following that, are sections that highlights limitation of the study subsequently recommendations for future research. Finally, this thesis ends with concluding remarks culminating the findings gained from the study.

7.2 Recapitulation of Research

The first chapter provided the underlying foundation for this study in the perspective of process improvement and Lean Six Sigma in particular. The background of the study explains Lean Six Sigma studies done in Malaysia and the corresponding scarcity and research issues that are inherent in the country with regards to the subject. That led to the identification of problem statement from a general viewpoint and the Malaysian industrial context. Lean Six Sigma's impact towards far reaching outcomes which involves sustaining competitive advantage and innovation performance has limited reach especially in explaining how the path unfolds towards these outcomes.

The concept of absorptive capacity, which seemed to be a crucial conductor towards these outcomes, thus far were studied in a unidimensional mode, discounting potential and realized absorptive capacity's influence in the concept. Corresponding to the gaps, the research sets out to enquire and seek the answers on how does Lean Six Sigma functions as a source of dynamic capability by imparting traits of absorptive capacity which consequently influence far reaching prospects of innovation and competitive advantage in firms. Finally, this chapter explains the scope of the study, provides the summary of significance and contributions of the study.

The main objective of Chapter 2 is to provide an overview and understand the patterns of previous studies that examined the Lean Six Sigma topic. In order to understand the subject matter in greater depth and length, a content analysis approach was adopted which resulted in the analysis of 257 articles which ranged for the past 17 years from reputable journals and database, renown for quality management related studies. This assisted in identifying and strengthening of the research gaps. This chapter also provided the discussion on the idiosyncrasies of Lean Six Sigma for conceptualization purpose; examined past literatures on the relationship between Lean Six Sigma, knowledge, absorptive capacity, innovation performance and sustainable competitive advantage.

Chapter 3 discoursed on the underlying theories of the study which are dynamic capability, absorptive capacity and resource based view of the firm. The function of Lean Six Sigma frames the theory of dynamic capability which represents the ability of firms to systematically modify or reconfigure operational routines, capabilities and competencies for improved effectiveness. This in turn instills traits that are equally dynamic and ambidextrous in the form of absorptive capacity which consequently enables firm to achieve profound organizational outcomes that sustains competitive edge. This subsumes the resource based view of the firm's notion. This chapter also sketches nineteen hypotheses derived from the developed research model.

Chapter 4 described the research methodology of the study. The study's research design involved a quantitative method using survey questionnaires. Data analysis technique was also discussed here wherein the use of structural equation modelling (SEM), in particular partial least square (PLS-SEM) was adopted to assess the validity and reliability of this study's measurement and structural model.

The results of the data analysis were discussed in Chapter 5. This included profile of the respondents and descriptive statistics; measurement model analysis; structural model analysis; mediation analysis and finally importance-performance matrix (IPMA) analysis.

The hypotheses from the research model were assessed and corroborated through the data analysis.

Finally, Chapter 6 provided the discourse on the findings in accordance with the research questions and objectives. Overall, eleven hypotheses are supported (H2a, H2b, H3a, H3b, H4a, H5b, H6, H7d, H8, H9, H10) and eight hypotheses were not supported (H1a, H1b, H4b, H5a, H7a, H7b, H7c, H7e) by the study's findings. A short summary of the discussion is presented below:

Research Objective 1: To examine the positive effects of Lean Six Sigma's practices (LTP, LSP, RS, SIP, FOM) on Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP).

The research findings explained that Lean's social practice (LSP), Six Sigma's role structure (RS) and structured improvement procedure (SIP) have a positive and significant effect on potential absorptive capacity (PACAP). LSP, RS and focus on metrics (FOM) have positive and significant effect on realized absorptive capacity (RACAP). Lean's technical practice (LTP) was found to be non-influential towards both PACAP and RACAP. SIP was found to be not significant towards RACAP. FOM on the other hand was found to be conversely related to PACAP. These results validated hypotheses H2a, H2b H3a, H3b, H4a and H5b and does not validate H1a, H1b, H4b, and H5a.

Research Objective 2: To investigate the relationship of Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP) under the context of Lean Six Sigma application.

The research findings showed that PACAP and RACAP coexist in Lean Six Sigma application and that PACAP significantly and positively predicts RACAP. This enlightens that being a process improvement endeavor, Lean Six Sigma does not only inspires learning activity and enhances the learning capability of the organization (PACAP), but it assist in the process of transpiring the learning outcomes into tangible organizational benefits (RACAP) in the form of enhanced operational routines, increased organizational and human capability, greater profitability and the likes. This result validated hypothesis H6.

Research Objective 3: To analyze the mediating role of Potential Absorptive Capacity (PACAP) between Lean Six Sigma practices (LTP, LSP, RS, SIP, FOM) and Realized Absorptive Capacity (RACAP).

Interestingly, only one of the mediation relationship was discovered to be significant. The results of the analysis shows that SIP was not directly related to RACAP, instead it was indirectly related through PACAP. This provides an important contribution to the process management and Lean Six Sigma body of knowledge by enlightening that the continuous improvement philosophy has a sequential effect which goes through exploration characteristics (PACAP) before resorting to exploitation characteristics (RACAP). These results validated hypotheses H7d but not H7a, H7b, H7c and H7e.

Research Objective 4: To evaluate the relationship between Potential Absorptive Capacity (PACAP), Realized Absorptive Capacity (RACAP), innovation performance and sustainable competitive advantage in Lean Six Sigma firms.

The research findings revealed PACAP significantly predicts sustainable competitive advantage (SCA) whereas RACAP significantly influences innovation performance (IP) which in turn positively influences SCA. These results validated hypotheses H8, H9 and H10.

7.3 Managerial Implication

Lean Six Sigma has been moving from a direction of being viewed as an improvement methodology towards a management philosophy in recent years (Dahlgaard & Dahlgaard-Park, 2006; George & George, 2003; Näslund, 2008; Pepper & Spedding, 2010). Given its practical application, the know-how of commandeering the philosophy should be considered pragmatically for sake of efficacy. Lean Six Sigma involves five distinct practices as operationalized in this study in which two explains Lean (technical and social practice) and three explains Six Sigma (role structure, structured improvement procedure and focus on metrics). A manager or practitioner should be aware on how these idiosyncrasies function towards generating capabilities that are dynamic in the form of potential and realized absorptive capacity. These capabilities would bring about differential performance outcomes in the form of innovation and ultimately sustained competitive advantage.

This study rationalizes the potency of Lean Six Sigma catering ambidextrous capability in organization by creating a balance between exploration and exploitative features through the components of absorptive capacity. Potential absorptive capacity involves exploration features whereas realized absorptive capacity involves exploitation characteristics (Datta, 2012). This will enable firms to concurrently balance the exploration of new opportunities and exploitation of existing ones (Gibson & Birkinshaw, 2004; O'Reilly & Tushman, 2008). This way organizations could dynamically renew themselves through the creation of incremental and breakthrough products, services and processes without hampering current capabilities. One such Lean Six Sigma company which has this balance is Nokia. With an array of new mobile technology product, Nokia still continued to make pricing and other product decisions to sustain its position as a leading mobile provider (Gibson & Birkinshaw, 2004).

In order to tap into exploration traits through Lean Six Sigma initiatives, practitioners and managers should opt to adhere to the structured procedure catered by Six Sigma. However the nature of adherence should be carefully addressed as being too rigid may hinder exploration requirements. Since experiential learning is involved in the final two phases of Improve and Control, extended timeline should be provided in the circumstance where exploration is highly needed wherein exploitation is taking place concurrently. This would ensure the solution space is given a higher degree of freedom to encourage creative solutions in the project-based learning approach of Six Sigma (Werder, 2015). A proper system to gather ideas from employees, suppliers and customers is essential in every phase of the DMAIC structure. In adhering to the structured method, team members should also be empowered through the social practices as advocated by Lean principles.

Having multifunctional team members with appropriate reward and performance system are some of the features which could motivate team members to participate. This sort of empowerment could incite creativity besides creates a psychologically safe environment. Managers also should embody the role structure of the belt system enables a hierarchical coordination mechanism which facilitates knowledge exchange between several levels of employees in the organization. Hence this creates a collective desire to learn by increasing learning capabilities and create boundary spanning communication. In order to make it effective, project leaders with Green and Black belt should be trained at every department within an organization. Strategic projects based on divisions could be conveniently handled that way.

Differing Lean Six Sigma aptitudes are required for influencing exploitation traits through realized absorptive capacity. The practices of Lean Six Sigma that are central to exploitation characteristics as per the findings in this study are Lean’s social practice, Six Sigma’s role structure and focus on metrics. The social practices were deemed to be vital similarly to the traits of exploration. Socialization capabilities in Lean creates tacitly understood rules that are appropriate for exploitation activities (Camerer & Vepsalainen, 1988; Volberda, 1999). Project teams should encourage interactions between stakeholders such as customer-supplier relationship where tacit knowledge could be derived for defined exploitation process.

This would enable accurate achievement of project targets from stakeholders' perspective. Project leaders should be trained to coach and synthesize the knowledge of team members in assisting the transformation and exploitation process in reaching project goals (Hoerl et al., 2001). Solutions that had been identified for execution would be aligned to facilitate all level of employees. This should become a vital objective in the role structure that companies should have. Managers should also create a stringent focus on metrics when it comes to realizing project goals. Targets for the projects should be realistically high and challenging in which it motivates team members to take more initiative and make more effort in order to achieve those goals. This positively propels an exploitative learning process aligned to achieving the set target as tightly coupled connections foster exploitative learning (Burns & Stalker, 1961; Hansen et al., 2001; Rowley et al., 2000; Weick & Westley, 1999).

The use of structured methodology however, need to be initiated systematically and sequentially as was depicted in the findings of this study. Since the structured method influences realized absorptive capacity (exploitation) through potential absorptive capacity (exploration), appropriate space for exploration activities in the beginning of the phases should be encouraged. This should include providing time and resources necessary for the project team to explore the problems faced, study the viable options which could yield novel outcomes. Having these novelty at hand would consequently permit to effective exploitation activities by transforming the ideas and making them a reality. Combining exploratory learning with structured practice has significant contribution in fostering robust fractions of knowledge involving conceptual and procedural knowledge

(Rummel et al., 2016). Firms that are in favor of innovation capabilities or performance, shall focus on the application of the practices of Lean's social practice, Six Sigma's role structure and focus on metrics in addition to systematic control of the structured improvement procedure as it eventually leads to the sustainment of competitive advantage.

Also, in order to achieve sustainability in competitive advantage, firms employing Lean Six Sigma should strike the balance between potential absorptive capacity (exploration) and realized absorptive capacity (exploitation) since these dynamic capabilities require differing attention from the practices of Lean Six Sigma. The balance between these practices should most importantly be aligned to the business objectives through Lean Six Sigma projects as its practices meticulously nurture ambidextrous capability. Additionally, Lean Six Sigma practitioners and relevant managers could use the scales from this study to assess how each of the idiosyncrasies and components of absorptive capacity are being implemented in their organization. Items in the scales could be used as checklist to track or monitor their progress in deployment of Lean Six Sigma in accordance to the objective managers would like to achieve.

7.4 Theoretical Implication

Dynamic capability refers to the ability of firms to integrate, build and reconfigure internal and external competences to address the rapidly changing business environments (Teece et al., 1997). The business environment is a constantly fluctuating podium wherein firms which are not able to align their competences in accordance to the changes may experience a dwindling effect in their ability to compete in the market. Zollo and Winter (1999) expressed the cyclical evolution of organizational knowledge; tacit accumulation of past experience, knowledge articulation and knowledge codification processes constantly reshapes organizational routines by producing new and improvising existing operational routines which creates distinctive competences as means of competitive advantage. They believe characteristics of dynamic capability enable a firm to engage in a collective learning environment through which it systematically generates and modifies operational routines to better suit the business challenges and in pursuit of improved effectiveness (Zollo & Winter, 1999, 2002).

Zahra and George (2002) recognized absorptive capacity as a source of dynamic capability which elicits sustained competitive advantage. They went on to define absorptive capacity as a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability. These four dimensions or capability make up two components of absorptive capacity, PACAP and RACAP which has different developmental path which influences organizational outcomes (SCA) differently. PACAP acts as a learning mechanism of the firm by enabling greater flexibility in reconfiguring resource base which sustains the firm's competitive advantage. RACAP capitalizes the enriched knowledge base by incorporating them into firm's operations which produces innovative outcomes. From an ambidextrous point of view, PACAP resonates exploration quality of a firm whereas RACAP resembles exploitation characteristics. The ability to possess both features creates ambidextrous capability. Given this qualities firms are able to maneuver strategies and engender resources that are valuable, rare, inimitable and non-substitutable which asserts the resource-based view of the firm's conception.

Lean Six Sigma is a contemporary process improvement and management philosophy which functions as a breakthrough strategy by increasing profit margin through improvement projects (Antony, 2011; Black & Revere, 2006; George, 2002). It is a systematic and scientific improvement methodology which enhances internal competences to meet external turbulence in the business environment. This study investigated Lean Six Sigma as a form of dynamic capability generating capabilities that empowers and develops absorptive capacity's components which subsequently influences sustainability in competitive advantage through different ways. The research findings revealed Lean Six Sigma is a form of dynamic capability that develops organization's absorptive capacity. Through Lean Six Sigma projects and practices, organizations develop the capability to learn and extract information from external stimuli such as the market condition, customers, and suppliers besides internal stakeholders. Enriching its knowledge base, the organization is able to explore opportunities to deploy its resources strategically and timely. In addition to it, transforming those knowledge and exploiting them into operational routines allow organizations to nurture innovative performance which in turn sustain its competitive advantage. Lean Six Sigma enfolds practices which prove to be potent in stimulating exploration and exploitation traits balancing which enables an ambidextrous organization.

This study submits that dynamic capabilities are indeed rooted in operational routines or processes which determines the functional ability of an organization and modifying them to suit the changes in the business environment proves vital for survival of the organization. Hence, this corroborate the theory of dynamic capability and resource based view of the firm. The findings also substantiate that components of absorptive capacity needs to be managed differently wherein the findings empirically showed Six Sigma's structured method, role structure and Lean's social practice positively influence potential absorptive capacity. Meanwhile, Lean's social practice, Six Sigma's role structure and focus on metrics influences realized absorptive capacity. The findings also concurred to theoretical notions that potential and realized absorptive capacity sustains competitive advantage differently, the latter of which through innovation performance.

Lean Six Sigma endows organization to possess capabilities and resources which are valuable, exceptional, inimitable and non-substitutable which weathers competitive advantage, an attribute highly sought after in a hypercompetitive era.

7.5 Policy Implication

The findings of this study provides empirical justification on the stance of Lean Six Sigma acting as a source of dynamic capability by imparting exploration (PACAP) and exploitation (RACAP) capabilities in firms. These capabilities facilitates towards the realization of innovation and sustainability in competitive advantage, inevitably. Although there are a number of articles which reveal how government institution could make use of Lean Six Sigma (Anuar, 2015; Franchetti & Barnala, 2013; Khoo, 2004: Kumar & Bauer, 2010; Maleyeff, 2007), there is a paucity when it comes to formulating a governmental or official policy in relevance to Lean Six Sigma in the business environment. The rational for this is: it is an organization's prerogative to choose and embrace whichever management or process improvement philosophy it wants to. Therefore, it may not be viable nor practical to impose strict measures or regulations that formalizes Lean Six Sigma as an obligation. This section discourses on how governmental institutions could be of assistance to business organizations in realizing or capitalizing these abovementioned capabilities and benefits through Lean Six Sigma.

Current limitation that exist in the application or adoption Lean Six Sigma in organization is that the decision to adopt the philosophy rest on the discretion of top management wherein it may be short-lived and inconsistent, therefore truncating the ability to realize the outcomes stated in the study. Besides this, as mentioned in problem statement, multitude of government agencies have been on the rise in assisting companies to cultivate innovation capabilities through improvement in business processes, which sustains their competitive advantage in the market. As Olsson (2012) claim, one of the important aspects towards these outcomes is to address the weak attention and dissemination of absorptive capacities in firms.

Given the issues in formalizing Lean Six Sigma as mentioned above, the government institutions should instead take steps to entice the adoption of Lean Six Sigma in the first place. For now, this seems to be an impediment and a gray zone given the fact the decision to adopt Lean Six Sigma lies on the discretion of firms' top management. Therefore, one way to institutionalize Lean Six Sigma adoption is through quality standards certification, such as the ones embraced by firms universally is the ISO standards. Firms these days look up to the ISO standardization given its universal reputation in endorsing a firm of quality standards across multiple categories.

With the substantiation of Lean Six Sigma being a source of dynamic capability and the importance of quality certifications for firms, government institution could begin to formalize the use of ISO 13053-1 standard which emphasizes on the use of quantitative methods in process improvement of Six Sigma (ISO, 2011). This enables firms to indulge into a consistent mode of Lean Six Sigma application and at the same time gain quality standards recognition. The government institution on the other hand will gain significant benefits in monitoring and tracking the use of Lean Six Sigma in firms conveniently. Additionally, this could act as a channel to convey economic and business policies with relevance to market conditions and changes that could assist companies to look up for fluctuations in a timely manner. Intuitively, this creates a platform of partnership between the government and business institutions under the umbrella of continuous improvement.

This also overcomes the issue of identifying firms that are practicing the philosophy at a particular time, since a database can now be conveniently build through the standard's details. Given the involvement of ISO, SIRIM can act as the primary point of contact for such database. Additionally, firms that are closely related to innovation products and services, can be supplemented with BS 7001-1 which stands as the requirement for an efficient management system for research, development and innovation (BS7000-1, 2008).

To track the progress of firms in the application of Lean Six Sigma and to define the capabilities engendered by firms through the philosophy, government institutions could use this study's questionnaires as a means of tracking instrument. Besides that, the context of this study advocates on the source of external knowledge which is very much relevant to the resilience market networks where knowledge transfer is possible. Government agencies could act as facilitators in organizing summits, conferences and knowledge sharing sessions on the application and deployment of Lean Six Sigma between firms, especially, multinational corporations that are successful in business process improvement domains. Benefits in the form of tax exemptions or lower tax rates could be offered to those multinational corporations that are willing to actively participate in this endeavor and render support in the form of knowledge and technology transfer as well as guiding local organizations in the effort of process and continuous improvement. This creates a socialization process amongst Lean Six Sigma practitioners which consequently aids the process of external knowledge acquisition and assimilation (PACAP) and external knowledge transformation and exploitation (RACAP) for firms.

7.6 Limitations and Future Research

Although extensive articulation and effort is devoted in this study, it is not one without limitation as with many studies. Identifying firms implementing Lean Six Sigma had been a difficult journey by itself as it is time consuming. One of the reason to this is the absence of database on this account such that SIRIM has for ISO. Besides, the decision to adopt process improvement practices rest on the discretion of top management. Therefore a firm which is known to be implementing Lean Six Sigma could part ways with it in near future if the management wants to do so. In addition to it, there happens to be firms which calls it differently linking it as their own trademark practice wherein the tools and techniques used are of Lean Six Sigma's. This complicates identification of those companies and consumes time by doing so.

The study is cross-sectional in nature. Data collection happened approximately at the same time. The development of absorptive capacity does not happen swiftly as time is of essence. Besides knowledge is never complete as it tends to shift and change over time and across circumstances (Ang, 2015). It is therefore imperative to understand how Lean Six Sigma weathers absorptive capacity consequently innovation and sustained competitive advantage over time as sustainability in competitive advantage is an aspect that develops over time. A recommendation to this would be to engage in a longitudinal study to see the changes on components of absorptive capacity parallel to the practices of Lean Six Sigma at two different timelines, preferably in the beginning stages of the application and in the long run.

Given the limited information on firms practicing Lean Six Sigma, only manufacturing firms were able to be approached. Interpreting the results should be dealt with caution as the findings are applicable in the context of manufacturing industry in Peninsular Malaysia. In addition to it, this study did not manage to control for any variable. Initial intention of the study was to carry out a comprehensive research based of the framework developed encompassing both manufacturing and services industry. There have been conception that philosophies such as Lean Six Sigma is only applicable for manufacturing and not for services industry which was largely disputed as there are service-based companies demonstrating great achievements with Lean Six Sigma application (George, 2003; George & George, 2003). Therefore, it was postulated earlier in this study that it will be interesting to see the outcomes of the analysis by controlling for type of industry.

It would have been insightful to learn whether a difference exist in the outcome based on the theoretical framework developed from which valuable implication could be capitalized. However in the course of the study it was realized that gathering data for the services industry was highly complex, time consuming and tedious task as mentioned in chapter four (Target Population and Sample). With the absence of a reference or database to collect information on companies practicing Lean Six Sigma and the ever-changing nature of companies embracing Lean Six Sigma, the study did not manage to consolidate the true population that practices Lean Six Sigma. To look into other possible controls on the other hand, this study faced another drawback. A relative small sample size (n=125) which is proportionately uneven. Amongst the categories there were biased distribution or frequencies where one category amassed large sample and another being too small. This deterred a fair comparison between control groups.

As aforementioned in policy implication, institutionalizing the use of Lean Six Sigma through a common standard requirement may in fact overcome this predicament. Intuitively it creates a database of the companies that are practicing Lean Six Sigma at a given moment in time, regardless of industry. This could be useful to stretch the study to find the differences in manufacturing and services industry through a multi-group analysis or controlling for the type of industry is an avenue for future research. This could also be done across sub-sectors, preferably with a considerable sample size.

Lean Six Sigma is a philosophy that is debated to be one which efforts incremental innovation but some believe it has potential towards radical innovation (Antony et al., 2016). Given the work Flor et al. (2017) which clarifies how potential and realized absorptive capacity effects radical innovation, future research may undertake a study to learn how Lean Six Sigma would be influential towards incremental versus radical innovation. The measurement used for innovation was chosen as a broad concept. This concept could be defined further to differentiate between product, process, and management or administration innovation wherein researchers could view how potential and realized absorptive capacity differentially relates to these types of innovation.

Lean tools or technical practices (LTP) was found to be an insignificant factor in predicting both potential and realized absorptive capacity. As mentioned in discussion above, the items used in operationalizing the construct was adopted from past literature which outlines the commonly used tools in the industrial world or Lean organizations. Furthermore, these low number of items were chosen to facilitate the convenience of respondents who may detract in answering genuinely given a long list of questions which require them to identify each of it, one by one in their organizational context. The classification of commonly used tools and techniques of Lean in the manufacturing and services industry into bundles of practice may have an alternate outcome towards the components of absorptive capacity one such administered by Shah and Ward (2003) and Hadid et al. (2016). This could portray an interesting view in the context of this research model.

Another proposition for future research is to study which of the DMAIC phases attribute or significantly related to potential and realized absorptive capacity as it was found the structured methodology seemed to impact realized absorptive capacity through potential absorptive capacity. Future studies may also look into clarifying the interlinkage between role structure, potential absorptive capacity and innovation performance.

7.7 Conclusion

The objective of this study is fourfold. First, it examined which of Lean Six Sigma practices' positively relates the components of absorptive capacity, PACAP and RACAP. Second, it analyzed in what way the components of absorptive capacity are associated in the perspective of Lean Six Sigma application. Third, it examined the possibility of PACAP mediating the relationship between Lean Six Sigma practices' and RACAP. And finally, it evaluated how PACAP and RACAP relate to innovation performance and sustainable competitive advantage in the context of Lean Six Sigma.

This study found that Lean Six Sigma practices differentially influence absorptive capacity. Lean's social practice and Six Sigma's role structure seem to influence both potential and realized absorptive capacity. Six Sigma's focus on metrics seem to effect realized absorptive capacity and the DMAIC structured method of Six Sigma seems to influence potential absorptive capacity. However it was also discovered the structured improvement procedure influences realized absorptive capacity through potential absorptive capacity paving the way to understanding that the structured improvement procedure works sequentially in the context of absorptive capacity through the use of DMAIC methodology in Six Sigma projects. What this implies is that Lean Six Sigma taps into exploration (PACAP) and exploitation (RACAP) traits through the concept of absorptive capacity therefore enabling firms to shape their ambidextrous capability which has been deliberated in Six Sigma literatures. This study however provides empirical justification on this account.

In the context of Lean Six Sigma, it was also found that potential absorptive capacity positively impacts realized absorptive capacity. This justifies the need to view absorptive capacity in a dual dimension as it coexist and the need for both characters which galvanize the dynamic capability of a company. Potential absorptive capacity was found to be imperative in providing strategic flexibility in maneuvering firms' resources and timely deployment of same which sustains competitive advantage of firms embracing Lean Six Sigma. Realized absorptive capacity seemed to be substantial in enhancing innovation performance of firms that practice Lean Six Sigma. Finally, innovation garnered in Lean Six Sigma considerably effects the sustainability of competitive advantage of a firm.

Lean Six Sigma allows for exploration and exploitation activities alike. However to tap into these qualities, different practices should be administered as abovementioned. Being able to learn from external stimuli and the ability to exploit the enriched resources through the knowledge obtain from Lean Six Sigma projects is critical to inspire innovation and sustain competitive advantage. The result of the study shows the need to view absorptive capacity in a multidimensional perspective as different components warrants different managerial capabilities which are possible through administering Lean Six Sigma practices as commended.

Literatures in the past have mentioned that Lean Six Sigma is proficient in reaching overarching performances. This study acts as a standing proof to those statements through the context of absorptive capacity. Therefore, organizations are encouraged to appropriate the practices of Lean Six Sigma in tapping into their resources in enabling dynamically capable organization that is wary of market or external stimuli. This would be considerable to Malaysian firms in bridging the gap between business efficiency and productivity performance and inspire to reach an innovatively driven economy with knowledge at its forefront. In the meantime, this also addresses a resolution on the incumbent weakened attention on absorptive capacity.

Firms need to view Lean Six Sigma as a comprehensive management philosophy that drives business strategies. Governing Lean Six Sigma projects as a mechanism to cushion market fluctuations which enables the firm to learn and exploit necessary knowledge and improvise the changes in organizational routines through systematic and methodological means gains dynamism in the qualities of the firm. This warrants the study's proposition that Lean Six Sigma is indeed a source of dynamic capability.

REFERENCES

Abdullah, S. R., & Keenoy, T. (1995). Japanese managerial practices in the Malaysian electronics industry: two case studies. *Journal of Management Studies, 32*(6), 747-766.

Abdulmalek, F. A., & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *International Journal of Production Economics, 107*(1), 223-236.

Abrunhosa, A., & Sa, P. M. E. (2008). Are TQM principles supporting innovation in the Portuguese footwear industry? *Technovation, 28*(4), 208-221.

Abu Bakar, F. A., Subari, K., & Mohd Daril, M. A. (2015). Critical success factors of Lean Six Sigma deployment: a current review. *International Journal of Lean Six Sigma, 6*(4), 339-348.

Adler, P. S., Goldoftas, B., & Levine, D. I. (1999). Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science, 10*(1), 43-68.

Adler, P. S., & Kwon, S.-W. (2002). Social capital: Prospects for a new concept. *Academy of Management Review, 27*(1), 17-40.

Agus, A., & Shukri Hajinoor, M. (2012). Lean production supply chain management as driver towards enhancing product quality and business performance: Case study of manufacturing companies in Malaysia. *International Journal of Quality & Reliability Management, 29*(1), 92-121.

Ahmed, S., Manaf, N. H., & Islam, R. (2013). Effects of Lean Six Sigma application in healthcare services: a literature review. *Reviews on Environmental Health, 28*(4), 189-194.

Ahuja, G., & Morris Lampert, C. (2001). Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal, 22*(6-7), 521-543.

Alam, S., Osama, M., Iqbal, F., & Sawar, I. (2018). Reducing pharmacy patient waiting time. *International Journal of Health Care Quality Assurance, 31*(7), 834-844.

Albliwi, S. A., Antony, J., & Lim, S. A. H. (2015). A systematic review of Lean Six Sigma for the manufacturing industry. *Business Process Management Journal, 21*(3), 665-691.

Aldrich, H., & Herker, D. (1977). Boundary spanning roles and organization structure. *Academy of Management Review, 2*(2), 217-230.

Ali, M., & Park, K. (2016). The mediating role of an innovative culture in the relationship between absorptive capacity and technical and non-technical innovation. *Journal of Business Research, 69*(5), 1669-1675.

Allen, T. J. (1977). *Managing the flow of technology: Technology transfer and the dissemination of technological information within the R & D organization*. Cambridge, MA: MIT Press.

Alukal, G. (2006). Keeping lean alive. *Quality Progress, 39*(10), 67-69.

Amabile, T. (1996). Creativity and innovation in organizations (Vol. 5). *Boston: Harvard Business School, 396-239*.

Amabile, T., & Gryskiewicz, S. S. (1987). *Creativity in the R&D laboratory*. Greensboro: Center for Creative Leadership.

Amabile, T. M., & Gryskiewicz, N. D. (1989). The creative environment scales: Work environment inventory. *Creativity Research Journal, 2*(4), 231-253.

Amar, K., & Akpolat, H. (2005). *Preliminary Study on a Six Sigma Framework for Indonesian SMEs.* Paper presented at the International Conference on Operations and Supply Chain Management.

Amar, K., & Davis, D. (2015). Ready for Six Sigma?-a survey of Indonesian SMEs. *International Journal of Productivity and Quality Management, 16*(3), 281-297.

Amernic, J., Craig, R., & Tourish, D. (2007). The transformational leader as pedagogue, physician, architect, commander, and saint: Five root metaphors in Jack Welch's letters to stockholders of General Electric. *Human Relations, 60*(12), 1839-1872.

Amit, R. (1986). Cost leadership strategy and experience curves. *Strategic Management Journal, 7*(3), 281-292.

Amit, R., & Schoemaker, P. J. (1993). Strategic assets and organizational rent. *Strategic Management Journal, 14*(1), 33-46.

Anand, G., & Kodali, R. (2009). Selection of lean manufacturing systems using the analytic network process–a case study. *Journal of Manufacturing Technology Management, 20*(2), 258-289.

Anand, G., Ward, P. T., & Tatikonda, M. V. (2010). Role of explicit and tacit knowledge in Six Sigma projects: An empirical examination of differential project success. *Journal of Operations Management, 28*(4), 303-315.

Anand, G., Ward, P. T., Tatikonda, M. V., & Schilling, D. A. (2009). Dynamic capabilities through continuous improvement infrastructure. *Journal of Operations Management, 27*(6), 444-461.

Anbari, F. T. (2002). *Six Sigma method and its applications in project management.* Paper presented at the Proceedings of the Project Management Institute Annual Seminars and Symposium [CD], San Antonio, Texas. Oct.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411-423.

Anderson, J. C., Rungtusanatham, M., & Schroeder, R. G. (1994). A theory of quality management underlying the Deming management method. *Academy of Management Review, 19*(3), 472-509.

Ang, B. S. (2015). *A Study Of Knowledge Creation In Six Sigma Dmaic Project Success And Its Impact On Organizational Performance* (Unpublished doctoral dissertation). Universiti Sains Malaysia. Retrieved from http://eprints.usm.my/31615/1/Ang_Boon_Sin.pdf.

Angelis, J., Conti, R., Cooper, C., & Gill, C. (2011). Building a high-commitment lean culture. *Journal of Manufacturing Technology Management, 22*(5), 569-586.

Antony, J. (2004a). Six Sigma in the UK service organisations: results from a pilot survey. *Managerial Auditing Journal, 19*(8), 1006-1013.

Antony, J. (2004b). Some pros and cons of six sigma: an academic perspective. *The TQM Magazine, 16*(4), 303-306.

Antony, J. (2011). Six Sigma vs Lean: Some perspectives from leading academics and practitioners. *International Journal of Productivity and Performance Management, 60*(2), 185-190.

Antony, J. (2014). Readiness factors for the Lean Six Sigma journey in the higher education sector. *International Journal of Productivity and Performance Management, 63*(2), 257-264.

Antony, J., & Banuelas, R. (2002). Key ingredients for the effective implementation of Six Sigma program. *Measuring Business Excellence, 6*(4), 20-27.

Antony, J., & Coronado, R. (2001). A strategy for survival. *Manufacturing Engineer, 80*(3), 119-121.

Antony, J., Escamilla, J. L., & Caine, P. (2003). Lean Sigma [production and supply chain management]. *Manufacturing Engineer, 82*(2), 40-42.

Antony, J., Gupta, S., Sunder M, V., & Gijo, E. (2018). Ten commandments of Lean Six Sigma: a practitioners' perspective. *International Journal of Productivity and Performance Management, 67*(6), 1033-1044.

Antony, J., Krishan, N., Cullen, D., & Kumar, M. (2012). Lean Six Sigma for higher education institutions (HEIs) Challenges, barriers, success factors, tools/techniques. *International Journal of Productivity and Performance Management, 61*(8), 940-948.

Antony, J., Kumar, M., & Madu, C. N. (2005). Six sigma in small-and medium-sized UK manufacturing enterprises: Some empirical observations. *International Journal of Quality & Reliability Management, 22*(8), 860-874.

Antony, J., Setijono, D., & Dahlgaard, J. J. (2016). Lean Six Sigma and Innovation–an exploratory study among UK organisations. *Total Quality Management & Business Excellence, 27*(1-2), 124-140.

Anuar, A. N. B. (2015). Assessing the Implementation of Lean Six Sigma Programme in one of Malaysian Government Owned Companies. *World Journal of Social Sciences, 5*(2), 90-99.

Anvari, A., Zulkifli, N., Yusuff, R. M., Hojjati, S. M. H., & Ismail, Y. (2011). A proposed dynamic model for a lean roadmap. *African Journal of Business Management, 5*(16), 6727-6737.

Argyris, C. (1999). *On organizational learning*. Malden, Mass.: Blackwell Business.

Argyris, C., & Schön, D. A. (1978). *Organizational learning: A theory of action perspective* (Vol. 173). Reading, Mass.: Addison-Wesley Pub. Co.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, 396-402.

Arnheiter, E. D., & Maleyeff, J. (2005). The integration of lean management and Six Sigma. *The TQM Magazine, 17*(1), 5-18.

Arumugam, V., Antony, J., & Kumar, M. (2013). Linking learning and knowledge creation to project success in Six Sigma projects: An empirical investigation. *International Journal of Production Economics, 141*(1), 388-402.

Arumugam, V., Antony, J., & Linderman, K. (2014). A multilevel framework of Six Sigma: A systematic review of the literature, possible extensions, and future research. *The Quality Management Journal, 21*(4), 36-61.

Arumugam, V., Antony, J., & Linderman, K. (2016). The influence of challenging goals and structured method on Six Sigma project performance: A mediated moderation analysis. *European Journal of Operational Research, 254*(1), 202-213.

Assen, M. F. v. (2016). Exploring the impact of higher management's leadership styles on Lean management. *Total Quality Management & Business Excellence*, 1-30.

Atkinson, P. (2010). Lean is a cultural issue. *Management Services, 54*(2), 35-41.

Austenfeld Jr, R. B. (2006). Toyota and Why it is so Successful. *Papers of the Research Society of Commerce and Economics- Hiroshima Shudo University, 47*, 109-173.

Autant-Bernard, C. (2001). Science and knowledge flows: evidence from the French case. *Research Policy, 30*(7), 1069-1078.

Ayeni, F. O. (2003). An empirical study of the impact of Six Sigma methodology on organization financial performance in the United States. Regent University, Virginia Beach, VA.

Azis, Y., & Osada, H. (2010). Innovation in management system by Six Sigma: an empirical study of world-class companies. *International Journal of Lean Six Sigma, 1*(3), 172-190.

Babakus, E., & Mangold, W. G. (1992). Adapting the SERVQUAL scale to hospital services: an empirical investigation. *Health Services Research, 26*(6), 767-786.

Bakar, F. A. A., Subari, K., & Daril, M. A. M. (2015). Critical success factors of Lean Six Sigma deployment: a current. *International Journal of Lean Six Sigma, 6*(4), 339-348.

Baker, N. R., Green, S. G., & Bean, A. S. (1986). Why R&D projects succeed or fail. *Research Management, 29*(6), 29-34.

Barclay, D., Higgins, C., & Thompson, R. (1995). The Partial Least Squares (pls) Approach to Casual Modeling: Personal Computer Adoption Ans Use as an Illustration. *Technology Studies*, 2(2), 285-309.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99-120.

Barney, J. B. (1986). Strategic factor markets: Expectations, luck, and business strategy. *Management Science, 32*(10), 1231-1241.

Barney, J. B. (1989). Asset stocks and sustained competitive advantage: A comment. *Management Science, 35*(12), 1511-1513.

Barney, M. (2002). Macro, meso, micro: six sigma. *The Industrial Organizational Psychologist, 39*(4), 104-107.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Barry, C. (2012). PolyOne's Lean Six Sigma Success. Retrieved from http://blog.minitab.com/blog/real-world-quality-improvement/polyone-lean-six-sigma-success.

Bartlett, C. A., & Wozny, M. (1999). *GE's two-decade transformation: Jack Welch's leadership*: European Case Clearing House.

Baudin, M. (2007). *Working with machines: the nuts and bolts of lean operations with jidoka*: New York: Productivity Press.

Beckenbach, F., & Daskalakis, M. (2003). Invention and innovation as creative problem solving. A contribution to evolutionary microeconomics. *[Economic Discussion Contributions]*. Kassel: Univ., Department of Business Economics.

Beebe, K. R., Randy, J., & Seasholtz, M. (1998). Chemometrics: A practical guide. *John Willey and Sons Inc., New York*, 56-67.

Belsley, D. A., Kuh, E., & Welsch, R. E. (1980). Regression diagnostics: Identifying influential data and sources of collinearity. *Wiley Series in Probability and Mathematical Statistics*. New York: Wiley.

Bendell, T. (2006). A review and comparison of six sigma and the lean organisations. *The TQM Magazine, 18*(3), 255-262.

Benner, M. J., & Tushman, M. L. (2003). Exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of Management Review, 28*(2), 238-256.

Bergman, B., & Kroslid, D. (2000). *Six Sigma-a revival of the profound knowledge of variation.* Paper presented at the Proceedings of the 3rd International Conference on Building People and Organizational Excellence, Aarhus, Denmark.

Berry, B. (2011). There is a relationship between systems thinking and W. Edwards Deming's theory of profound knowledge. Retrieved from http://www.berrywood.com/wp-content/uploads/2011/08/DemingPaper.pdf.

Bhamu, J., & Singh Sangwan, K. (2014). Lean manufacturing: literature review and research issues. *International Journal of Operations & Production Management, 34*(7), 876-940.

Bhasin, S. (2011). Performance of organisations treating lean as an ideology. *Business Process Management Journal, 17*(6), 986-1011.

Bhasin, S. (2015). Lean management beyond manufacturing. *New York, NY: Springer International Publishing, 10*, 978-973.

Bhasin, S., & Burcher, P. (2006). Lean viewed as a philosophy. *Journal of Manufacturing Technology Management, 17*(1), 56-72.

Bhuiyan, N., & Baghel, A. (2005). An overview of continuous improvement: from the past to the present. *Management Decision, 43*(5), 761-771.

Bisgaard, S., Redman Thomas, C., Tartarone, S. A., Jones, B., & Kessels, R. (2008). *Innovation and Six Sigma.* Paper presented at the Six Sigma Forum Magazine.

Black, K., & Revere, L. (2006). Six Sigma arises from the ashes of TQM with a twist. *International journal of health care quality assurance, 19*(3), 259-266.

Bodwell, W., & Chermack, T. J. (2010). Organizational ambidexterity: Integrating deliberate and emergent strategy with scenario planning. *Technological Forecasting and Social Change, 77*(2), 193-202.

Bon, A. T., & Mustafa, E. M. (2013). Impact of total quality management on innovation in service organizations: Literature review and new conceptual framework. *Procedia Engineering, 53*, 516-529.

Bonavia, T., & Marin-Garcia, J. A. (2011). Integrating human resource management into lean production and their impact on organizational performance. *International Journal of Manpower, 32*(8), 923-938.

Bortolotti, T., Boscari, S., & Danese, P. (2015). Successful lean implementation: Organizational culture and soft lean practices. *International Journal of Production Economics, 160*, 182-201.

Bothe, D. R. (2002). Statistical reason for the 1.5 σ shift. *Quality Engineering, 14*(3), 479-487.

Bozarth, C. C., Handfield, R. B., & Chandiran, P. (2008). *Introduction to Operations and Supply Chain Management*: NJ.: Pearson Prentice Hall Upper Saddle River.

Brewer, P. C. (2004). Six Sigma helps a company create a culture of accountability. *Journal of Organizational Excellence, 23*(3), 45-59.

Breyfogle, F., Cupello, J., & Meadows, B. (2001). *Managing six sigma*. Canada: John Wiley & Sons.

Breyfogle, F., & Forrest, T. (1999). *Implementing Six Sigma Part 1.* Paper presented at the The Quality Management Forum, ASQ, Summer.

Breyfogle III, F. W. (2003). *Implementing six sigma: smarter solutions using statistical methods*. Hoboken, NJ: John Wiley & Sons.

Bryman, A., & Bell, E. (2011). *Business research methods* (3rd ed.). Cambridge: Oxford University Press.

BS7000-1. (2008). *Guide to Managing Innovation* (2nd ed.). London: BSI, British Standards.

Buavaraporn, N., & Tannock, J. (2013). Business process improvement in services: Case studies of financial institutions in Thailand. *International Journal of Quality & Reliability Management, 30*(3), 319-340.

Burns, T., & Stalker, G. (1961). *The Management of Innovation.* London: Tavistock Publications.

Burns, T., & Stalker, G. (1981). *The Management of Innovation.* London: Tavistock Publications.

Burton, T. T. (2011). *Accelerating Lean Six Sigma Results: how to achieve improvement excellence in the new economy*: Lauderdale, Fla.: J. Ross Pub.

Business Improvement Times (2013). *The Technical History of Six Sigma*. Retrieved from https://drmikelharry.wordpress.com/2013/10/22/the-technical-history-of-six-sigma/

Byrne, G., Lubowe, D., & Blitz, A. (2007a). *Driving Operational Innovation Using Lean Six Sigma: Strategy and Change*: Somers, N.Y.: IBM Institute for Business Value.

Byrne, G., Lubowe, D., & Blitz, A. (2007b). Using a Lean Six Sigma approach to drive innovation. *Strategy & Leadership, 35*(2), 5-10.

Cain, M. K., Zhang, Z., & Yuan, K.-H. (2017). Univariate and multivariate skewness and kurtosis for measuring nonnormality: Prevalence, influence and estimation. *Behavior Research Methods, 49*(5), 1716-1735.

Calantone, R. J., Cavusgil, S. T., & Zhao, Y. (2002). Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management, 31*(6), 515-524.

Calantone, R. J., Vickery, S. K., & Dröge, C. (1995). Business performance and strategic new product development activities: an empirical investigation. *Journal of Product Innovation Management, 12*(3), 214-223.

Caldwell, C., Butler, G., Posten, N., & Quality, A. S. (2009). *Lean-Six Sigma for Healthcare: A Senior Leader Guide to Improving Cost and Throughput*. Milwaukee, Wisconsin: ASQ Quality Press.

Camerer, C., & Vepsalainen, A. (1988). The economic efficiency of corporate culture. *Strategic Management Journal, 9*(S1), 115-126.

Camisón, C., & Puig-Denia, A. (2016). Are quality management practices enough to improve process innovation? *International Journal of Production Research, 54*(10), 2875-2894.

Campbell, D. J. (1988). Task complexity: A review and analysis. *Academy of Management Review, 13*(1), 40-52.

Cano, E. L., Moguerza, J. M., & Redchuk, A. (2012). Six sigma in a nutshell *Six Sigma with R* (pp. 3-13): Statistical engineering for process improvement. New York: Springer. doi:10.1007/978-1-4614-3652-2

Cao, M., Vonderembse, M. A., Zhang, Q., & Ragu-Nathan, T. (2010). Supply chain collaboration: conceptualisation and instrument development. *International Journal of Production Research, 48*(22), 6613-6635.

Carlson Dean, C. (1997). Primer of Scientific Management by Frank B. Gilbreth: A response to publication of Taylor's Principles in The American Magazine. *Journal of Management History, 3*(1), 31-41.

Carnegie, R., & Butlin, M. (1993). *Managing the innovative enterprise: Australian companies competing with the world's best*: Melbourne, Vic.: Business Library.

Catherwood, P. (2002). What's different about Six Sigma? *Manufacturing Engineer, 81*(4), 186-189.

Caulcutt, R. (2001). Why is Six Sigma so successful? *Journal of Applied Statistics, 28*(3-4), 301-306.

Cepeda-Carrion, G., Cegarra-Navarro, J. G., & Jimenez-Jimenez, D. (2012). The effect of absorptive capacity on innovativeness: Context and information systems capability as catalysts. *British Journal of Management, 23*(1), 110-129.

Cezar Lucato, W., Araujo Calarge, F., Loureiro Junior, M., & Damasceno Calado, R. (2014). Performance evaluation of lean manufacturing implementation in Brazil. *International Journal of Productivity and Performance Management, 63*(5), 529-549.

Chakrabarty, A., & Chuan, K. T. (2009). An exploratory qualitative and quantitative analysis of Six Sigma in service organizations in Singapore. *Management Research News, 32*(7), 614-632.

Chakraborty, A., Bhattacharya, M., Ghosh, S., & Sarkar, G. (2013). Importance of kaizen concept in medium manufacturing enterprises. *International Journal of Management and Strategy (IJMS), Vol, 4*.

Chakravorty, S. S., & Shah, A. D. (2012). Lean Six Sigma (LSS): an implementation experience. *European Journal of Industrial Engineering, 6*(1), 118-137.

Chapman, R. L., & Hyland, P. W. (1997). Continuous improvement strategies across selected Australian manufacturing sectors. *Benchmarking for Quality Management & Technology, 4*(3), 175-188.

Chaurasia, B., Garg, D., & Agarwal, A. (2016). Framework to improve performance through implementing Lean Six Sigma strategies to oil exporting countries during recession or depression. *International Journal of Productivity and Performance Management, 65*(3), 422-432.

Chavez, R., Gimenez, C., Fynes, B., Wiengarten, F., & Yu, W. (2013). Internal lean practices and operational performance: The contingency perspective of industry clockspeed. *International Journal of Operations & Production Management, 33*(5), 562-588.

Chen, Y.-S., Lin, M.-J. J., & Chang, C.-H. (2009). The positive effects of relationship learning and absorptive capacity on innovation performance and competitive advantage in industrial markets. *Industrial Marketing Management, 38*(2), 152-158.

Chermers, G., & Cronin, P. (2015). Social Learning Applied to Six Sigma Projects. Retrieved from https://www.qualitydigest.com/inside/six-sigma-article/102815-social-learning-applied-six-sigma-projects.html#

Cheser, R. N. (1998). The effect of Japanese Kaizen on employee motivation in US manufacturing. *The International Journal of Organizational Analysis, 6*(3), 197-217.

Chetty, S. K., & Wilson, H. I. (2003). Collaborating with competitors to acquire resources. *International Business Review, 12*(1), 61-81.

Chiarini, A. (2011). Integrating lean thinking into ISO 9001: a first guideline. *International Journal of Lean Six Sigma, 2*(2), 96-117.

Chin, W. W. (1998a). Commentary: Issues and Opinion on Structural Equation Modeling. MIS Quarterly, 22(1), Vii-Xvi. Retrieved from http://www.jstor.org/stable/249674.

Chin, W. W. (1998b). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research, 295*(2), 295-336.

Chinn, P. L., & Kramer, M. K. (1999). *Theory and Nursing Integrated Knowledge Development*. St. Louis: Mosby.

Cho, H.-C., & Abe, S. (2013). Is two-tailed testing for directional research hypotheses tests legitimate? Journal of Business Research, 66(9), 1261-1266.

Choi, B., Kim, J., Leem, B.-h., Lee, C.-Y., & Hong, H.-k. (2012). Empirical analysis of the relationship between Six Sigma management activities and corporate competitiveness: Focusing on Samsung Group in Korea. *International Journal of Operations & Production Management, 32*(5), 528-550.

Choo, A. S. (2011). Impact of a stretch strategy on knowledge creation in quality improvement projects. *IEEE Transactions on Engineering Management, 58*(1), 87-96.

Choo, A. S., Linderman, K. W., & Schroeder, R. G. (2007a). Method and context perspectives on learning and knowledge creation in quality management. *Journal of Operations Management, 25*(4), 918-931.

Choo, A. S., Linderman, K. W., & Schroeder, R. G. (2007b). Method and psychological effects on learning behaviors and knowledge creation in quality improvement projects. *Management Science, 53*(3), 437-450.

Christopher, M., & Towill, D. R. (2000). Supply chain migration from lean and functional to agile and customised. *Supply Chain Management: An International Journal, 5*(4), 206-213.

Churchill, G. A., & Iacobucci, D. (2002). *Marketing Research:Methodological Foundations* (8 ed.). Fort Worth, TX: Harcourt College Publishers.

Claycomb, C., Germain, R., & Dröge, C. (1999). Total system JIT outcomes: inventory, organization and financial effects. *International Journal of Physical Distribution & Logistics Management, 29*(10), 612-630.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, N.J.: L. Erlbaum Associates.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155.

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: the two faces of R & D. *The Economic Journal, 99*(397), 569-596.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152.

Collins, L. M., Graham, J. J., & Flaherty, B. P. (1998). An alternative framework for defining mediation. *Multivariate Behavioral Research, 33*(2), 295-312.

Collis, D. J., & Montgomery, C. A. (1995). Competing on Resources: Strategy in the 1990s. *Harvard Business Review*, 73(4), 118-128.

Cool, K., & Schendel, D. (1988). Performance differences among strategic group members. *Strategic Management Journal, 9*(3), 207-223.

Cooper, D., & Schindler, P. (2010). *Business Research Methods*: New York: McGraw-Hill Education.

Cooper, R. G. (1988). Predevelopment activities determine new product success. *Industrial Marketing Management, 17*(3), 237-247.

Cooper, R. G. (1993). *Winning at New Products: Accelerating the Process from Idea to Launch*. Reading, Mass.: Addison-Wesley.

Cooper, R. G., & Kleinschmidt, E. J. (1995). Benchmarking the firm's critical success factors in new product development. *Journal of Product Innovation Management, 12*(5), 374-391.

Corbett, L. M. (2011). Lean Six Sigma: the contribution to business excellence. *International Journal of Lean Six Sigma, 2*(2), 118-131.

Cordero, R. (1990). The measurement of innovation performance in the firm: an overview. *Research Policy, 19*(2), 185-192.

Cousins, P. D., & Menguc, B. (2006). The implications of socialization and integration in supply chain management. *Journal of Operations management, 24*(5), 604-620. doi:https://doi.org/10.1016/j.jom.2005.09.001

Coyne, K. P. (1986). Sustainable competitive advantage—What it is, what it isn't. *Business Horizons, 29*(1), 54-61.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, California: Sage Publications.

Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2011). Best practices for mixed methods research in the health sciences. *Bethesda (Maryland): National Institutes of Health*, 2094-2103.

Cronbach, L. (1971). Test validation. *Educational measurement* (2nd ed.). Washington, DC: American Council on Education.

Crosby, P. B. (1979). *Quality is free: The art of marketing quality certain*. New York: New American Library.

Crosby, P. B. (2005). Crosby's 14 steps to improvement. *Quality Progress, 38*(12), 60-64.

Crute, V., Wickham, A., Johns, R., & Graves, A. (2008). Exploring competitive advantage through lean implementation in the aerospace supply chain. *Lean Business Systems and Beyond*, 357-364.

Cua, K. O., McKone, K. E., & Schroeder, R. G. (2001). Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. *Journal of Operations Management, 19*(6), 675-694.

Daft, R. (2001). *Organization theory and design*. (7th ed.). International Student Edition. Cincinnati, Ohio: South-Western College Publishing.

Daft, R. (2006). *Organization Theory and Design*: Cengage Learning.

Daft, R. (2012). *Organization theory and design*: Nelson Education.

Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science, 32*(5), 554-571.

Daghfous, A. (2004). Absorptive capacity and the implementation of knowledge-intensive best practices. *SAM Advanced Management Journal, 69*(2), 21-27.

Dahlgaard, J. J., & Dahlgaard-Park, S. (2006). Lean production, six sigma quality, TQM and company culture. *TQM Magazine, 18*(3), 263-281.

Danese, P., Romano, P., & Boscari, S. (2017). The transfer process of lean practices in multi-plant companies. *International Journal of Operations & Production Management, 37*(4), 468-488.

Dasgupta, T. (2003). Using the six-sigma metric to measure and improve the performance of a supply chain. *Total Quality Management & Business Excellence, 14*(3), 355-366.

Datta, A. (2011). An integrative model to explain the ability to commercialize innovations: Linking networks, absorptive capacity, ambidexterity and environmental factors. *Journal of Management and Strategy*, 2(2), 2-22.

Datta, A. (2012). Combining networks, ambidexterity and absorptive capacity to explain commercialization of innovations: A theoretical model from review and extension. *Journal of Management and Strategy*, 2(4), 2-25.

Davenport, T. H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Boston, Mass: Harvard Business School Press.

David, P. A. (1985). Clio and the Economics of QWERTY. *The American Economic Review, 75*(2), 332-337.

Dawes, J. (2008). Do data characteristics change according to the number of scale points used. *International Journal of Market Research, 50*(1), 61-77.

Day George, S. (1990). *Market Driven Strategy*: New York: The Free Press.

De Freitas, S., & Neumann, T. (2009). The use of 'exploratory learning'for supporting immersive learning in virtual environments. *Computers & Education, 52*(2), 343-352.

De Geus, A. P. (1988). Planning as learning. *Harvard Business Review*. Retrieved from https://hbr.org/1988/03/planning-as-learning.

De Mast, J. (2006). Six Sigma and competitive advantage. *Total Quality Management and Business Excellence, 17*(04), 455-464.

De Mast, J., & Lokkerbol, J. (2012). An analysis of the Six Sigma DMAIC method from the perspective of problem solving. *International Journal of Production Economics, 139*(2), 604-614.

De Treville, S., & Antonakis, J. (2006). Could lean production job design be intrinsically motivating? Contextual, configurational, and levels-of-analysis issues. *Journal of Operations Management, 24*(2), 99-123.

Deblois, S., & Lepanto, L. (2016). Lean and Six Sigma in acute care: a systematic review of reviews. *International Journal of Health Care Quality Assurance, 29*(2), 192-208.

Deming, W. E. (1952). *Elementary principles of the statistical control of quality: a series of lectures*. Tokyo: Nippon Kegaku Gijutsu Remmei.

Deming, W. E. (1986). *Out of the crisis*, Massachusetts Institute of Technology, Center for Advanced Engineering Study. Cambridge, MA.

Deming, W. E. (1990). A system of profound knowledge. *Action Line*, 20-26.

Deming, W. E. (2000). *The New Economics: For Industry, Government, Education*. Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge.

Denk, W. (2005). Six Sigma the "Breakthrough Management Strategy"? *Economic Quality Control, 20*(2), 171-176.

Devlin, S. J., Dong, H., & Brown, M. (1993). Selecting a scale for measuring quality. *Marketing Research, 5*(3), 12-17.

Diamantopoulos, A., & Siguaw, J. A. (2000). *Introducing LISREL: A guide for the uninitiated*. London: SAGE.

Dierickx, I., & Cool, K. (1989). Asset stock accumulation and sustainability of competitive advantage. *Management Science, 35*(12), 1504-1511.

Dillman, D. A. (2011). *Mail and Internet surveys: The tailored design method--2007 Update with new Internet, visual, and mixed-mode guide*. Hoboken, N.J.: Wiley.

Ding, L., Velicer, W. F., & Harlow, L. L. (1995). Effects of estimation methods, number of indicators per factor, and improper solutions on structural equation modeling fit indices. *Structural Equation Modeling: A Multidisciplinary Journal, 2*(2), 119-143.

Dodgson, M. (1991). *The management of technological learning: lessons from a biotechnology company* (Vol. 29). Berlin: W. de Gruyter.

Dombrowski, U., & Crespo, I. (2008). Strategy-oriented qualification framework as a supporting function of lean production system implementation in small and medium-sized enterprises. *Manufacturing Systems and Technologies for the New Frontier*, 77-82.

Dombrowski, U., Mielke, T., & Engel, C. (2012). Knowledge management in lean production systems. *Procedia CIRP, 3*, 436-441.

Dombrowski, U., Schmidt, S., & Crespo, I. (2007). *Knowledge management as a supporting function in lean production system implementation.* Paper presented at the Proceedings of the 2nd international conference on changeable, agile, reconfigurable and virtual production.

Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. *Research Policy, 11*(3), 147-162.

Drucker, P. F. (1999). Knowledge-worker productivity: The biggest challenge. *California Management Review, 41*(2), 79-94.

Druskat, V. U., & Wheeler, J. V. (2003). Managing from the boundary: The effective leadership of self-managing work teams. *Academy of Management Journal, 46*(4), 435-457.

Dyer, J. H., & Hatch, N. W. (2004). Using supplier networks to learn faster. *MIT Sloan Management Review, 45*(3), 57.

Dyer, J. H., & Nobeoka, K. (2000). Creating and managing a high-performance knowledge-sharing network: the Toyota case. *Strategic Management Journal, 21*(3), 345-367.

Ean Lee, C., Cheng Kan, S., & Chuin Foo, Y. (2012). Deploying the NUS Service Class framework at the NUS Libraries to scale the peaks of service excellence. *Library Management, 33*(6/7), 343-356.

Earley, P. C., Connolly, T., & Ekegren, G. (1989). Goals, strategy development, and task performance: some limits on the efficacy of goal setting. *Journal of Applied Psychology, 74*(1), 24-33.

Earley, P. C., Lee, C., & Hanson, L. A. (1990). Joint moderating effects of job experience and task component complexity: Relations among goal setting, task strategies, and performance. *Journal of Organizational Behavior, 11*(1), 3-15.

Earley, P. C., & Perry, B. C. (1987). Work plan availability and performance: An assessment of task strategy priming on subsequent task completion. *Organizational Behavior and Human Decision Processes, 39*(3), 279-302.

Easton, G. S., & Rosenzweig, E. D. (2012). The role of experience in six sigma project success: An empirical analysis of improvement projects. *Journal of Operations Management, 30*(7), 481-493.

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly, 44*(2), 350-383.

Edquist, C. (1997). *Systems of innovation: technologies, institutions, and organizations*. London: Pinter.

Ehigie, B. O., & McAndrew, E. B. (2005). Innovation, diffusion and adoption of total quality management (TQM). *Management Decision, 43*(6), 925-940.

Ehrlich, B. H. (2006). Service with a smile: lean solutions extend beyond the factory floor. *Industrial Engineer, 38*(8), 40-45.

Eichhorn, B. R. (2014). *Common Method Variance Techniques.* Cleveland State University, Department of Operations & Supply Chain Management. Cleveland, OH: SAS Institute Inc.

Eisenhardt, K. M. (1985). Control: Organizational and economic approaches. *Management Science, 31*(2), 134-149.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal*, 1105-1121.

Ellis, H. C. (1965). *The transfer of learning*. Oxford, England: Macmillan.

Ellis, S. C., Goldsby, T. J., Bailey, A. M., & Oh, J. Y. (2014). Teaching Lean Six Sigma within A Supply Chain Context: The Airplane Supply Chain Simulation. *Decision Sciences Journal of Innovative Education, 12*(4), 287-319.

Emiliani, M. (2006). Origins of lean management in America: The role of Connecticut businesses. *Journal of Management History, 12*(2), 167-184.

Emiliani, M., & Emiliani, M. (2013). Music as a framework to better understand Lean leadership. *Leadership & Organization Development Journal, 34*(5), 407-426.

Erez, M., & Zidon, I. (1984). Effect of goal acceptance on the relationship of goal difficulty to performance. *Journal of Applied Psychology, 69*(1), 69-78.

Eroglu, C., & Hofer, C. (2011). Lean, leaner, too lean? The inventory-performance link revisited. *Journal of Operations Management, 29*(4), 356-369.

Evans, J., & Lindsay, W. (2007). *Managing for Quality and Performance Excellence*. Australia: South-Western Cengage Learning.

Fadly Habidin, N., & Mohd Yusof, S. R. (2013). Critical success factors of Lean Six Sigma for the Malaysian automotive industry. *International Journal of Lean Six Sigma, 4*(1), 60-82.

Fawaz, A. (2003). *Lean manufacturing tools and techniques in the process industry with a focus on steel* (Doctoral Dissertation, University of Pittsburgh). Retrieved from http://d-scholarship.pitt.edu/7968/1/Abdullah.pdf.

Feigenbaum, A. V. (1956). Total quality-control. *Harvard business review, 34*(6), 93-101.

Feigenbaum, A. V. (1961). *Total quality control: engineering and management, the technical and managerial field for improving product quality, including its reliability, and for reducing operating cost and losses*. New York, NY: McGraw-Hill.

Feld, W. M. (2000). *Lean manufacturing: tools, techniques, and how to use them*: Boca Raton, FL: CRC Press.

Fendler, L., & Muzaffar, I. (2008). The history of the bell curve: Sorting and the idea of normal. *Educational Theory, 58*(1), 63-82.

Ferrer-Bonsoms Castan, B. (2012). *Continues improvement and search of flexibility in the production plant* (Internship Final Project). Retrieved from https://upcommons.upc.edu/bitstream/handle/2099.1/19789/RAPORT%20Final%20Version.pdf.

Ferrier, W. J., Smith, K. G., & Grimm, C. M. (1999). The role of competitive action in market share erosion and industry dethronement: A study of industry leaders and challengers. *Academy of Management Journal, 42*(4), 372-388.

Fine, C. H. (1986). Quality improvement and learning in productive systems. *Management Science, 32*(10), 1301-1315.

Fine, D., Hansen, M. A., & Roggenhofer, S. (2008). From lean to lasting: making operational improvements stick. *McKinsey Quarterly, 1*(11), 38-55.

Fiol, C. M. (1996). Squeezing harder doesn't always work: Continuing the search for consistency in innovation research. *Academy of Management Review, 21*(4), 1012-1021.

Flor, M. L., Cooper, S. Y., & Oltra, M. J. (2017). External knowledge search, absorptive capacity and radical innovation in high-technology firms. *European Management Journal*, 1-12. doi: 10.1016/j.emj.2017.08.003

Flynn, B. B., Schroeder, R., & Sakakibara, S. (1996). Determinants of quality performance in high and low quality plants. *Quality Control and Applied Statistics, 41*, 73-76.

Flynn, B. B., Schroeder, R. G., & Sakakibara, S. (1994). A framework for quality management research and an associated measurement instrument. *Journal of Operations Management, 11*(4), 339-366.

Flynn, B. B., Schroeder, R. G., & Sakakibara, S. (1995). The impact of quality management practices on performance and competitive advantage. *Decision Sciences, 26*(5), 659-691.

Flynn, E. J., & Flynn, B. B. (1996). Achieving simultaneous cost and differentiation competitive advantages through continuous improvement: world class manufacturing as a competitive strategy. *Journal of Managerial Issues*, 360-379.

Fornari, A., & Maszle, G. (2004). Lean six sigma leads Xerox. In *Six Sigma Forum Magazine*, 3(4), 11-16.

Fornell, C., & Bookstein, F. L. (1982). Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research*, 440-452.

Fornell, C., & Cha, J. (1994). Partial least squares. *Advanced Methods of Marketing Research, 407*(3), 52-78.

Fornell, C., Johnson, M. D., Anderson, E. W., Cha, J., & Bryant, B. E. (1996). The American customer satisfaction index: nature, purpose, and findings. *The Journal of Marketing*, 7-18.

Fornell, C., & Larcker, D. (1987). A second generation of multivariate analysis: Classification of methods and implications for marketing research. *Review of Marketing, 1*, 407-450.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 39-50.

Fosfuri, A., & Tribó, J. A. (2008). Exploring the antecedents of potential absorptive capacity and its impact on innovation performance. *Omega, 36*(2), 173-187.

Foster, R. N. (1988). *Innovation: The attacker's advantage*. New York: Summit Books.

Fotopoulos, C. B., & Psomas, E. L. (2009). The impact of "soft" and "hard" TQM elements on quality management results. *International Journal of Quality & Reliability Management, 26*(2), 150-163.

Fowler, F. J. (2008). *Survey Research Methods*. Los Angeles: SAGE Publications.

Frankenhoff, W. P., & Granger, C. H. (1971). Strategic management: A new managerial concept for an era of rapid change. *Long Range Planning, 3*(3), 7-12.

Frederick, T. (1911). The principles of scientific management. USA: Harper & Brothers.

Fullerton, R. R., & McWatters, C. S. (2001). The production performance benefits from JIT implementation. *Journal of Operations Management, 19*(1), 81-96.

Fullerton, R. R., McWatters, C. S., & Fawson, C. (2003). An examination of the relationships between JIT and financial performance. *Journal of Operations Management, 21*(4), 383-404.

Fullerton, R. R., & Wempe, W. F. (2009). Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Operations & Production Management, 29*(3), 214-240.

Fursule, N., Bansod, S., & Fursule, S. (2012). Understanding the benefits and limitations of Six Sigma Methodology. *International Journal of Scientific and Research Publications, 2*(1), 1-9.

Furuoka, F. (2007). Malaysia-Japan Relations under the Mahathir Administration: Case Studies of the ""Look East"" Policy and Japanese Investment in Malaysia. *Asian Survey, 47*(3), 505-519.

Fynes, B., & Ainamo, A. (1998). Organisational learning and lean supply relationships: the case of Apple Ireland. *Supply Chain Management: An International Journal, 3*(2), 96-107.

Galli, B. J., & Kaviani, M. A. (2018). The impacts of risk on deploying and sustaining lean six sigma initiatives. *International Journal of Risk and Contingency Management, 7*(1), 46-70.

Galbraith, J. R. (1973). *Designing complex organizations*. Reading, Mass: Addison-Wesley Pub.

Gamal Aboelmaged, M. (2010). Six Sigma quality: a structured review and implications for future research. *International Journal of Quality & Reliability Management, 27*(3), 268-317.

García-Morales, V. J., Ruiz-Moreno, A., & Llorens-Montes, F. J. (2007). Effects of technology absorptive capacity and technology proactivity on organizational learning, innovation and performance: An empirical examination. *Technology Analysis & Strategic Management, 19*(4), 527-558.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management, 19*(2), 110-132.

Gartner, W. B., & Naughton, M. J. (1988). The Deming theory of management. *Academy of Management Review, 13*(1), 138-142.

Garud, R. (1997). On the distinction between know-how, know-what, and know-why. *Advances in Strategic Management, 14*, 81-102.

Garud, R., & Nayyar, P. R. (1994). Transformative capacity: Continual structuring by intertemporal technology transfer. *Strategic Management Journal, 15*(5), 365-385.

Garvin, D. (1993). Building a Learning Organization. *Harvard Business Review, 71*(4), 78-91.

Gebauer, H., Worch, H., & Truffer, B. (2012). Absorptive capacity, learning processes and combinative capabilities as determinants of strategic innovation. *European Management Journal, 30*(1), 57-73.

Gefen, D., Straub, D., & Boudreau, M.-C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems, 4*(1), 1-78.

Geisser, S. (1974). A predictive approach to the random effect model. *Biometrika, 61*(1), 101-107.

George, M. (2002). *Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed*. New York, NY: McGraw-Hill Education.

George, M. (2003). *Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions*. New York, NY: McGraw-Hill Education.

George, M. L., & George, M. (2003). *Lean six sigma for service*. New York, NY: McGraw-Hill.

Georgescu, D. D. (2011). Lean Thinking and Transferring Lean Management-The Best Defence against an Economic Recession? *European Journal of Interdisciplinary Studies, 3*(1), 4.

Gibson, C., & Birkinshaw, J. (2004). Building ambidexterity into an organization. *MIT Sloan Management Review* (4), 47-55.

Gibson, J. W., Deem, J., Einstein, J. E., & Humphreys, J. H. (2016). Applying a critical biography perspective to the work of Frank Gilbreth. *Journal of Management History, 22*(4), 413-436.

Gilbreth, F. B. (1912). *Primer of scientific management*. London, England: Constable & Company.

Gloet, M., & Terziovski, M. (2004). Exploring the relationship between knowledge management practices and innovation performance. *Journal of Manufacturing Technology Management, 15*(5), 402-409.

Godfrey, A. B. (1996). *Creativity, innovation and quality*. Juran Institute, Inc. Series of satellite broadcast presentation, Fev, 2. Retrieved from https://www.researchgate.net/profile/A_Godfrey/publication/255551076_Creativity_Innovation_and_Quality/links/555dbf0b08ae8c0cab2af467.pdf.

Gold, A. H., Malhotra, A., & Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. *Journal of Management Information Systems, 18*(1), 185-214.

Gong, Y., & Janssen, M. (2015). Demystifying the benefits and risks of Lean service innovation: a banking case study. *Journal of Systems and Information Technology, 17*(4), 364-380.

Gonzalez Aleu, F., Van Aken, E. M., & Antony, J. (2016). Systematic literature review of critical success factors for continuous improvement projects. *International Journal of Lean Six Sigma, 7*(3), 214-232.

Gowen, C. R., & Tallon, W. J. (2005). Effect of technological intensity on the relationships among Six Sigma design, electronic-business, and competitive advantage: A dynamic capabilities model study. *The Journal of High Technology Management Research, 16*(1), 59-87.

Gowen III, C., Stock, G., & McFadden, K. (2008). Simultaneous implementation of Six Sigma and knowledge management in hospitals. *International Journal of Production Research, 46*(23), 6781-6795.

Gowen III, C. R., McFadden, K. L., & Settaluri, S. (2012). Contrasting continuous quality improvement, Six Sigma, and lean management for enhanced outcomes in US hospitals. *American Journal of Business, 27*(2), 133-153.

Graban, M. (2011). *Lean Hospitals: Improving Quality, Patient Safety, and Employee Satisfaction*. Boca Raton: CRC Press.

Grachev, M., & Rakitsky, B. (2013). Historic horizons of Frederick Taylor's scientific management. *Journal of Management History, 19*(4), 512-527.

Grant, R. M. (1991). The resource-based theory of competitive advantage: implications for strategy formulation. *California Management Review, 33*(3), 114-135.

Grant, R. M. (1996a). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science, 7*(4), 375-387.

Grant, R. M. (1996b). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109-122.

Greene, W. H. (2003). *Econometric analysis*. Upper Saddle River, N.J.: Prentice Hall.

Griffin, A. (1997). PDMA research on new product development practices: Updating trends and benchmarking best practices. *Journal of Product Innovation Management, 14*(6), 429-458.

Gryna, F. M. (2001). *Quality planning and analysis: from product development through use*: New York, NY: McGraw-Hill Science Engineering.

Gupta, A. K., & Govindarajan, V. (2000). Knowledge flows within multinational corporations. *Strategic Management Journal*, 473-496.

Gutiérrez Gutiérrez, L. J., Lloréns-Montes, F. J., & Bustinza Sánchez, Ó. F. (2009). Six sigma: from a goal-theoretic perspective to shared-vision development. *International Journal of Operations & Production Management, 29*(2), 151-169.

Gutiérrez, L. G., Bustinza, O., & Molina, V. B. (2012). Six sigma, absorptive capacity and organisational learning orientation. *International Journal of Production Research, 50*(3), 661-675.

Habidin, N., & Yusof, S. (2012). Relationship between lean six sigma, environmental management systems, and organizational performance in the Malaysian automotive industry. *International Journal of Automotive Technology, 13*(7), 1119-1125.

Habidin, N. F., Mohd Yusof, S. r., & Mohd Fuzi, N. (2016). Lean Six Sigma, strategic control systems, and organizational performance for automotive suppliers. *International Journal of Lean Six Sigma, 7*(2), 110-135.

Hadid, W., Mansouri, S. A., & Gallear, D. (2016). Is lean service promising? A socio-technical perspective. *International Journal of Operations & Production Management, 36*(6), 618-642.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (1998). *Multivariate data analysis* (Vol. 5). Upper Saddle River, N.J.: Prentice Hall.

Hair, J. F., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2016). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Los Angeles: SAGE Publications.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice, 19*(2), 139-152.

Hallam, C. R., Muesel, J., & Flannery, W. (2010). *Analysis of the Toyota Production System and the genesis of Six Sigma programs: An imperative for understanding failures in technology management culture transformation in traditional manufacturing companies.* Paper presented at the Picmet 2010 Technology Management For Global Economic Growth.

Hamberg, D. (1963). Invention in the industrial research laboratory. *Journal of Political Economy, 71*(2), 95-115.

Hamel, G. (2000). Reinvent your company. *Fortune, 141*(12), 98-109.

Hamel, G., & Prahalad, C. K. (1993). Strategy as stretch and leverage. *Harvard Business Review, 71*(2), 75-84.

Hamel, G., & Prahalad, C. K. (1994). Competing for the Future. *Harvard Business Review, 72*(4), 122-128.

Hammer, M. (2002). Process management and the future of Six Sigma. *MIT Sloan Management Review, 43*(2), 26.

Hancock, W. M., & Zayko, M. J. (1998). Lean production: Implementation problems. *IIE Solutions, 30*(6), 38-43.

Hansen, M. T., Podolny, J. M., & Pfeffer, J. (2001). So many ties, so little time: A task contingency perspective on corporate social capital in organizations *Social Capital of organizations* (pp. 21-57). Bingley, United Kingdom: Emerald Group Publishing Limited.

Harlow, H. F. (1949). The formation of learning sets. *Psychological Review, 56*(1), 51-65.

Harman, D. (1967). A single factor test of common method variance. *Journal of Psychology, 35*(1967), 359-378.

Harry, M. (1985). Practical Experiment Design: Level I Engineering Workbook. *Research Dynamics, Tempe, Arizona* (2nd ed.). Published by the Government Electronics Group, Motorola Inc., Scottsdale, Arizona.

Harry, M., & Linsenmann, D. R. (2006). *The Six Sigma Fieldbook: How DuPont Successfully Implemented the Six Sigma Breakthrough Management Strategy*: New York, NY. New York: Currency.

Harry, M. J. (1994). *The vision of six sigma: Tools and methods for breakthrough*. Phoenix, AZ: Sigma Publishing Company.

Harry, M. J., & Schroeder, R. R. (2000). *Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations*: Currency.

Hart, C. (1998). *Doing a literature review: Releasing the social science research imagination*. London: Sage.

Harwood, T. G., & Garry, T. (2003). An overview of content analysis. *The Marketing Review, 3*(4), 479-498.

Hatch, N. W., & Dyer, J. H. (2004). Human capital and learning as a source of sustainable competitive advantage. *Strategic Management Journal, 25*(12), 1155-1178.

Hatten, K. J., & Hatten, M. L. (1987). Strategic groups, asymmetrical mobility barriers and contestability. *Strategic Management Journal, 8*(4), 329-342.

Hayes, J., & Allinson, C. W. (1988). Cultural differences in the learning styles of managers. *Management International Review*, 75-80.

He, Z., Deng, Y., Zhang, M., Zu, X., & Antony, J. (2015). An empirical investigation of the relationship between Six Sigma practices and organisational innovation. *Total Quality Management & Business Excellence*, 1-22.

Helfat, C. E., & Lieberman, M. B. (2002). The birth of capabilities: market entry and the importance of pre-history. *Industrial and Corporate Change, 11*(4), 725-760.

Helm, S., Eggert, A., & Garnefeld, I. (2010). Modeling the impact of corporate reputation on customer satisfaction and loyalty using partial least squares. *Handbook of Partial Least Squares*, 515-534.

Henderson, K. M., & Evans, J. R. (2000). Successful implementation of six sigma: benchmarking General Electric Company. *Benchmarking: An International Journal, 7*(4), 260-282.

Henderson, R., & Cockburn, I. (1994). Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal, 15*(S1), 63-84.

Hendricks, C. A., & Kelbaugh, R. L. (1998). Implementing six sigma at GE. *The Journal for Quality and Participation, 21*(4), 48-53.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115-135.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In R. Sinkovics & P. Ghauri (Eds.), *New challenges to international marketing* (pp. 277-319). Bingley, U.K.: Emerald/Jai Press.

Herbig, P. A. (1995). *Innovation Japanese style: A cultural and historical perspective*. Westport: Quorum Book.

Hidalgo, A., & Albors, J. (2008). Innovation management techniques and tools: a review from theory and practice. *R&D Management, 38*(2), 113-127.

Hill, C. W. (1988). Differentiation versus low cost or differentiation and low cost: a contingency framework. *Academy of Management Review, 13*(3), 401-412.

Hilton, R. J., & Sohal, A. (2012). A conceptual model for the successful deployment of Lean Six Sigma. *International Journal of Quality & Reliability Management, 29*(1), 54-70.

Hindo, B. (2007). At 3M, a struggle between efficiency and creativity. *Business Week, 11*(11), 8-14.

Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: a review of contemporary lean thinking. *International Journal of Operations & Production Management, 24*(10), 994-1011.

Hines, P., & Lethbridge, S. (2008). New development: Creating a lean university. *Public Money and Management, 28*(1), 53-56.

Hino, S. (2006). *Inside the mind of Toyota: Management principles for enduring growth.* New York, NY: Productivity Press.

Hinton, P. R., McMurray, I., & Brownlow, C. (2004). *SPSS Explained*. New York, NY: Taylor & Francis.

Hoang, D. T., Igel, B., & Laosirihongthong, T. (2006). The impact of total quality management on innovation. *The International Journal of Quality & Reliability Management, 23*(9), 1092-1117.

Hobbs, D. P. (2003). *Lean Manufacturing Implementation: A Complete Execution Manual for Any Size Manufacturer*: Boca Raton, FL: J. Ross Publishing.

Hock, C., Ringle, C. M., & Sarstedt, M. (2010). Management of multi-purpose stadiums: Importance and performance measurement of service interfaces. *International Journal of Services Technology and Management, 14*(2-3), 188-207.

Hoerl, R. W. (1998). Six Sigma and the future of the quality profession. *IEEE Engineering Management Review, 26*, 87-94.

Hoerl, R. W., & Gardner, M. M. (2010). Lean Six Sigma, creativity, and innovation. *International Journal of Lean Six Sigma, 1*(1), 30-38.

Hoerl, R. W., Montgomery, D. C., Lawson, C., & Molnau, W. E. (2001). Six Sigma black belts: What do they need to know?/Discussion/Response. *Journal of Quality Technology, 33*(4), 391-406.

Holbeche, L., & Mayo, A. (2009). *Motivating People in Lean Organizations*. United Kingdom: Taylor & Francis.

Holbrook, D., Cohen, W. M., Hounshell, D. A., & Klepper, S. (2000). The nature, sources, and consequences of firm differences in the early history of the semiconductor industry. *Strategic Management Journal, 21*(10-11), 1017-1041.

Holmqvist, M. (2004). Experiential learning processes of exploitation and exploration within and between organizations: An empirical study of product development. *Organization Science, 15*(1), 70-81.

Hook, C. (2016). Deploying lean Six Sigma in logistical battles. *Industrial Engineer: IE, 48*(3), 33-37.

Horng, T.-C. (2006). *A comparative analysis of supply chain management practices by Boeing and Airbus: long-term strategic implications* (Doctoral Dissertation, Massachusetts Institute of Technology). Retrieved from https://dspace.mit.edu/handle/1721.1/38579.

Hotho, J. J., Becker-Ritterspach, F., & Saka-Helmhout, A. (2012). Enriching absorptive capacity through social interaction. *British Journal of Management, 23*(3), 383-401.

Howell, M. T. (2006). *Actionable performance measurement: a key to success*. North America: ASQ Quality Press.

Huber, F., Herrmann, A., Meyer, F., Vogel, J., & Vollhardt, K. (2008). *Causal modeling with partial least squares: an application-oriented introduction*. Berlin, Germany: Springer-Verlag.

Huber, G. P. (1991). Organizational learning: The contributing processes and the literatures. *Organization Science, 2*(1), 88-115.

Huber, G. P. (1996). Organizational learning: a guide for executives in technology–critical organizations. *International Journal of Technology Management, 11*(7-8), 821-832.

Hurley, R. F., & Hult, G. T. M. (1998). Innovation, market orientation, and organizational learning: an integration and empirical examination. *The Journal of marketing*, 42-54.

Hutchins, D. (1999). *Just in time*. Hampshire, England: Gower Publishing Limited.

Hwang, G. H., Lee, K. C., & Seo, Y. W. (2017). How does Six Sigma influence creativity and corporate performance through exploration and exploitation? *Total Quality Management & Business Excellence*, 1-17.

Ibrahim, H. W., Zailani, S., & Tan, K. C. (2015). A content analysis of global supply chain research. *Benchmarking: An International Journal, 22*(7), 1429-1462.

Ichrakie, F. (2013). Intangible Resources as Key Determinants of Job Network Providers' Success: A Resource-based Study. *Australian Journal of Business and Management Research, 2*(11), 43.

Imai, M. (1986). *Kaizen: The key to Japan's competitive success*. New York, NY: McGraw-Hill Education.

Imai, M. (1997). *Gemba Kaizen: A Commonsense, Low-Cost Approach to Management.* New York, NY: McGraw Hill.

Irani, S. A. (2001). *Value stream mapping in custom manufacturing and assembly facilities*. Department of Industrial, Welding and Systems Engineering, The Ohio State University, Columbus, Ohio.

ISO. (2011). *ISO 13053-1: Quantitative Methods in Process Improvement – Six Sigma – Part 1: DMAIC Methodology*. Geneva: International Standards Organization.

Itami, H., & Roehl, T. W. (1991). *Mobilizing invisible assets*: Cambridge, MA: Harvard University Press.

Iwai, K. (1984). Schumpeterian dynamics: An evolutionary model of innovation and imitation. *Journal of Economic Behavior & Organization, 5*(2), 159-190.

Jain, S. K., & Ahuja, I. S. (2012). ISO 9000 Quality Management System: literature review and directions. *International Journal of Technology, Policy and Management, 12*(4), 312-343.

James, L. R., Mulaik, S. A., & Brett, J. M. (2006). A tale of two methods. *Organizational Research Methods, 9*(2), 233-244.

Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W. (2005). Managing potential and realized absorptive capacity: how do organizational antecedents matter? *Academy of Management Journal, 48*(6), 999-1015.

Jarvis, C. B., MacKenzie, S. B., & Podsakoff, P. M. (2003). A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of Consumer Research, 30*(2), 199-218.

Jassawalla, A. R., & Sashittal, H. C. (2002). Cultures that support product-innovation processes. *The Academy of Management Executive, 16*(3), 42-54.

Javier Lloréns-Montes, F., & Molina, L. M. (2006). Six Sigma and management theory: processes, content and effectiveness. *Total Quality Management and Business Excellence, 17*(04), 485-506.

Jayaraman, K., Leam Kee, T., & Lin Soh, K. (2012). The perceptions and perspectives of Lean Six Sigma (LSS) practitioners: An empirical study in Malaysia. *The TQM Journal, 24*(5), 433-446.

Jeffrey, L., & David, M. (2005). *The Toyota way fieldbook*. New York: McGraw-Hill.

Jensen, P., & Webster, E. (2009). Knowledge management: does capture impede creation? *Industrial and Corporate Change, 18*(4), 701-727.

Jeyaraman, K., & Kee Teo, L. (2010). A conceptual framework for critical success factors of lean Six Sigma: Implementation on the performance of electronic manufacturing service industry. *International Journal of Lean Six Sigma, 1*(3), 191-215.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly, 24*(4), 602-611.

Jirasukprasert, P., Arturo Garza-Reyes, J., Kumar, V., & K. Lim, M. (2014). A Six Sigma and DMAIC application for the reduction of defects in a rubber gloves manufacturing process. *International Journal of Lean Six Sigma, 5*(1), 2-21.

Johnson, A., & Swisher, B. (2003). Managers at Work: How Six Sigma Improves R&D. *Research-Technology Management, 46*(2), 12-15.

Johnstone, C., Pairaudeau, G., & Pettersson, J. A. (2011). Creativity, innovation and lean sigma: a controversial combination? *Drug Discovery Today, 16*(1), 50-57.

Jugulum, R., & Samuel, P. (2010). *Design for lean six sigma: A holistic approach to design and innovation*. Hoboken, N.J.: John Wiley & Sons.

Juran, J., & Gyrna, F. (1993). *Quality Planning and Analysis*. Singapore: MacGraw Hill Book Company.

Juran, J. M. (1988). *Juran on planning for quality*: New York, NY: Free Press.

Juran, J. M., & Godfrey, A. B. (1999). *Juran's quality handbook*. USA: McGraw-Hill Professional.

Juran, J. M., & Riley, J. F. (1999). *The quality improvement process*. New York, NY: McGraw Hill.

Kanigolla, D., A. Cudney, E., M. Corns, S., & Samaranayake, V. (2014). Enhancing engineering education using project-based learning for Lean and Six Sigma. *International Journal of Lean Six Sigma, 5*(1), 45-61.

Kanter, R. M. (1983). *The change masters: innovation for productivity in the American corporations*. New York, NY: Simon and Schuster.

Karthi, S., Devadasan, S., & Murugesh, R. (2011). Lean Six Sigma through ISO 9001 standard-based quality management system: an investigation for research. *International Journal of Productivity and Quality Management, 8*(2), 180-204.

Karthi, S., Devadasan, S., Murugesh, R., Sreenivasa, C., & Sivaram, N. (2012). Global views on integrating Six Sigma and ISO 9001 certification. *Total Quality Management & Business Excellence, 23*(3-4), 237-262.

Kazanjian, R. K., Drazin, R., & Glynn, M. A. (2002). Implementing strategies for corporate entrepreneurship: A knowledge-based perspective. *Strategic Entrepreneurship: Creating a New Mindset*, 173-199.

Keitany, P., & Riwo-Abudho, M. (2014). Effects of lean production on organizational performance: a case study of flour producing company in Kenya. *European Journal of Logistics Purchasing and Supply Chain Management, 2*(2), 1-14.

Kerlinger, F. N. (1986). *Foundations of Behavioral Research*. Orlando: Holt, Rinehart and Winston Inc.

Kerr, S., & Ulrich, D. (1995). Creating the boundaryless organization: The radical reconstruction of organization capabilities. *Planning Review, 23*(5), 41-45.

Khalili, A., Ismail, M. Y., & Karim, A. (2015). Integration of lean manufacturing and quality management system through structural equation modeling. *International Journal of Productivity and Quality Management, 20*(4), 534-556.

Khoo, N. (2004). *How Six Sigma can effectively integrated into the Government agencies?* Paper presented at the The Asia Business Forum, Kuala Lumpur, Malaysia.

Kilpatrick, J. (2003). Lean principles. *Utah Manufacturing Extension Partnership*, *68*, 1-5.

Kim, D.-Y., Kumar, V., & Kumar, U. (2012). Relationship between quality management practices and innovation. *Journal of Operations Management, 30*(4), 295-315.

Kim, D. H. (1993). *A framework and methodology for linking individual and organizational learning: Applications in TQM and product development.* (Unpublished doctoral dissertation). Massachusetts Institute of Technology, Department of Civil and Environmental Engineering. Retrieved from https://dspace.mit.edu/bitstream/handle/1721.1/12657/28591423-MIT.pdf?sequence=2.

Kim, J., & Gershwin, S. B. (2005). Integrated quality and quantity modeling of a production line. *OR Spectrum, 27*(2-3), 287-314.

Kim, L. (1995). Absorptive capacity and industrial growth: A conceptual framework and Korea's experience. In B. Koo & D. Perkins (Eds.), *Social capability and long-term economic growth* (pp. 266-287). London: St. Martin's Press.

Kim, L. (1998). Crisis construction and organizational learning: Capability building in catching-up at Hyundai Motor. *Organization Science, 9*(4), 506-521.

King, A. A., & Lenox, M. J. (2001a). Lean and green? An empirical examination of the relationship between lean production and environmental performance. *Production and Operations Management, 10*(3), 244-256.

King, A. A., & Lenox, M. J. (2001b). *Who adopts management standards early? An examination of iso 14001 certifications.* Paper presented at the Academy of Management Meetings, Washington DC, USA.

Kline, R. B. (2011). *Principles and Practice of Structural Equation Modeling* (3rd ed.). New York, NY: Guilford Publications.

Kline, S. J., & Rosenberg, N. (1986). An overview of innovation. In Landau, R. & Rosenberg, N. (Eds.), *The positive sum strategy: harnessing technology for economic growth* (pp. 275-306). Washington DC: National Academic Press.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383-397.

Kogut, B., & Zander, U. (1996). What firms do? Coordination, identity, and learning. *Organization Science, 7*(5), 502-518.

Kolb, D. A. (1993). The process of experiential learning. In Thorpe, M. E. & Hanson, A. (Eds.), *Culture and processes of adult learning* (pp. 138-156). New York: Routledge.

Kostopoulos, K. C., Spanos, Y. E., & Prastacos, G. P. (2002). *The resource-based view of the firm and innovation: identification of critical linkages.* Paper presented at the The 2nd European Academy of Management Conference.

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*. India: New Age International.

Kristensen, K., Martensen, A., & Gronholdt, L. (2000). Customer satisfaction measurement at post Denmark: results of application of the European customer satisfaction index methodology. *Total Quality Management, 11*(7), 1007-1015.

Kumar, M., Antony, J., Madu, C. N., Montgomery, D. C., & Park, S. H. (2008). Common myths of Six Sigma demystified. *International Journal of Quality & Reliability Management, 25*(8), 878-895.

Kumar, M., Antony, J., Singh, R., Tiwari, M., & Perry, D. (2006). Implementing the Lean Sigma framework in an Indian SME: a case study. *Production Planning and Control, 17*(4), 407-423.

Kusunoki, K., Nonaka, I., & Nagata, A. (1998). Organizational capabilities in product development of Japanese firms: a conceptual framework and empirical findings. *Organization Science, 9*(6), 699-718.

Kwak, Y. H., & Anbari, F. T. (2004). Benefits, obstacles, and future of six sigma approach. *Technovation, 20*, 1-8.

Lamming, R. (1996). Squaring lean supply with supply chain management. *International Journal of Operations & Production Management, 16*(2), 183-196.

Lande, M., Shrivastava, R., & Seth, D. (2016). Critical success factors for Lean Six Sigma in SMEs (small and medium enterprises). *The TQM Journal, 28*(4), 613-635.

Landesberg, P. (1999). In the beginning, there were Deming and Juran. *The Journal for Quality and Participation, 22*(6), 59-61.

Lane, P. J., Koka, B. R., & Pathak, S. (2006). The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy of Management Review, 31*(4), 833-863.

Lane, P. J., & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal, 19*(5), 461-477.

Langley, P., & Trivedi, N. (2013). Elaborations on a theory of human problem solving. *Advances in Cognitive Systems, 3*, 1-12.

Lapré, M. A., Mukherjee, A. S., & Van Wassenhove, L. N. (2000). Behind the learning curve: Linking learning activities to waste reduction. *Management Science, 46*(5), 597-611.

Larteb, Y., Haddout, A., Benhadou, M., Manufacturing, L., Yang, C., Yeh, T., et al. (2015). Successful lean implementation: the systematic and simultaneous consideration of soft and hard lean practices. *International Journal of Engineering Research and General Science, 3*(2), 1258-1270.

Laureani, A., & Antony, J. (2018). Leadership–a critical success factor for the effective implementation of Lean Six Sigma. *Total Quality Management & Business Excellence, 29*(5-6), 502-523.

Laureani, A., & Antony, J. (2017). Leadership characteristics for lean six sigma. *Total Quality Management & Business Excellence, 28*(3-4), 405-426.

Laureani, A., & Antony, J. (2011). Standards for lean six sigma certification. *International Journal of Productivity and Performance Management, 61*(1), 110-120.

Laureani, A., & Antony, J. (2012). Critical success factors for the effective implementation of Lean Sigma: Results from an empirical study and agenda for future research. *International Journal of Lean Six Sigma, 3*(4), 274-283.

Laureani, A., Antony, J., & Douglas, A. (2010). Lean six sigma in a call centre: a case study. *International Journal of Productivity and Performance Management, 59*(8), 757-768.

Lavie, D. (2006). The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of Management Review, 31*(3), 638-658.

Lawler, E. E. (2008). *From The Ground Up: Six Principles for Building the New Logic Corporation.* San Francisco, CA:John Wiley & Sons.

Lawson, B., Petersen, K. J., Cousins, P. D., & Handfield, R. B. (2009). Knowledge sharing in interorganizational product development teams: The effect of formal and informal socialization mechanisms. *Journal of Product Innovation Management, 26*(2), 156-172.

Lazaric, N., Longhi, C., & Thomas, C. (2008). Gatekeepers of knowledge versus platforms of knowledge: from potential to realized absorptive capacity. *Regional Studies, 42*(6), 837-852.

Leal-Rodríguez, A. L., Roldán, J. L., Ariza-Montes, J. A., & Leal-Millán, A. (2014). From potential absorptive capacity to innovation outcomes in project teams: The conditional mediating role of the realized absorptive capacity in a relational learning context. *International Journal of Project Management, 32*(6), 894-907.

Learned, E. P. (1969). *Business policy: text and cases*. Homewood, Ill: RD Irwin.

Lee, C., Lee, K., & Pennings, J. M. (2001). Internal capabilities, external networks, and performance: a study on technology-based ventures. *Strategic Management Journal, 22*(6-7), 615-640.

Lee, K.-C., & Choi, B. (2006). Six Sigma management activities and their influence on corporate competitiveness. *Total Quality Management & Business Excellence, 17*(7), 893-911.

Lee, K. (2002). *Success factors of Six Sigma implementation and the impact on operations performance*. (Unpublished doctoral dissertation). Cleveland State University, Cleveland, OH.

Lee, M., & Cunningham, L. F. (2001). A cost/benefit approach to understanding service loyalty. *Journal of Services Marketing, 15*(2), 113-130.

Lee, M., & Na, D. (1994). Determinants of technical success in product development when innovative radicalness is considered. *Journal of Product Innovation Management, 11*(1), 62-68.

Lee, M. B. (1992). 40 Years, 20 Million Ideas: The Toyota Suggestion System. *Industrial and Labor Relations Review, 45*(3), 620-622.

Lee, M. S. (2010). An empirical study about the effect of Six Sigma CSFs on quality and cost. *International Journal of Economics and Business Research, 2*(6), 568-580.

Lei, D., Hitt, M. A., & Bettis, R. (1996). Dynamic core competences through meta-learning and strategic context. *Journal of Management, 22*(4), 549-569.

LeMahieu, P. G., Nordstrum, L. E., & Cudney, E. A. (2017). Six Sigma in education. *Quality Assurance in Education, 25*(1), 91-108.

Lenox, M., & King, A. (2004). Prospects for developing absorptive capacity through internal information provision. *Strategic Management Journal, 25*(4), 331-345.

Leonard-Barton, D. (1995). *Wellsprings of knowledge: Building and sustaining the sources of innovation*. Boston: Harvard Business School Press.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal, 13*(S1), 111-125.

Lertwattanapongchai, S., & Swierczek, F. W. (2014). Assessing the change process of Lean Six Sigma: a case analysis. *International Journal of Lean Six Sigma, 5*(4), 423-443.

Levin, D. Z. (2000). Organizational learning and the transfer of knowledge: An investigation of quality improvement. *Organization Science, 11*(6), 630-647.

Levinthal, D., & March, J. G. (1981). A model of adaptive organizational search. *Journal of Economic Behavior & Organization, 2*(4), 307-333.

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal, 14*(S2), 95-112.

Lewis, B. R., Templeton, G. F., & Byrd, T. A. (2005). A methodology for construct development in MIS research. *European Journal of Information Systems, 14*(4), 388-400.

Lewis, M. A. (2000). Lean production and sustainable competitive advantage. *International Journal of Operations & Production Management, 20*(8), 959-978.

Li, S., Rao, S. S., Ragu-Nathan, T., & Ragu-Nathan, B. (2005). Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management, 23*(6), 618-641.

Li, T., & Cavusgil, S. T. (1995). A classification and assessment of research streams in international marketing. *International Business Review, 4*(3), 251-277.

Liao, S.-H., Fei, W.-C., & Chen, C.-C. (2007). Knowledge sharing, absorptive capacity, and innovation capability: an empirical study of Taiwan's knowledge-intensive industries. *Journal of Information Science, 33*(3), 340-359.

Lichtenthaler, U. (2009). Absorptive capacity, environmental turbulence, and the complementarity of organizational learning processes. *Academy of Management Journal, 52*(4), 822-846.

Lieberman, M. B. (1987). The learning curve, diffusion, and competitive strategy. *Strategic Management Journal, 8*(5), 441-452.

Lieberman, M. B., & Montgomery, D. B. (1988). First-mover advantages. *Strategic Management Journal, 9*(S1), 41-58.

Liehr, P., & Smith, M. J. (1999). Middle range theory: Spinning research and practice to create knowledge for the new millennium. *Advances in Nursing Science, 21*(4), 81-91.

Liker, J. (2004). *The Toyota Way: 14 management principles from the world's greatest manufacturer*. New York, NY: McGraw-Hill Professional.

Liker, J., & Convis, G. L. (2011). *The Toyota way to lean leadership: Achieving and sustaining excellence through leadership development*. New York, NY: McGraw-Hill.

Liker, J., & Rother, M. (2011). *Why lean programs fail*. Lean Enterprise Institute, 1-5. Retrieved from http://www.essence-leadership.com/wp-content/uploads/2015/08/Why_Lean_Programs_Fail.pdf.

Liker, J. K. (1997). *Becoming Lean: Inside Stories of U.S. Manufacturers*. Portland, Or.: Productivity Press.

Liker, J. K., & Morgan, J. M. (2006). The Toyota way in services: the case of lean product development. *The Academy of Management Perspectives, 20*(2), 5-20.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, *22*(140), 5-55.

Lim, K. & Falk, M. R. (2013). Absorptive Capacity. In Augier, M. & Teece, D. J. (Eds.), *The Palgrave Encyclopedia of Strategic Management.* Palgrave Macmillan Publishers Ltd, (forthcoming). Retrieved from https://pdfs.semanticscholar.org/b5c1/4846d54fe0176ed91abb9edcb94592e14a9a.pdf.

Limaj, E., & Bernroider, E. W. (2017). The roles of absorptive capacity and cultural balance for exploratory and exploitative innovation in SMEs. *Journal of Business Research,* (in press). Retrieved from https://reader.elsevier.com/reader/sd/3E849179CEA475B04D5FC003579533258CDFD0374DFFA044BD8460EEB10F6C2F3EC9789BF8BA51D20FAE4F4B39E98D79.

Linderman, K., Schroeder, R. G., & Choo, A. S. (2006). Six Sigma: The role of goals in improvement teams. *Journal of Operations Management, 24*(6), 779-790.

Linderman, K., Schroeder, R. G., & Sanders, J. (2010). A knowledge framework underlying process management. *Decision Sciences, 41*(4), 689-719.

Linderman, K., Schroeder, R. G., Zaheer, S., & Choo, A. S. (2003). Six Sigma: a goal-theoretic perspective. *Journal of Operations Management, 21*(2), 193-203.

Linderman, K., Schroeder, R. G., Zaheer, S., Liedtke, C., & Choo, A. S. (2004). Integrating quality management practices with knowledge creation processes. *Journal of Operations Management, 22*(6), 589-607.

Lindlöf, L., Söderberg, B., & Persson, M. (2013). Practices supporting knowledge transfer–an analysis of lean product development. *International Journal of Computer Integrated Manufacturing, 26*(12), 1128-1135.

Lindner, J. R., Murphy, T. H., & Briers, G. E. (2001). Handling nonresponse in social science research. *Journal of Agricultural Education, 42*(4), 43-53.

Lippman, S. A., & Rumelt, R. P. (1982). Uncertain imitability: An analysis of interfirm differences in efficiency under competition. *The Bell Journal of Economics*, 418-438.

Lis, A., & Sudolska, A. (2015). Absorptive capacity and its role for the company growth and competitive advantage: the case of Frauenthal Automotive Toruń company. *Journal of Entrepreneurship, Management and Innovation, 11*(4), 63-91.

Livingstone, L. P., Palich, L. E., & Carini, G. R. (1998). Viewing strategic innovation through the logic of contradiction. *Competitiveness Review: An International Business Journal, 8*(1), 46-54.

Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting & task performance*. Englewood Cliffs, N.J.: Prentice Hall.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist, 57*(9), 705-717.

Locke, E. A., Shaw, K. N., Saari, L. M., & Latham, G. P. (1981). Goal setting and task performance: 1969–1980. *Psychological Bulletin, 90*(1), 125-152.

Lohmöller, J.-B. (1989). Predictive vs. Structural Modeling: PLS vs. ML. In Lohmöller, J.-B. (Ed.), *Latent Variable Path Modeling with Partial Least Squares* (pp. 199-226): Berlin: Springer.

Losonci, D., & Demeter, K. (2013). Lean production and business performance: international empirical results. *Competitiveness Review: An International Business Journal, 23*(3), 218-233.

Lowe, H. (1995). *Management of Technology: Perception and opportunities*. London: Chapman & Hall.

Lubatkin, M. H., Simsek, Z., Ling, Y., & Veiga, J. F. (2006). Ambidexterity and performance in small-to medium-sized firms: The pivotal role of top management team behavioral integration. *Journal of Management, 32*(5), 646-672.

Lubit, R. (2001). The keys to sustainable competitive advantage. *Organizational Dynamics, 29*(3), 164-178.

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1*(2), 130-149.

MacDuffie, J. P. (1995). Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry. *ILR Review, 48*(2), 197-221.

MacDuffie, J. P. (1997). The road to "root cause": Shop-floor problem-solving at three auto assembly plants. *Management Science, 43*(4), 479-502.

MacDuffie, J. P., & Helper, S. (1997). Creating lean suppliers: diffusing lean production through the supply chain. *California Management Review, 39*(4), 118-151.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7*(1), 83-104.

Mader, D. P. (2003). DFSS and your current design process. *Quality Progress, 36*(7), 88-89.

Mader, D. P. (2009). Lean Six Sigma's evolution: Integrated method uses different deployment models. *Quality Control and Applied Statistics, 54*(1), 43-44.

Maguire, M. (1999). Six sigma saga. *Quality Progress, 32*(10), 6.

Mahalanobis, P. (1948). Walter A. Shewhart and statistical quality control in India. *Sankhyā: The Indian Journal of Statistics*, 51-60.

Mahoney, J. T., & Pandian, J. R. (1992). The resource-based view within the conversation of strategic management. *Strategic Management Journal, 13*(5), 363-380.

Main, J. (1994). *Quality Wars: The Triumphs and Defeats of American Business*: New York, NY: Simon and Schuster.

Malaysia Productivity Corporation (MPC). (2016). *Business Excellence Programme*. Retrieved from http://www.mpc.gov.my/business-excellence/

Malaysia Productivity Corporation (MPC). (2017a). *24th Productivity Report 2016/2017*. Retrieved from http://www.mpc.gov.my/wp-content/uploads/2017/05/Productivity-Report-2017.pdf

Malaysia Productivity Corporation (MPC). (2017b). *Malaysia In The IMD World Competitiveness Yearbook*. Retrieved from http://www.mpc.gov.my/wp-content/uploads/2017/06/WCY-2017-bi.pdf

Malaysian External Trade Development Corporation (MATRADE). (2013). *Malaysian innovations*. Retrieved 18 September 2016 from http://techmonitor.net/tm/images/f/fd/13oct_dec_managing_innovation.pdf

Maleyeff, J. (2007). *Improving service delivery in government with Lean Six Sigma*. Washington DC: IBM Center for the Business of Government.

Maleyeff, J., Arnheiter, E. A., & Venkateswaran, V. (2012). The continuing evolution of lean six sigma. *The TQM Journal, 24*(6), 542-555.

Malhotra, M. K., & Grover, V. (1998). An assessment of survey research in POM: from constructs to theory. *Journal of Operations Management, 16*(4), 407-425.

Malhotra, M. K., Singhal, C., Shang, G., & Ployhart, R. E. (2014). A critical evaluation of alternative methods and paradigms for conducting mediation analysis in operations management research. *Journal of Operations Management, 32*(4), 127-137.

Mamat, R. C., & Rahman, M. (2015). Soft lean practices for successful lean production system implementation in malaysia automotive smes: A proposed framework. *Science and Engineering, 77*(27), 141-150.

Manev, I. M., & Stevenson, W. B. (2001). Balancing ties: Boundary spanning and influence in the organization's extended network of communication. *The Journal of Business Communication (1973), 38*(2), 183-205.

Mann, D. (2014). *Creating a lean culture: tools to sustain lean conversions* (3rd ed.). Boca Raton, FL: CRC Press.

Manville, G., Greatbanks, R., Krishnasamy, R., & Parker, D. W. (2012). Critical success factors for Lean Six Sigma programmes: a view from middle management. *International Journal of Quality & Reliability Management, 29*(1), 7-20.

Marash, S. A. (2000). *Six sigma: business results through innovation.* Paper presented at the Annual Quality Congress Proceedings, Milwaukee, Wisconsin. Retrieved from https://search.proquest.com/openview/28f5e501667ad2fab248b276c9337c39/1?pq-origsite=gscholar&cbl=39817

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71-87.

March, J. G., & Simon, H. A. (1958). *Organizations*. Oxford, England: Wiley.

Marques, P., Requeijo, J., Saraiva, P., & Frazao-Guerreiro, F. (2013). Integrating Six Sigma with ISO 9001. *International Journal of Lean Six Sigma, 4*(1), 36-59.

Marsden, D. (1990). Using local knowledge. *Community Development Journal, 25*, 266-271.

Martensen, A. (1998). Leadership for product development: a business excellence approach. *Total Quality Management, 9*(4-5), 172-176.

Martilla, J. A., & James, J. C. (1977). Importance-performance analysis. *The Journal of Marketing*, 77-79.

Martínez-Costa, M., & Martínez-Lorente, A. R. (2008). Does quality management foster or hinder innovation? An empirical study of Spanish companies. *Total Quality Management, 19*(3), 209-221.

Martínez-Lorente, A. R., Dewhurst, F., & Dale, B. G. (1998). Total quality management: origins and evolution of the term. *The TQM Magazine, 10*(5), 378-386.

Marton-Williams, J. (1986). Questionnaire design. In Worcester, R. M. & Downham, J. (Eds.), *Consumer Market Research Handbook.* London: McGraw-Hill.

Mat Roni, S. (2014). *Introduction to SPSS*. School of Business, Edith Cowan University, Australia. Retrieved from https://www.researchgate.net/publication/262151892_Introduction_to_SPSS.

Matusik, S. F., & Hill, C. W. (1998). The utilization of contingent work, knowledge creation, and competitive advantage. *Academy of Management Review, 23*(4), 680-697.

Matzler, K., Bailom, F., Hinterhuber, H. H., Renzl, B., & Pichler, J. (2004). The asymmetric relationship between attribute-level performance and overall customer satisfaction: a reconsideration of the importance–performance analysis. *Industrial Marketing Management, 33*(4), 271-277.

Mauléon, C., & Bergman, B. (2009). Exploring the epistemological origins of Shewhart's and Deming's theory of quality: Influences from CI Lewis' conceptualistic pragmatism. *International Journal of Quality and Service Sciences, 1*(2), 160-171.

McAdam, R., Antony, J., Kumar, M., & Hazlett, S. A. (2014). Absorbing new knowledge in small and medium-sized enterprises: A multiple case analysis of Six Sigma. *International Small Business Journal, 32*(1), 81-109.

McAdam, R., & Hazlett, S. A. (2010). An absorptive capacity interpretation of Six Sigma. *Journal of Manufacturing Technology Management, 21*(5), 624-645.

McAdam, R., & Lafferty, B. (2004). A multilevel case study critique of six sigma: statistical control or strategic change? *International Journal of Operations & Production Management, 24*(5), 530-549.

McFadden, K. L., Lee, J. Y., & Gowen III, C. (2015). Factors in the Path From Lean to Patient Safety: Six Sigma, Goal Specificity and Responsiveness Capability. *The Quality Management Journal, 22*(4), 37-53.

McGrath, R. G., & MacMillan, I. C. (2000). *The entrepreneurial mindset: Strategies for continuously creating opportunity in an age of uncertainty*. Cambridge, MA: Harvard Business School Press.

McKinlay, A. (2011). Longitudinal Research. In Goldstein, S. & J. A. Naglieri, J. A. (Eds.), *Encyclopedia of Child Behavior and Development* (pp. 900-901). Boston, MA: Springer.

Meichenbaum, D. (1977). Cognitive behaviour modification. *Cognitive Behaviour Therapy, 6*(4), 185-192.

Melnyk, S. A., Sroufe, R. P., & Calantone, R. (2003). Assessing the impact of environmental management systems on corporate and environmental performance. *Journal of Operations Management, 21*(3), 329-351.

Mertens, D. M. (2014). *Research and Evaluation in Education and Psychology: Integrating Diversity With Quantitative, Qualitative, and Mixed Methods*. Los Angeles: SAGE Publications.

Mi Dahlgaard-Park, S., Mi Dahlgaard-Park, S., & Dahlgaard, J. J. (2007). Excellence-25 years evolution. *Journal of Management History, 13*(4), 371-393.

Micklewright, M. (2014). *Build Lean Into Your QMS When Converting to ISO 9001:2015*. Retrieved from https://www.qualitydigest.com/inside/quality-insider-column/build-lean-your-qms-when-converting-iso-90012015.html.

Minbaeva, D., Pedersen, T., Björkman, I., Fey, C. F., & Park, H. J. (2003). MNC knowledge transfer, subsidiary absorptive capacity, and HRM. *Journal of International Business Studies, 34*(6), 586-599.

Mo Yang, H., Seok Choi, B., Jin Park, H., Soo Suh, M., & Chae, B. (2007). Supply chain management six sigma: a management innovation methodology at the Samsung Group. *Supply Chain Management: An International Journal, 12*(2), 88-95.

Moen, R., & Norman, C. (2006). *Evolution of the PDCA cycle*. Retrieved from http://www.uoc.cw/financesite/images/stories/NA01_Moen_Norman_fullpaper.pdf.

Molina, L. M., Lloréns-Montes, J., & Ruiz-Moreno, A. (2007). Relationship between quality management practices and knowledge transfer. *Journal of Operations Management, 25*(3), 682-701.

Monden, Y. (2011). *Toyota production system: an integrated approach to just-in-time* (4th ed.). London: CRC Press.

Montgomery, D. C. (2008). *Introduction to Statistical Quality Control.* New York, NY: John Wiley & Sons.

Montgomery, D. C. (2010). A modern framework for achieving enterprise excellence. *International Journal of Lean Six Sigma, 1*(1), 56-65.

Montgomery, D. C., & Woodall, W. H. (2008). An overview of six sigma. *International Statistical Review, 76*(3), 329-346.

Morgan, N. A., & Piercy, N. F. (1996). Competitive advantage, quality strategy and the role of marketing. *British Journal of Management, 7*(3), 231-245.

Mueller, W. F. (1962). The origins of the basic inventions underlying du pont's major product and process innovations, 1920 to 1950. In R. R. Nelson (Ed.), *The rate and direction of inventive activity: Economic and social factors* (pp. 323-358). Princeton: Princeton University Press.

Mukherjee, A. S., Lapré, M. A., & Van Wassenhove, L. N. (1998). Knowledge driven quality improvement. *Management Science, 44*(11-part-2), S35-S49.

Murugappan, M., & Keeni, G. (2000). *Quality improvement-the six sigma way.* Paper presented at the Proceedings of First Asia-Pacific Conference on Quality Software (APAQS), Hong Kong, China.

Mustapha, M. R., Abu Hasan, F., & Muda, M. S. (2018). Lean Six Sigma implementation: multiple case studies in a developing country. *International Journal of Lean Six Sigma* (Just accepted).

Mustapha, R., & Abdullah, A. (2004). Malaysia Transitions toward a Knowledge-Based Economy. *Journal of Technology Studies, 30*(3), 51-61.

Myerson, P. (2012). *Lean supply chain and logistics management*. New York, NY: McGraw-Hill.

Nahm, A. Y., Vonderembse, M. A., & Koufteros, X. A. (2003). The impact of organizational structure on time-based manufacturing and plant performance. *Journal of Operations Management, 21*(3), 281-306.

Narasimhan, R., Swink, M., & Kim, S. W. (2006). Disentangling leanness and agility: an empirical investigation. *Journal of Operations Management, 24*(5), 440-457.

Narver, J. C., & Slater, S. F. (1990). The effect of a market orientation on business profitability. *The Journal of Marketing*, 20-35.

Näslund, D. (2008). Lean, six sigma and lean sigma: fads or real process improvement methods? *Business Process Management Journal, 14*(3), 269-287.

Nelson, R., & Winter, S. (1982). *An evolutionary theory of economic change*. Cambridge, MA: Cambridge University Press.

Netland, T. H., & Powell, D. J. (2016). *The Routledge Companion to Lean Management*. Taylor & Francis.

Newell, A., & Simon, H. A. (1976). Computer science as empirical inquiry: Symbols and search. *Communications of the ACM, 19*(3), 113-126.

Ngo, T. (2010). *The relationship between Lean Six Sigma and organizational performance: An empirical investigation* (Unpublished doctoral dissertation). Lincoln University. Retrieved from https://researcharchive.lincoln.ac.nz/bitstream/handle/10182/3456/ngo_mcm.pdf?sequence=3

Nicoletti, B. (2015). Optimizing Innovation with the Lean and Digitize Innovation Process. *Technology Innovation Management Review, 5*(3), 29-38.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14-37.

Nonaka, I., & Takeuchi, H. (1995a). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Nonaka, I., & Takeuchi, H. (1995b). *The knowledge creation company: how Japanese companies create the dynamics of innovation*. New York, NY: Oxford University Press.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: a unified model of dynamic knowledge creation. *Long Range Planning, 33*(1), 5-34.

Nonthaleerak, P., & Hendry, L. (2008). Exploring the Six Sigma phenomenon using multiple case study evidence. *International Journal of Operations & Production Management, 28*(3), 279-303.

Nutt, P. C., & Backoff, R. W. (1997). Organizational transformation. *Journal of Management Inquiry, 6*(3), 235-254.

Nyström, H. (1990). Organizational innovation. In M. S. West & J. L. Farr (Eds.), *Innovation and creativity at work: Psychological and organizational strategies* (pp. 143-162). New York, NY: Wiley.

O'Leary-Kelly, A. M., Martocchio, J. J., & Frink, D. D. (1994). A Review of the Influence of Group Goals on Group Performance. *Academy of Management Journal*, 1285-1301.

O'Rourke, P. (2005). *A Multiple-case comparison of Lean six sigma deployment and implementation strategies.* Paper presented at the ASQ World Conference on Quality and Improvement Proceedings, Milwaukee, WI, USA.

O'Reilly, C. A., & Tushman, M. L. (2008). Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. *Research in Organizational Behavior, 28*, 185-206.

OECD. (2016). *OECD Reviews of Innovation Policy: Malaysia 2016*: OECD Reviews of Innovation Policy, OECD Publishing, Paris https://doi.org/10.1787/9789264255340-en

Ohno, T. (1988). *Toyota production system: beyond large-scale production*. New York, NY: Productivity Press.

Olivella, J., Cuatrecasas, L., & Gavilan, N. (2008). Work organisation practices for lean production. *Journal of Manufacturing Technology Management, 19*(7), 798-811.

Olsson, Å. (2012). *Programme on Innovation, Higher Education and Research for Development IHERD*. Retrieved from http://www.oecd.org/sti/Pan%20African%20University%20final.pdf

Pacheco, D., Pergher, I., Vaccaro, G. L. R., Jung, C. F., & ten Caten, C. (2015). 18 comparative aspects between Lean and Six Sigma: Complementarity and implications. *International Journal of Lean Six Sigma, 6*(2), 161-175.

Palady, P., & Olyai, N. (2002). The status quo's failure in problem solving. *Quality Progress, 35*(8), 34-39.

Pallant, J. (2010). *SPSS Survival Manual: A step by step guide to data analysis using SPSS* (3rd ed.). Crows Nest, NSW: Allen & Unwin.

Pamfilie, R., Petcu, A. J., & Draghici, M. (2012). The importance of leadership in driving a strategic Lean Six Sigma management. *Procedia-Social and Behavioral Sciences, 58*, 187-196.

Pande, P. S., & Holpp, L. (2002). *What is six sigma?.* New York, NY: McGraw-Hill.

Pande, P. S., Neuman, R. P., & Cavanagh, R. R. (2000). *The six sigma way*. New York, NY: McGraw-Hill.

Parast, M. M. (2011). The effect of Six Sigma projects on innovation and firm performance. *International Journal of Project Management, 29*(1), 45-55.

Parayitam, S., & Guru, K. (2010). Economics of resource based and dynamic capabilities view: A contemporary framework. *Academy of Strategic Management Journal, 9*(1), 83-94.

Pardo, A., & Román, M. (2013). Reflections on the Baron and Kenny model of statistical mediation. *Annals of Psychology, 29*(2), 614-623.

Park, S. H., Ntuen, C. A., & Park, E. H. (2009). A new paradigm of six sigma: knowledge-based digital six sigma. *Total Quality Management, 20*(9), 945-952.

Parker, M., & Slaughter, J. (1994). Lean production is mean production. *Canadian Dimension, 28*(1), 21-22.

Pavlovic, D., Todorovic, M., Mladenovic, S., & Milosavljevic, P. (2014). The role of quality methods in improving education process: Case study. *Serbian Journal of Management, 9*(2), 219-230.

Penrose, E. T. (1959). *The theory of the growth of the firm*. New York, NY: Sharpe.

Pentland, B. T., & Feldman, M. S. (2005). Organizational routines as a unit of analysis. *Industrial and Corporate Change, 14*(5), 793-815.

Pepper, M. P., & Spedding, T. A. (2010). The evolution of lean six sigma. *The International Journal of Quality and Reliability Management, 27*(2), 138-155.

Perez-Wilson, M. (1989). *Machine/Process Capability Study. A five stage methodology for optimizing manufacturing processes.* Scottsdale, AZ: Advanced Systems Consultants.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal, 14*(3), 179-191.

Petter, S., Straub, D., & Rai, A. (2007). Specifying formative constructs in information systems research. *MIS quarterly*, 623-656.

Phusavat, K., & Kanchana, R. (2008). Future competitiveness: viewpoints from manufacturers and service providers. *Industrial management & Data systems, 108*(2), 191-207.

Pinder, C. C. (1984). *Work motivation: Theory, issues, and applications*. Glenview, IL: Scott Foresman & Co.

Plsek, P. E. (2013). *Accelerating health care transformation with lean and innovation: The Virginia Mason experience*: Boca Raton, FL: CRC Press.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879-903.

Ponanake, P., Limnararat, S., Pithuncharurnlap, M., & Sangmanee, W. (2014). Path Analysis of the Core Competency of Thai Private Hospitals in the ASEAN Economic Community. *Research Journal of Business Management, 8*(3), 157-172.

Popaitoon, S., & Popaitoon, P. (2016). Motivation synergy, knowledge absorptive capacity and NPD project performance in multinational automobiles in Thailand. *The Journal of High Technology Management Research, 27*(2), 129-139.

Poppendieck, M., & Poppendieck, T. (2003). *Lean Software Development: An Agile Toolkit*. Upper Saddle River, NJ: Addison-Wesley.

Porter, M. E. (1981). The contributions of industrial organization to strategic management. *Academy of Management Review, 6*(4), 609-620.

Porter, M. E. (1985). *Competitive advantage: creating and sustaining superior performance*. New York, NY: Free press.

Powell, T. C. (1995). Total quality management as competitive advantage: a review and empirical study. *Strategic Management Journal, 16*(1), 15-37.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review, 68*(3), 79-91.

Prajogo, D. I., & Ahmed, P. K. (2006). Relationships between innovation stimulus, innovation capacity, and innovation performance. *R&D Management, 36*(5), 499-515.

Prajogo, D. I., & Sohal, A. S. (2003). The relationship between TQM practices, quality performance, and innovation performance: An empirical examination. *International Journal of Quality & Reliability Management, 20*(8), 901-918.

Prajogo, D. I., & Sohal, A. S. (2004). The multidimensionality of TQM practices in determining quality and innovation performance—an empirical examination. *Technovation, 24*(6), 443-453.

Prasanna, M., & Vinodh, S. (2013). Lean Six Sigma in SMEs: an exploration through literature review. *Journal of Engineering, Design and Technology, 11*(3), 224-250.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, 36*(4), 717-731.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879-891.

Punnakitikashem, P., Laosirihongthong, T., Adebanjo, D., & McLean, M. W. (2010). A study of quality management practices in TQM and non-TQM firms: Findings from the ASEAN automotive industry. *International Journal of Quality & Reliability Management, 27*(9), 1021-1035.

Pyzdek, T. (2003). *The Six Sigma handbook: The complete guide for greenbelts, blackbelts, and managers at all levels, revised and expanded edition*. New York, NY: McGraw-Hill.

Pyzdek, T., & Keller, P. A. (2014). *The six sigma handbook*. New York, NY: McGraw-Hill Education.

Raff, D. M. (2000). Superstores and the evolution of firm capabilities in American bookselling. *Strategic Management Journal*, 1043-1059.

Rahman, S., Laosirihongthong, T., & Sohal, A. S. (2010). Impact of lean strategy on operational performance: a study of Thai manufacturing companies. *Journal of Manufacturing Technology Management, 21*(7), 839-852.

Raisinghani, M. S., Ette, H., Pierce, R., Cannon, G., & Daripaly, P. (2005). Six Sigma: concepts, tools, and applications. *Industrial management & Data Systems, 105*(4), 491-505.

Ramayah, T. (2011). *Notes for data analysis workshop*. Retrieved from http://ramayah.com/wp-content/uploads/2011/04/Data-Analysis.pdf

Ramberg, J. S. (2000). Six sigma: Fad or fundamental. *Quality Digest, 6*(5), 30-31.

Rand, A. (1990). *Introduction to Objectivist Epistemology: Expanded Second Edition*. New York, NY: Penguin.

Rangus, K., & Slavec, A. (2017). The interplay of decentralization, employee involvement and absorptive capacity on firms' innovation and business performance. *Technological Forecasting and Social Change*, *120*, 195-203.

Ranjan, K. R., Sugathan, P., & Rossmann, A. (2015). A narrative review and meta-analysis of service interaction quality: new research directions and implications. *Journal of Services Marketing, 29*(1), 3-14.

Reed, R., Lemak, D. J., & Mero, N. P. (2000). Total quality management and sustainable competitive advantage. *Journal of Quality Management, 5*(1), 5-26.

Reigle, R. F. (2001). Measuring organic and mechanistic cultures. *Engineering Management Journal, 13*(4), 3-8.

Reinartz, W., Haenlein, M., & Henseler, J. (2009). An empirical comparison of the efficacy of covariance-based and variance-based SEM. *International Journal of Research in Marketing, 26*(4), 332-344.

Riikkinen, R., Kauppi, K., & Salmi, A. (2017). Learning Sustainability? Absorptive capacities as drivers of sustainability in MNCs' purchasing. *International Business Review, 26*(6), 1075-1087.

Rindova, V. P., & Fombrun, C. J. (1999). Constructing competitive advantage: The role of firm-constituent interactions. *Strategic Management Journal*, 691-710.

Ringle, C. M., & Sarstedt, M. (2016). Gain more insight from your PLS-SEM results: The importance-performance map analysis. *Industrial management & Data Systems, 116*(9), 1865-1886.

Ringle, C. M., Wende, S., & Becker, J.-M. (2015). *SmartPLS 3*. SmartPLS GmbH: Boenningstedt.

Robbins, S. P. (1997). *Essentials of organizational behavior*: Englewood Cliffs, NJ: Prentice Hall.

Robbins, S. P., & Judge, T. A. (2003). *Organizational Behavior*. Upper Saddle River, NJ: Pearson Education.

Robertson, P. L., Casali, G. L., & Jacobson, D. (2012). Managing open incremental process innovation: absorptive capacity and distributed learning. *Research Policy, 41*(5), 822-832.

Rogers, E. M. (2010). *Diffusion of innovations* (4th ed.). New York, NY: Simon and Schuster.

Rooke, J. A., Sapountzis, S., Koskela, L. J., Codinhoto, R., & Kagioglou, M. (2010). *Lean knowledge management: the problem of value.* Paper presented at the Proceedings of the 18th Annual Conference of the International Group for Lean Construction, Haifa, Israel.

Roscoe, J. T. (1975). *Fundamental Research Statistics for the Behavioral Sciences*. New York, NY: Holt, Rinehart and Winston.

Rothenberg, S., Pil, F. K., & Maxwell, J. (2001). Lean, green, and the quest for superior environmental performance. *Production and Operations Management, 10*(3), 228-243.

Rother, M., & Shook, J. (1999). *Learning to see: value stream mapping to add value and eliminate muda*. Brookline, MA: Lean Enterprise Institute Inc.

Rowley, T., Behrens, D., & Krackhardt, D. (2000). Redundant governance structures: An analysis of structural and relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal*, 369-386.

Rucker, D. D., Preacher, K. J., Tormala, Z. L., & Petty, R. E. (2011). Mediation analysis in social psychology: Current practices and new recommendations. *Social and Personality Psychology Compass, 5*(6), 359-371.

Rumelt, R. P. (1984). Towards a Strategic Theory of the Firm. Competitive strategic management. *Competitive Strategic Management*, 556-570.

Rumelt, R. P., & Lamb, R. (1984). Competitive strategic management. *Toward a Strategic Theory of the Firm*, 556-570.

Rummel, N., Mavrikis, M., Wiedmann, M., Loibl, K., Mazziotti, C., Holmes, W., et al. (2016). *Combining exploratory learning with structured practice to foster conceptual and procedural fractions knowledge*. Paper presented at the 12th International Conference of the Learning Sciences, Singapore.

Rymaszewska, A. (2013). When a set of tools is not enough-Lean placed strategically. *International Journal of Industrial Engineering and Management, 4*(4), 215-220.

Sachdev, S. B., & Verma, H. V. (2004). Relative importance of service quality dimensions: a multisectoral study. *Journal of Services Research, 4*(1), 93-116.

Salah, S., Rahim, A., & Carretero, J. A. (2010). The integration of Six Sigma and lean management. *International Journal of Lean Six Sigma, 1*(3), 249-274.

Saravanamuttu, J. (1988). The look east policy and Japanese economic penetration in Malaysia. In K. S. Jomo (Ed.), *Mahathir's Economic Policy* (pp. 4-28). Kuala Lumpur: INSAN.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students*. Harlow, England: Prentice Hall.

Saurin, T. A., Marodin, G. A., & Ribeiro, J. L. D. (2011). A framework for assessing the use of lean production practices in manufacturing cells. *International Journal of Production Research, 49*(11), 3211-3230.

Savolainen, T., & Haikonen, A. (2007). Dynamics of organizational learning and continuous improvement in six sigma implementation. *The TQM Magazine, 19*(1), 6-17.

Scally, G., & Donaldson, L. J. (1998). Clinical governance and the drive for quality improvement in the new NHS in England. *British Medical Journal, 317*(7150), 61-65.

Scaringella, L., Miles, R. E., & Truong, Y. (2017). Customers involvement and firm absorptive capacity in radical innovation: The case of technological spin-offs. *Technological Forecasting and Social Change, 120,* 144-162.

Schlegelmilch, B. B., Diamantopoulos, A., & Kreuz, P. (2003). Strategic innovation: the construct, its drivers and its strategic outcomes. *Journal of Strategic Marketing, 11*(2), 117-132.

Schroeder, D. & Robinson, A. (1991). America's Most Successful Export to Japan: Continuous Improvement Programmes. *Sloan Management Review, 32*(3), 67-81.

Schroeder, R. G., Linderman, K., Liedtke, C., & Choo, A. S. (2008). Six Sigma: Definition and underlying theory. *Journal of Operations Management, 26*(4), 536-554.

Schumpeter, J. (1942). Creative destruction. *Capitalism, Socialism and Democracy*, 82-85.

Schumpeter, J. A. (1976). *Capitalism, Socialism and Democracy*. London: Routledge.

Schutta, J. T. (2006). *Business performance through lean six sigma: linking the knowledge worker, the twelve pillars, and Baldrige*. Milwaukee, Wisconsin: ASQ Quality Press.

Scott, R. (1987). 1981 *Organizations: rational, natural and open systems*. Englewood Cliffs, NJ: Prentice-Hall.

Sehested, C., & Sonnenberg, H. (2010). *Lean innovation: a fast path from knowledge to value*. New York, NY: Springer Science & Business Media.

Seijts, G. H., & Latham, G. P. (2005). Learning versus performance goals: When should each be used? *The Academy of Management Executive, 19*(1), 124-131.

Sekaran, U., & Bougie, R. (2003). *Research method of business: A skill Building Approach*. New York, NY: John Willey & Sons Inc.

Sekaran, U., & Bougie, R. (2010). *Research Methods for Business: A Skill. Building Approach.* United Kingdom: John Wiley & Sons.

Sekaran, U., & Bougie, R. (2013). *Research Methods for Business: A Skill-Building Approach*. United Kingdom: John Wiley & Sons.

Senge, P. (1990). *The fifth discipline: The art and science of the learning organization*. New York: Currency Doubleday.

Senge, P. (1999). It's the learning: The real lesson of the quality movement. *The Journal for Quality and Participation, 22*(6), 34-40.

Shafer, S. M., & Moeller, S. B. (2012). The effects of Six Sigma on corporate performance: An empirical investigation. *Journal of Operations Management, 30*(7), 521-532.

Shah, P., & Shrivastava, R. (2013). Identification of performance measures of Lean Six Sigma in small-and medium-sized enterprises: a pilot study. *International Journal of Six Sigma and Competitive Advantage, 8*(1), 1-21.

Shah, R., Chandrasekaran, A., & Linderman, K. (2008). In pursuit of implementation patterns: the context of Lean and Six Sigma. *International Journal of Production Research, 46*(23), 6679-6699.

Shah, R., & Ward, P. T. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management, 21*(2), 129-149.

Shah, R., & Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management, 25*(4), 785-805.

Shamsi, M. A., & Alam, A. (2018). Exploring Lean Six Sigma implementation barriers in Information Technology industry. *International Journal of Lean Six Sigma, 9*(4), 523-542.

Sharma, S., & Vredenburg, H. (1998). Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. *Strategic Management Journal, 19*(8), 729-753.

Shekhawat, V. S. (2015). The Perplexing Enigma of Supply Chain Management: Literature Review. *Journal of Supply Chain Management Systems, 4*(4), 45-71.

Sheridan, J. H. (2000). Lean sigma synergy. *Industry Week, 249*(17), 81-82.

Shewhart, W. A., & Deming, W. E. (1986). *Statistical method from the viewpoint of quality control.* New York, NY: Courier Corporation.

Shing, C. K., Nadarajan, S., & Chandren, S. (2014). Scraps Management With Lean Six Sigma. *International Journal of Supply Chain Management, 3*(3), 121-127.

Shokri, A., & Nabhani, F. (2015). LSS, a problem solving skill for graduates and SMEs: Case Study of investigation in a UK Business School curriculum. *International Journal of Lean Six Sigma, 6*(2), 176-202.

Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods, 7*(4), 422-445.

Shuen, A. A. (1994). *Technology sourcing and learning strategies in the semiconductor industry.* (Unpublished doctoral dissertation). University of California, Berkeley.

Siemerink, M. (2014). The effects of lean management on organizational structure and the type of innovations influenced by this structure. (Unpublished doctoral dissertation). University of Twente, Netherlands. Retrieved from http://essay.utwente.nl/65325/1/Bachelor_Thesis_M%20G%20J%20Siemerink%20.pdf

Siew, M. L., & Chin, T. T. (1991). Assessing National Competitive Superiority:An Importance-Performance Matrix Approach. *Asia Pacific International Journal of Marketing, 3*(2), 26-37.

Sime Darby Berhad. (2015). *Sime Darby Annual Report 2015: Connecting Opportunities*. Retrieved from http://www.simedarby.com/sites/default/files/annualreport-pdf/sime_darby_annual_report_2015.pdf

Sin, A. B., Zailani, S., Iranmanesh, M., & Ramayah, T. (2015). Structural equation modelling on knowledge creation in Six Sigma DMAIC project and its impact on organizational performance. *International Journal of Production Economics, 168*, 105-117.

Singh, B., Garg, S., & Sharma, S. (2009). Lean can be a survival strategy during recessionary times. *International Journal of Productivity and Performance Management, 58*(8), 803-808.

Sinha, K. K., & Van de Ven, A. H. (2005). Designing work within and between organizations. *Organization Science, 16*(4), 389-408.

Sitorus, P. M. T. (2011). *Quality planning improvement with lean six sigma approach and economic valuation with willingness to pay: Case in PT Telekomunikasi Indonesia.* Paper presented at the Business Innovation and Technology Management (APBITM), 2011 IEEE International Summer Conference of Asia Pacific.

Sjoblom, L., & Michels-Kim, N. (2011). James Singh: leading Nestle's house of finance: Nestle global executive vice president and CFO Jim Singh, CMA (Canada), talks about the evolution of corporate finance from bean counter to business partner. His tip to budding financial managers? Get a professional certification early in your career. *Strategic Finance, 93*(3), 29-34.

Skogmalm, M. (2015). *Knowledge management within a Lean organization: a case study at Volvo Cars* (Bachelor Thesis, Linnaeus University). Retrieved from https://www.diva-portal.org/smash/get/diva2:800419/FULLTEXT01.pdf

Smith, K. G., & Di Gregorio, D. (2002). Bisociation, discovery and the role of entrepreneurial action. In M. A. Hitt, R. D. Ireland, S. M. Camp & D. L. Sexton (Eds.), *Strategic Entrepreneurship: Creating a new mindset*. New York, NY: Blackwell Publishers.

Snee, R. D. (2000). Six Sigma improves both statistical training and processes. *Quality Progress, 33*(10), 68-72.

Snee, R. D. (2007). Use DMAIC to make improvement part of "the way we work.". *Quality Progress, 40*(9), 52-54.

Snee, R. D. (2008). W. Edwards Deming's "Making AnotherWorld" A Holistic Approach to Performance Improvement and The Role of Statistics. *The American Statistician, 62*(3), 251-255.

Snee, R. D. (2010). Lean Six Sigma-getting better all the time. *International Journal of Lean Six Sigma, 1*(1), 9-29.

Snee, R. D., & Hoerl, R. W. (2003). *Leading Six Sigma: a step-by-step guide based on experience with GE and other Six Sigma companies*. Upper Saddle River, NJ: Financial Times Prentice Hall.

Snee, R. D., & Hoerl, R. W. (2005). *Six Sigma Beyond the Factory Floor: Deployment Strategies for Financial Services, Health Care, and the Rest of the Real Economy*. New York, NY: Financial Times Prentice-Hall.

Snee, R. D., & Hoerl, R. W. (2007). Integrating Lean and Six Sigma-a holistic approach. *Six Sigma Forum Magazine, 6*(3), 15-21.

Snyder, K., Ingelsson, P., & Bäckström, I. (2016). Enhancing the study of Lean transformation through organizational culture analysis. *International Journal of Quality and Service Sciences, 8*(3), 395-411.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology, 13*, 290-312.

Sohal, A. S., & Egglestone, A. (1994). Lean production: experience among Australian organizations. *International Journal of Operations & Production Management, 14*(11), 35-51.

Son, N. T., Rashid, S. H. A., Nguyen, N. D., & Nakano, M. (2011). *Using the value stream mapping and overall equipment effectiveness to improve productivity: a literature review.* Paper presented at the Proceedings of the 4th Regional Conference on Manufacturing, Yogyakarta.

Sony, M., & Naik, S. (2012). Six Sigma, organizational learning and innovation: An integration and empirical examination. *International Journal of Quality & Reliability Management, 29*(8), 915-936.

Sosik, J. J., Kahai, S. S., & Piovoso, M. J. (2009). Silver bullet or voodoo statistics? A primer for using the partial least squares data analytic technique in group and organization research. *Group & Organization Management, 34*(1), 5-36.

Spear, S., & Bowen, H. K. (1999). Decoding the DNA of the Toyota production system. *Harvard Business Review, 77*(5), 96-108.

Spear, S. J. (2004). Learning to lead at Toyota. *Harvard Business Review, 82*(5), 78-91.

Spence, A. M. (1981). The learning curve and competition. *The Bell Journal of Economics, 12*(1), 49-70.

Spender, J. C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal, 17*(S2), 45-62.

Spreitzer, G. M. (1995). Psychological empowerment in the workplace: Dimensions, measurement, and validation. *Academy of Management Journal, 38*(5), 1442-1465.

Sroufe, R. (2003). Effects of environmental management systems on environmental management practices and operations. *Production and operations management, 12*(3), 416-431.

Staats, B. R., Brunner, D. J., & Upton, D. M. (2011). Lean principles, learning, and knowledge work: Evidence from a software services provider. *Journal of Operations Management, 29*(5), 376-390.

Stalk Jr, G., & Hout, T. M. (1990). Competing against time. *Research-Technology Management, 33*(2), 19-24.

Stanica, S., & Peydro, J. (2016). How does the employee cross-training lean tool affect the knowledge transfer in product development processes? *VINE Journal of Information and Knowledge Management Systems, 46*(3), 371-385.

Stewart, T. A. (1997). *Intellectual Capital: the new wealth of organizations*. New York, NY: Bantam Doubleday Dell Publishing Group.

Stock, G. N., McFadden, K. L., & Gowen, C. R. (2007). Organizational culture, critical success factors, and the reduction of hospital errors. *International Journal of Production Economics, 106*(2), 368-392.

Stoiljković, V., Trajković, J., & Stoiljković, B. (2011). Lean Six Sigma sample analysis process in a microbiology laboratory. *Journal of Medical Biochemistry, 30*(4), 346-353.

Stone, K. B. (2012). Lean transformation: Organizational performance factors that influence firms' leanness. *Journal of Enterprise Transformation, 2*(4), 229-249.

Stone, M. (1974). Cross-validatory choice and assessment of statistical predictions. *Journal of the Royal Statistical Society. Series B (Methodological), 36*(2), 111-147.

Straub, D., Boudreau, M.-C., & Gefen, D. (2004). Validation guidelines for IS positivist research. *Communications of the Association for Information Systems, 13*(24), 380-427.

Suárez-Barraza, M. F., & Ramis-Pujol, J. (2010). Implementation of Lean-Kaizen in the human resource service process: A case study in a Mexican public service organisation. *Journal of Manufacturing Technology Management, 21*(3), 388-410.

Sugimori, Y., Kusunoki, K., Cho, F., & Uchikawa, S. (1977). Toyota production system and kanban system materialization of just-in-time and respect-for-human system. *The International Journal of Production Research, 15*(6), 553-564.

Sunder, M. V. (2013). Synergies of Lean Six Sigma. *IUP Journal of Operations Management, 12*(1), 21-31.

Sunder, M. V. (2016). Lean Six Sigma in higher education institutions. *International Journal of Quality and Service Sciences, 8*(2), 159-178.

Sutton, R. I., & Hargadon, A. (1996). Brainstorming groups in context: Effectiveness in a product design firm. *Administrative Science Quarterly, 41*(4), 685-718.

Svensson, C., Antony, J., Ba-Essa, M., Bakhsh, M., & Albliwi, S. (2015). A Lean Six Sigma program in higher education. *International Journal of Quality & Reliability Management, 32*(9), 951-969.

Szulanski, G. (1995). Unpacking stickiness: An empirical investigation of the barriers to transfer best practice inside the firm. *Academy of Management Journal, 38*, 437-441.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal, 17*(S2), 27-43.

Tabachnick, B., & Fidell, L. (2007). Multivariate analysis of variance and covariance. *Using multivariate Statistics, 3*, 402-407.

Tadajewski, M., MacLaran, P., & Graham, L. D. (2013). Lillian Gilbreth's psychologically enriched scientific management of women consumers. *Journal of Historical Research in Marketing, 5*(3), 351-369.

Takeuchi, H., & Nonaka, I. (2001). Classic work: Theory of organizational knowledge creation. In D. Morey, M. Maybury, & B. Thuraisingham (Eds.), *Knowledge Management: Classic and Contemporary Works (pp.* 139-182). Cambridge, Mass.: MIT Press.

Tan, K. C. (2002). Supply chain management: practices, concerns, and performance issues. *Journal of Supply Chain Management, 38*(4), 42-53.

Taylor, A., Taylor, M., & McSweeney, A. (2013). Towards greater understanding of success and survival of lean systems. *International Journal of Production Research, 51*(22), 6607-6630.

Taylor, F. W. (2004). *Scientific Management*. New York, NY: Routledge.

Teece, D., & Pisano, G. (1994). The dynamic capabilities of firms: an introduction. *Industrial and Corporate Change, 3*(3), 537-556.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319-1350.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509-533.

Tenenhaus, M., Vinzi, V. E., Chatelin, Y.-M., & Lauro, C. (2005). PLS path modeling. *Computational Statistics & Data Analysis, 48*(1), 159-205.

Tennant, G. (2001). *Six Sigma: SPC and TQM in manufacturing and services*. Hampshire, England: Gower Publishing Limited.

Thibodeaux, M. S., & Faden, S. K. (1994). Organizational design for self-managed teams. *Industrial Management & Data systems, 94*(10), 20-25.

Thompson, J. D. (1967). *Organizations in action: Social science bases of administration*. New York: McGraw-Hill.

Thompson, V. A. (1965). Bureaucracy and innovation. *Administrative Science Quarterly, 10*(1), 1-20.

Tian, A. W., & Soo, C. (2015). Absorptive Capacity, Motivation and Creativity at the Individual Level. *Proceedings of the Academy of Management Proceedings 2015*(1), https://doi.org/10.5465/ambpp.2015.16490abstract

Tidd, J., Bessant, J., & Pavitt, K. (2005). *Managing innovation integrating technological, market and organizational change* (3rd ed.). West Sussex, England: John Wiley & Sons Ltd.

Tiemessen, I., Lane, H. W., Crossan, M. M., & Inkpen, A. C. (1997). Knowledge management in international joint ventures. In P. W. Beamish & J. P. Killing (Eds.), *Cooperative Strategies: North American Perspectives* (pp. 370-399). San Francisco: New Lexington Press.

Todorova, G., & Durisin, B. (2007). Absorptive capacity: Valuing a reconceptualization. *Academy of Management Review, 32*(3), 774-786.

Tsai, W. (2001). Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal, 44*(5), 996-1004.

Tsang, E. W., & Zahra, S. A. (2008). Organizational unlearning. *Human Relations, 61*(10), 1435-1462.

Tu, Q., Vonderembse, M. A., Ragu-Nathan, T., & Sharkey, T. W. (2006). Absorptive capacity: Enhancing the assimilation of time-based manufacturing practices. *Journal of Operations Management, 24*(5), 692-710.

Turesky, E. F., & Connell, P. (2010). Off the rails: understanding the derailment of a lean manufacturing initiative. *Organization Management Journal, 7*(2), 110-132.

Tushman, M., & Nadler, D. (1986). Organizing for innovation. *California Management Review, 28*(3), 74-92.

Tushman, M. L. (1977). Special boundary roles in the innovation process. *Administrative Science Quarterly, 22*(4), 587-605.

Tushman, M. L., & Nadler, D. A. (1978). Information processing as an integrating concept in organizational design. *Academy of Management Review, 3*(3), 613-624.

Tushman, M. L., & Scanlan, T. J. (1981). Boundary spanning individuals: Their role in information transfer and their antecedents. *Academy of Management Journal, 24*(2), 289-305.

Tyagi, S., Cai, X., Yang, K., & Chambers, T. (2015). Lean tools and methods to support efficient knowledge creation. *International Journal of Information Management, 35*(2), 204-214.

Uhrin, Á., Bruque-Cámara, S., & Moyano-Fuentes, J. (2017). Lean production, workforce development and operational performance. *Management Decision, 55*(1), 103-118.

Ulrich, D., Kerr, S., & Ashkenas, R. (2002). *The GE work-out: How to implement GE's revolutionary method for busting bureaucracy & attacking organizational problems*. New York, NY: McGraw-Hill.

Urabe, K., Child, J., & Kagono, T. (1988). *Innovation and management: International comparisons* (Vol. 13): Berlin, Germany: Walter de Gruyter.

Urbach, N., & Ahlemann, F. (2010). Structural equation modeling in information systems research using partial least squares. *JITTA: Journal of Information Technology Theory and Application, 11*(2), 5-40.

Urbancova, H. (2013). Competitive advantage achievement through innovation and knowledge. *Journal of Competitiveness, 5*(1), 82-96.

Utterback, J. M. (1994). *Mastering the dynamics of innovation: how companies can seize opportunities in the face of technological change.* Boston, MA: Harvard Business School Press.

Utterback, J. M., & Abernathy, W. J. (1975). A dynamic model of process and product innovation. *Omega, 3*(6), 639-656.

Utterback, J. M., & Afuah, A. N. (1998). The dynamic 'diamond': a technological innovation perspective. *Economics of Innovation and New Technology, 6*(2-3), 183-200.

Van Den Bosch, F. A., Volberda, H. W., & De Boer, M. (1999). Coevolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organization Science, 10*(5), 551-568.

Verrier, B., Rose, B., Caillaud, E., & Remita, H. (2014). Combining organizational performance with sustainable development issues: the Lean and Green project benchmarking repository. *Journal of Cleaner Production, 85*, 83-93.

Vest, J. R., & Gamm, L. D. (2009). A critical review of the research literature on Six Sigma, Lean and StuderGroup's Hardwiring Excellence in the United States: the need to demonstrate and communicate the effectiveness of transformation strategies in healthcare. *Implementation Science, 4*(1), 35.

Vidal, M. (2007). Lean production, worker empowerment, and job satisfaction: A qualitative analysis and critique. *Critical Sociology, 33*(1-2), 247-278.

Vijaya Sunder, M. (2015). Corporate perspectives: commonalities and differences between Six Sigma and Lean. *Sigma, 6*(3), 281-288.

Vinodh, S., Kumar, S. V., & Vimal, K. (2014). Implementing lean sigma in an Indian rotary switches manufacturing organisation. *Production Planning & Control, 25*(4), 288-302.

Volberda, H. W. (1996). Toward the flexible form: How to remain vital in hypercompetitive environments. *Organization Science, 7*(4), 359-374.

Volberda, H. W. (1999). *Building the flexible firm: How to remain competitive*. USA: Oxford University Press.

Von Hippel, E. (1988). *The Sources of Innovation.* New York, NY: Oxford University Press.

Wada, K., & Yui, T. (2002). *Courage and Change: The Life of Kiichiro Toyoda* (trans. Skrzypczak, E. R.). Toyota City: Toyota Motor Corporation.

Walsh, J. P., & Ungson, G. R. (1991). Organizational memory. *Academy of Management Review, 16*(1), 57-91.

Watson, G. (2004). The legacy of Ishikawa. *Quality Progress, 37*(4), 54-57.

Watson, G. H. (2005). Feigenbaum's enduring influence. *Quality Progress, 38*(11), 51-55.

Watson, G. H., & DeYong, C. F. (2010). Design for Six Sigma: caveat emptor. *International Journal of Lean Six Sigma, 1*(1), 66-84.

Wee, H., & Wu, S. (2009). Lean supply chain and its effect on product cost and quality: a case study on Ford Motor Company. *Supply Chain Management: An International Journal, 14*(5), 335-341.

Weick, K. E., & Westley, F. (1999). Organizational learning: affirming an oxymoron. In S. R. Clegg, C. Hardy & W. R. Nord (Eds.), *Managing organizations: current issues* (pp. 190-208). Thousand Oaks, CA: Sage Publications.

Welch, J., & Byrne, J. A. (2001). *Straight from the gut*. New York, NY: Warner Business Books.

Werder, C. M. (2015). *Models and approaches for exploratory learning*. Retrieved from http://blog.careum.ch/pbl-congress-02/

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.

Werts, C. E., Linn, R. L., & Jöreskog, K. G. (1974). Intraclass reliability estimates: Testing structural assumptions. *Educational and Psychological Measurement, 34*(1), 25-33.

Westhead, P., Wright, M., & Ucbasaran, D. (2004). Internationalization of private firms: environmental turbulence and organizational strategies and resources. *Entrepreneurship & Regional Development, 16*(6), 501-522.

Wetzels, M., Odekerken-Schröder, G., & Van Oppen, C. (2009). Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration. *MIS quarterly, 33*(1), 177-195.

Wheat, B., Mills, C., & Carnell, M. (2003). *Leaning into Six Sigma: A parable of the journey to Six Sigma and a Lean enterprise*. New York, NY: McGraw-Hill Education.

Wickramasinghe, G., & Wickramasinghe, V. (2017). Implementation of lean production practices and manufacturing performance: The role of lean duration. *Journal of Manufacturing Technology Management, 28*(4), 531-550.

Wiklund, H., & Wiklund, P. S. (2002). Widening the Six Sigma concept: An approach to improve organizational learning. *Total Quality Management, 13*(2), 233-239.

Wilson, P. (2011). *Challenges for the Singapore Economy After the Global Financial Crisis*. Singapore: World Scientific.

Wincel, J. P. (2003). *Lean supply chain management: a handbook for strategic procurement*. New York, NY: CRC Press.

Winter, S. G. (1994). Organizing for continuous improvement: Evolutionary theory meets the quality revolution. In J. A. C. Baum & J. V. Singh (Eds.), *Evolutionary dynamics of organizations* (pp. 90-108), New York, NY: Oxford Univeristy Press.

Winter, S. G. (2000). The satisficing principle in capability learning. *Strategic Management Journal, 21*(10-11), 981-996.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal, 24*(10), 991-995.

Womack, J. P., & Jones, D. T. (1996). *Lean thinking: Banish waste and create wealth in your organisation.* New York, NY: Simon & Schuster.

Womack, J. P., Jones, D. T., & Roos, D. (1990). *Machine that changed the world*. New Yor, NY: Harper Perennial.

Woodbury, R. S. (1960). The legend of Eli Whitney and interchangeable parts. *Technology and Culture, 1*(3), 235-253.

Wu, C., & Lin, C. (2009). Case study of knowledge creation facilitated by Six Sigma. *International Journal of Quality & Reliability Management, 26*(9), 911-932.

Xia, T., & Roper, S. (2008). From capability to connectivity—Absorptive capacity and exploratory alliances in biopharmaceutical firms: A US–Europe comparison. *Technovation, 28*(11), 776-785.

Xu, E.-m., Chen, Y., Kwon, S., & Fang, H.-l. (2009). *Potential and realized absorptive capacities: Their effect on firms' competitive advantage and the role of communication.* Paper presented at the International Conference on Management Science and Engineering, Moscow, Russia.

Xu, K., Sikdar, C., & Gardner, M. (2006). Six Sigma roles in innovation. Paper presented at the Management of Innovation and Technology, 2006 IEEE International Conference on.

Yadav, G., & Desai, T. N. (2016). Lean Six Sigma: a categorized review of the literature. *International Journal of Lean Six Sigma, 7*(1), 2-24.

Yang, M. G. M., Hong, P., & Modi, S. B. (2011). Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms. *International Journal of Production Economics, 129*(2), 251-261.

Yusr, M., Othman, A. R., & Mokhtar, S. S. M. (2012). Assessing the relationship among Six Sigma, absorptive capacity and innovation performance. *Procedia-Social and Behavioral Sciences, 65*, 570-578.

Yusr, M. M., & Othman, A. R. (2011). Six sigma and innovation performance: a conceptual framework based on the absorptive capacity theory perspective. *International Journal of Emerging Sciences, 1*(3), 307-323.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185-203.

Zamri, F. I. M., Hibadullah, S. N., Fuzi, N. M., Desa, A. F. N. C., & Habidin, N. F. (2013). Green lean six sigma and financial performance in Malaysian automotive industry. *Business Management and Strategy, 4*(1), 97-106.

Zander, U., & Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization Science, 6*(1), 76-92.

Zhang, A., Luo, W., Shi, Y., Chia, S T., & Sim, Z. H. X. (2016). Lean and Six Sigma in logistics: a pilot survey study in Singapore. *International Journal of Operations & Production Management, 36*(11), 1625-1643.

Zhang, L., & Chen, X. (2016). Role of Lean Tools in Supporting Knowledge Creation and Performance in Lean Construction. *Procedia Engineering, 145*, 1267-1274.

Zhang, Q., Irfan, M., Khattak, M. A. O., Zhu, X., & Hassan, M. (2012). Lean Six Sigma: a literature review. *Interdisciplinary Journal of Contemporary Research in Business, 3*(10), 599-605.

Zhang, W., Hill, A. V., & Gilbreath, G. H. (2011). A research agenda for Six Sigma research. *The Quality Management Journal, 18*(1), 39-53.

Zhang, W., Hill, A. V., Schroeder, R. G., & Linderman, K. W. (2008). Project management infrastructure: The key to operational performance improvement. *Operations Management Research, 1*(1), 40-52.

Zhao, X., Lynch Jr, J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *Journal of Consumer Research, 37*(2), 197-206.

Zhuge, H. (2006). Knowledge flow network planning and simulation. *Decision Support Systems, 42*(2), 571-592.

Zien, K. A., & Buckler, S. A. (1997). From experience dreams to market: crafting a culture of innovation. *Journal of Product Innovation Management, 14*(4), 274-287.

Zikmund, W. G., Babin, B. J., Carr, J. C., & Griffin, M. (2013). *Business research methods* (9th ed.). Mason, OH: Cengage Learning.

Zollo, M., & Winter, S. G. (1999). *From organizational routines to dynamic capabilities* Working paper no. WP 99-07, University of Pensylvania, Philadelphia, USA.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science, 13*(3), 339-351.

Zu, X., & Fredendall, L. D. (2009). Enhancing Six Sigma implementation through human resource management. *The Quality Management Journal, 16*(4), 41-45.

Zu, X., Fredendall, L. D., & Douglas, T. J. (2008). The evolving theory of quality management: the role of Six Sigma. *Journal of Operations Management, 26*(5), 630-650.