2 LITERATURE REVIEW

2.1 Introduction

This chapter commenced with a review of the literature to gain a general understanding and appreciation of innovation as assisted by the intensified research and writings of Drucker (1985). In general, an organisation's ability to innovate was recognised as one of the determinant factors for it to survive and succeed (Cefis and Marsili, 2005; Doyle, 1998; Quinn, 2000). Stahle et. al., (2004) defined innovation as "the sum of a new idea, implementation of a value creation". Johannessen, et. al., (2001) also reflected on innovation as being something new, however, it had to be investigated as to whom it was new and the relative stance of how new it was. Additionally, the European Union defined innovation as "the successful production, assimilation and exploitation of novelty in the economic social spheres" (EU, 1995). Valikangas and Gibbert (2005, p.64) defined innovation as "explorative activities in an organisation that were novel and non-conformistic". The Merriam-Webster's Collegiate Dictionary defined the term innovation as "the introduction of something new, or a new idea, method or device (Encyclopaedia Britannica, 2004).

Innovation may exhibit itself in various forms such as; product innovation, process innovation, incremental innovation, radical innovation, administrative innovation or technological innovation (Mui, 2006; Zaltman et. al., 1993; Utterback, 1994; Cooper, 1998). Additionally, Rasiah (2011) asserts that the processes of innovation does not end at the point of its creation. Linkages are extremely important in the spread and diffusion of stocks of knowledge, which not only act as

building blocks for new stocks of knowledge but also are to be synergized further through creative duplication and accumulation into newer stocks of knowledge. This was further explored in the book by Dodgson et. al., (2008) who expounded the need for managing technological innovation. Additionally, Miller and Friesen (1983) explained innovation using four dimensions, viz., new product or service innovation, methods of production or rendering of services, risk taking by key executives and seeking unusual and novel solutions. This was further intensified by Capon et. al., (1992), who clarified the term innovation utilising three dimensions of organisational innovativeness, that is, market innovativeness, strategic tendency to pioneer and technological sophistication (Danneels et. al., 2001; Johne, 1999).

Equipped with a general understanding and appreciation of the term 'innovation' this chapter continues with an exposure of the various models that propagated the diffusion or adoption of new technology and innovation. Diffusion of innovation or technology was defined as "the process by which an innovation or technology was communicated through certain channels over time among the members of a social system" (Rogers, 1995, p.10). This meant that the innovation was adopted and gained acceptance by members of a certain community who used the innovation or technology.

According to King and Burgess (2006), they showed that for innovation and technology to be adopted, there were critical factors that needed to be in place such that the relationships between these critical success factors helped to encourage exploration of more appropriate implementation strategies. Some of the areas explored included; cooperation between parties, coordination of activities, communication between people, creativity and the level of chaos. Their study revealed

that cooperation would only be materialised when the parties involved established effective coordination of their activities. This was also corroborated in a research study conducted by Biemans (1990, 1992) and Drejer (2002). Successful coordination would include the creation of intra- and inter-organisational communication, while all of the four factors would help to reduce the level of chaos that was inevitable when new innovation and technology was introduced.

Further to that, Taatila et. al., (2006) examined the social aspects of successful diffusion of innovation and technology. They concluded that for a successful implementation to ensue, organisations should ensure that the key people or "innovators" should possess certain critical competencies, such as; individual competence attributes, structural competence attributes as well as resource based competence attributes. All these three competencies would help enhance the probability of success for the new innovation and technology to materialise.

In another research study conducted by Ahmed (1998), he summarised the multitude of factors that aided the successful diffusion of technology and innovation. Some of these factors included; "freedom from rules", "not obsessed with precision", "freedom to experiment", "non-hierarchical", "acceptance of mistakes", "no punishment for mistakes", "move people around", "flexibility in jobs, budgets, functional areas", "quick, flexible decision making", among others. These factors were also corroborated in the various studies conducted by the following researchers, Judge et. al., 1997, O'Reilly, 1989 and Scheider et. al., 1996.

Before a new innovation and technology could be diffused to the potential users, its genesis would entail three phases, viz., idea generation, technical development and commercialising

(Ojasalo, 2003; Ojasalo, et. al., 2005). Only through these processes would the innovation and technology be ready to be published to the end-users, who would then need to have a 'buy-in' into the new innovation and technology. Dreijer (2002) suggested that one of the most effective ways to secure the buy-in from the potential users was through 'technical-integration'. This process referred to the integration between the technology and the market where great emphasis was placed on satisfying the customer with the key benefits and importance of the innovation to them.

Continuing in this chapter is the explanation of the generic diffusion model as propagated by Rogers. Its explanation spans from its origin till its full development and common utilisation in a myriad of industries. Moving on, this chapter then progressed to construct an in-depth view of the success factors that were critical for the successful diffusion of new technological advancement to the potential end-users. Heong (1992) stated that many technological findings based on elaborate and heavily funded research, were either implemented poorly, or not at all. This unfortunate fate of events had to be arrested, so as to justify the major financial commitment used to fund the research activities, besides other factors such as time and commitment expended in the formulation of the innovation.

Bradford and Florin (2003) examined the factors on how innovation can be translated into reality through its successful implementation. This view was also reinforced by Kellinghusen and Wubbenhorst (1990) who stated that the key to success was not in the formulation stage but in the implementation or diffusion stage. Additionally, from the literature review conducted in this

study, many factors aided the successful implementation of technological innovation. In contrast, there were factors that impeded the successful diffusion of technological innovation, too.

2.2 General Diffusion Theory

The origin of the diffusion model emerged as early as 1903 in the work of a sociologist named Tarde and resurfaced later in the work of another sociologist, Bowers. However, at Iowa State University, two rural sociologists, Bryce Ryan and Neal Gross (1943) initiated more aggressive work into the diffusion theory which provided the genesis of modern diffusion research. In the 1943 Ryan and Gross study, which was done in the field of rural sociology, they interviewed adopters of an innovation to examine the success factors. This interview-based methodology had remained the predominant methodology in modern diffusion research. The above mentioned research provided the precedent that was followed through by a number of researchers from rural sociology (Fliegel and Kivlin, 1962) and other disciplines too (Weinstein, 1986). They built on Ryan and Gross' work, by conducting manifold studies and developed theories related to the diffusion of innovations, leading to the more renowned research work by Rogers (1960) which culminated in his book entitled, *Diffusion of Innovations.*

One of the most pressing issues at that time was that many of the developers of innovation or technology faced a growing realisation that their products and practices suffered from a lack of utilisation and were turning to diffusion theory in an effort to increase the adoption of these new technologies (Rogers, 1995). Soon it was evidenced that disciplinary boundaries eased, diffusion research proliferated, internationalisation occurred, and studies of knowledge, attitudes and

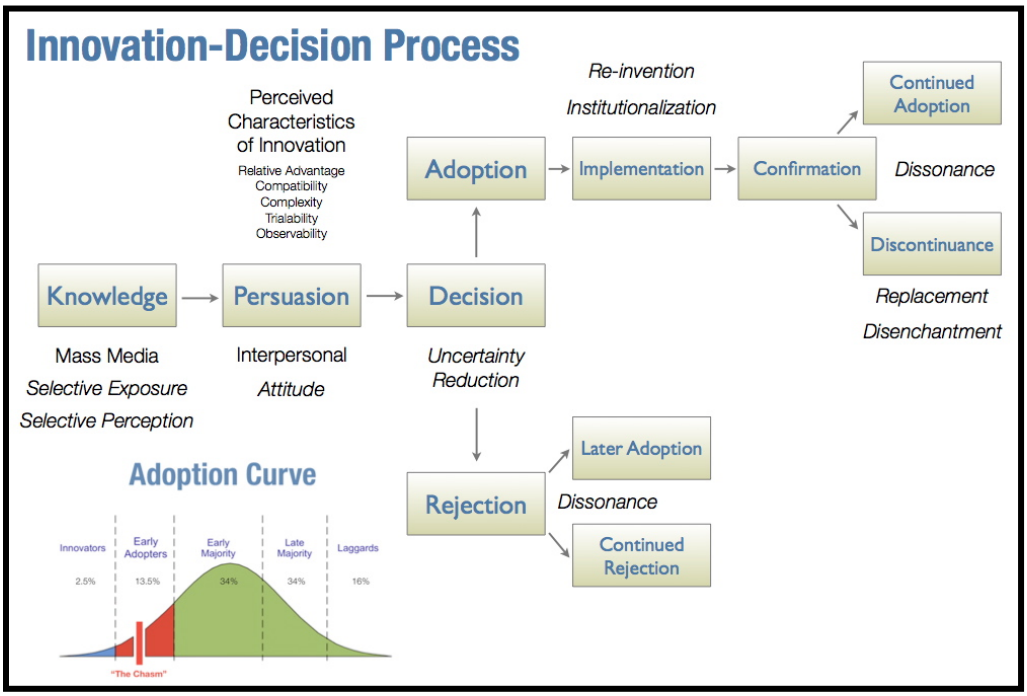
practices showed a multitude of shortcomings in existing models. All of these were critical and instrumental in stimulating the growth in the design of field-experimental research.

The year 1960 proved to be a pivotal year for the diffusion process study, as there was the merging of propositions that would mould ideas from several disciplines into a relatively integrated body of generalisations. An early example was the Rogers and Havens study on diffusion in which they assembled the various elements that set the direction for the formulation of a general theory of diffusion. They made a comprehensive review of the research literature that demonstrated the fruitfulness of interdisciplinary study. They sourced 405 European and U.S. studies to be researched and formulated into a theoretical framework. This different approach provided "a natural framework in which the impact of development programs in various fields such as agriculture, family planning, public health and nutrition were evaluated", both in developing and developed nations, all proving to be clearly an asset in today's "global village" (Rogers, 1995, p.xvi).

2.3 Rogers' Diffusion Model

Rogers' 1995 model focused on five key stages embedded in the diffusion process. As potential adopters passed through these stages, their understanding of the innovation in question underwent modification to a point where they made a decision to either adopt the innovation or reject it. The five key stages of his model were; Knowledge, Persuasion, Decision, Implementation and Confirmation. This is shown in Figure 2.1 below.

Figure 2.1 : Rogers' Five Stages of Innovation Decision Process (2003)



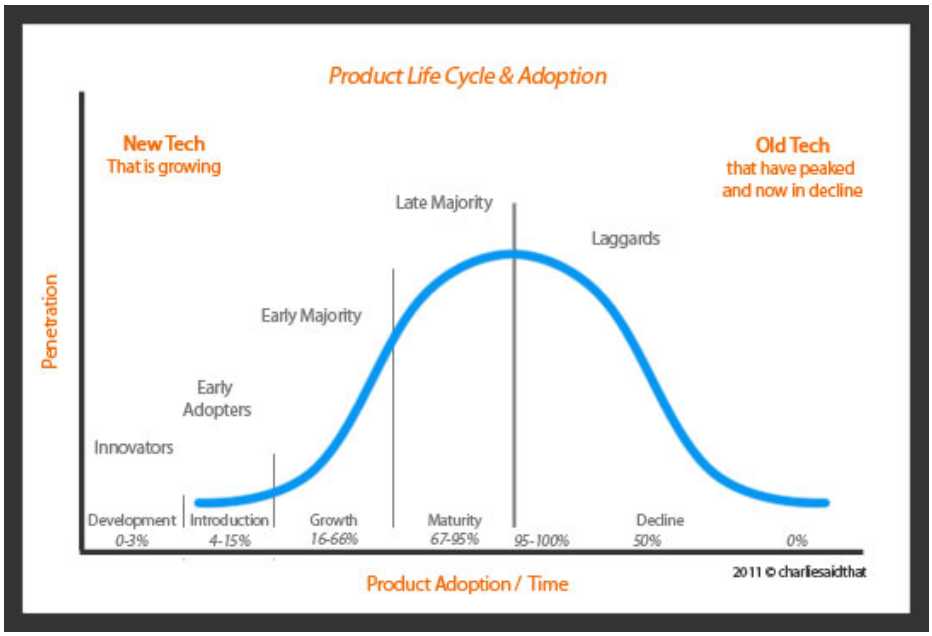
- **Knowledge**

At this stage, the potential adopter developed an awareness of the existence of the new innovation and obtained some understanding of its meaning and function. This came from the 'awareness knowledge' - finding out that an innovation existed, then the 'how-to knowledge' - information about how to use an innovation properly and finally the 'principles knowledge' - information that explained the reasons for the innovation. However, before a potential adopter even gave any conscious attention to an innovation, a need must have existed.

This steered the attention to the change agents' role. Change agents were the set of people who scanned the environment and analysed the potential needs of the adopters or users. They made every effort to understand the users' profile, such as their capacity to handle and manage their

problems. They then stimulated the research and development process to generate an innovation that would address the needs of the users. Once this innovation is available, then they become the early adopters of the innovation. This is shown in Rogers' Model for the Adoption and Diffusion of Innovations in Figure 2.2 below.

Figure 2.2 : Rogers's Model for the Adoption and Diffusion of Innovations



The early adopters or change agents are those who are seen to be responsible for pulling in the change for the new technology and innovation. They tend to have greater knowledge of the technology and innovation and hence this provides the fuel for their critical communication that is needed by the users. They also tend to fall into the category of being opinion leaders, who have the uncanny attribute of wanting to try out new ideas but all done in a careful and cautious way. They have great influence over others who trust them and hence they possess the power to affect the behaviour patterns of the users of the new technology and innovation.

- **Persuasion**

The second stage of Rogers' innovation-decision process is persuasion. The role of communication cannot be mitigated in the diffusion process. Change agents could minimise the widening of the 'adopt or non-adopt' gap through selective communication. Taylor and Francis (2008) compared traditional and virtual groups to identify the level of trust among teams that helped to enhance the success of projects. From their study, they found that communication that stimulated trust, simplicity, repetition and reinforcement were excellent contributors in persuasion. Contrarily, this raised the ethical issue of the deliberate creation of needs by the change agents, who could influence the potential users by persuasion and transformation, which indirectly, created a consciously 'planned change'.

With reference to Rogers' Model for the Adoption and Diffusion of Innovations in Figure 2.2 above, the early adopters or change agents use this skill of persuasion to ensure that they influence 'the early majority' to change more quickly than the average. By this method, they are encouraging a larger proportion of the users to adopt the new technology and innovation, such that there is a smaller group for the late majority and also the laggards.

- **Decision**

This is the key step in Rogers' innovation-decision process model. The users will now need to make a decision whether to adopt the new technology and innovation or to reject the new innovation. To assist the adoption decision, the change agents provide safeguards, advice, strong

benefits to be reaped and also critical communication of the innovations. By this process it is hoped that most of the adopters' reservations will be dispelled, and they will be propelled to make the decision to adopt the technology and innovation. This decision process facilitates a higher level of participation and eventually empowerment to the potential adopters or end-users. However, as a word of caution, change agents should remind themselves on the issue of accountability, as to whom they owe accountability to and also the type of accountability they owe.

With reference to Rogers' Model for the Adoption and Diffusion of Innovations in Figure 2.2 above, the early adopters or change agents key objective here is to ensure a higher percentage of users fall into the 'early majority' category such that they make that decision to adopt. Otherwise, if they reject, then there is a small possibility that they may adopt later and fall in to the 'late majority' category or an even more dismal scenario would be that they reject and continue their rejection to the new technology and innovation ever being adopted by them.

- **Implementation**

The implementation process is the result of the adopters' being persuaded by the new knowledge of the innovation, its advantages and also the benefits to be reaped. This leads to the adoption of the new technology and innovation. There is a likelihood that the new technology will be

implemented via a process of institutionalisation, viz., being adopted in the organisation as a whole or may even be re-invented or tailored to meet the specifications of the organisation that is implementing it.

With reference to Rogers' Model for the Adoption and Diffusion of Innovations in Figure 2.2 above, the users are those who fall into the category of 'early adopters', 'early majority' and also 'late majority'. It is hoped that by their adoption and successful implementation, this group will be seen by the 'laggards' or traditional users and be influenced to adopt the new technology and innovation. Generally those who are in this category of 'laggards' are those who have a predominant trait of caring for the 'old ways', are critical towards new innovation and new ideas and will only accept the innovation if the new ideas has become mainstream or even tradition.

- **Confirmation**

By comparative analysis, the adopters would be able to attain a feedback on the positive advantages of implementing the innovation and would be further encouraged to continue its implementation. Through the feedback loop, any unscrupulous hiccups could be identified and methods of eliminating them would be ensued to ensure the reaping of its maximum benefits. However, if the benefits of the new technology and innovation outweigh the costs of the new innovation, then there is a possibility that there will be discontinuance in the usage of the new innovation. Then these 'early adopters' or 'early majority' will seek the advice of the change agents to source a replacement so as to avoid the costs of disruption to their business activities.

With reference to Rogers' Model for the Adoption and Diffusion of Innovations in Figure 2.2 above, it is hoped that by the decision of 'confirmation' by the 'early adopters' and 'early majority' category, the 'late majority' and the 'laggards' category will be stimulated to exercise their decision making process of adopting the new technology and innovation. They would be more convinced now as a passage of time has lapsed for them to witness evidence of the benefits, advantages and also the success of adopting the new innovation. If the reverse scenario took place, then these 'late majority' and 'laggards' category would still remain with their original decision of 'not-to-adopt' the new technology and innovation.

As described above, the generic diffusion theory was, unequivocally, not a well defined, unified or comprehensive theory, but rather a meta-theory as the model assumed a linear, unidirectional pattern where all arrows pointed towards a culmination of the diffusion process in either continued adoption or final rejection. However, with the continued application of the model, it evolved itself into a rather useful model for a multitude of disciplines and accelerated their respective research process, as described below.

The diffusion theory encompassed a large number of theories from a wide variety of disciplines and each focused on a different element of the innovation process (Surry, 1997). To further enhance the practicality of the diffusion theory, many other studies in multiple industries also utilised the diffusion theory as the basis of their research. Some of these included; Peay (1997) who studied the critical success factors in implementing the latest technological innovations; Pannekoek (2004) who investigated and analysed the key success factors of innovation in Dutch glasshouse industry; Burke et. al., (2001) who researched on the role of human factors in the implementation of new innovations; Geisler & Clements (1995), whose research focussed on the

commercialisation of new technology from federal laboratories and their effectiveness; Mendez (1968) who did a study on the relationship between the effectiveness of diffusion of innovations and the prevalent social structure and the study by Green & Hevner (2000) who studied the successful diffusion of innovations of software development organisations.

From the above literature review, there had been sufficient evidence to indicate that progress had been accomplished in the utilisation of the generic diffusion model. This model had been used as the foundation to throw light onto various ramifications of successfully implementing innovations. By taking a more profound look into the model, one would be able to achieve a better understanding of the multitude of influencing factors that facilitated or impeded the diffusion of innovation and technology. This understanding would help to explain, predict and account for the repercussions in the diffusion process, according to the study conducted by Damanpour (2006), which looked at various influencing factors in the phases of innovation adoption.

The originality of this research was to lead to the development of a systematic, prescriptive model of adoption and diffusion. Through this process, it would augment the prevailing body of knowledge and result in a systematic model of diffusion that would help to guide the process of adoption and diffusion, leading to effective results and successful implementation. This view was echoed by Banyte and Salickaite (2008). According to them, this would lead to a more effective means of enhancing the competitiveness of organisations, notably when systematic models resulted in the design and development of effective and pedagogically sound innovations, coupled with the fact that systematic models encouraged the developers of the innovation to be more receptive to work with clients and potential adopters.

In this research study, the successful adoption of IPM innovation and technology by the rice farmers meant that they acquired a crisp and clear understanding of the new technological innovations in IPM by these processes, viz.,

- they acquired the knowledge from the agricultural extension officers who were the change agents or intermediaries

- they were duly persuaded by the agricultural extension officers or intermediaries or change agents of the innovation's benefits

- they were strongly supported to make the decision of adopting the innovation

- and they implemented the IPM innovation into practices

For this to happen, the success of the whole process narrated above was hinged on the KAP level of the agricultural extension officers. The ideal scenario would be that the agricultural extension officers possessed a high level of KAP, which could be translated and transferred to the rice farmers. Furthermore, this would mean that the agricultural extension officers would need certain success factors that enabled them to attain and secure a high level of KAP.

In the real world, the diffusion process of IPM innovation and technology by the agricultural extension officers to the rice farmers was inundated with multiple ubiquitous issues. A review of the literature helped to identify the key issues that either facilitated the successful adoption of

IPM technological innovations, or posed a hindrance to the successful diffusion process. This process would enable the formulation of a framework leading to a systematic, prescriptive model of adoption or diffusion for IPM innovation and technology.

2.4 Critical Success Factors of the Diffusion of New Technology

"Adoption" of new technology referred to the stage at which the technology was selected for use by an individual or an organisation. "Innovation" was the nuance of new technology being adopted, whereas "diffusion" referred to the stage in which the technology was spread for general use and application. The success of new technology being adopted and diffused depended heavily on certain critical success factors, which according to Hack (2000), were a small number of truly important matters that management should focus their attention on. Hence an in-depth understanding of the factors would enable greater appreciation of the issues and problems encountered in the adoption process of the new technological advances.

In this exploratory research study, an attempt was made to draw upon the similarities among the critical success factors and consequently determine a general framework that would enable an early identification of the factors that were supportive as well as factors that inhibited the diffusion process.

2.4.1 Top Management Role

One of the critical success factors as highlighted in the literature review was the role of top management in organisations, notably in their active role of involvement in strategy and policy

making decisions. The role of top management was one of the critical success factors that were highlighted in the exploratory study done by Pollard and Carter-Steel (2009). They studied the factors that would influence the successful implementation of IT Infrastructure Library systems, both in the United States as well as in Australia. Without the support of the top management, they discovered that many of the IT infrastructure projects were not implemented.

According to Rogers (1995) all new innovation should be publicised by the organisation's top management to their change agents. Through the top management's mandate, new innovation or new technology would be adopted and diffused within organisations following a top-down approach, which hopefully, would drive the successful implementation of the innovation. Top management should not delegate the strategic planning process to the planning department; rather treat planning as an integral part of their duties, Coulson-Thomas (1992).

This viewpoint was also shared by Lin (2011) whose study revealed the key role of top management support for knowledge-sharing and enabling their team to implement the new strategies of knowledge management. His study revealed that the role the top management played could not be mitigated under any circumstances notably for the diffusion of strategies. Ngai, et. al., (2004) also discovered in his study that one of the major key success factors for web-based supply chain management systems was top management commitment toward the strategy.

According to Zafar (2010) in his exploratory case study, he identified that one of the key critical success factors was the role of top management or executive management. They were critical in ensuring that the risk management programs in the organisation under study were successful. In

Motwani's (2005) exploratory study on ERP implementation, he identified the important bureaucratic role played by top management as they backed the changes and set the organisation in a positive light to be ready for the impact of several of the ERP implementations.

In the empirical study conducted by Boh and Yellin (2010), they concluded that their study revealed that top management support was a significant enabler for the service-oriented architecture project implementation. The successful implementation of innovation needed the advocacy and commitment from the top management, otherwise, other issues became moot as the process would likely be doomed to stalemate, if not to an early demise. If top management did not provide strong and consistent support, most likely one of these three elements; money, resources or leadership, would not be present over the life of the innovation. This would severely cripple the successful implementation of the innovation (Peay, 1997).

Quinn (1987) asserted that top management could improve the success rate of strategy (IPM) implementation, if they could artfully blend formal analysis, behavioural techniques and power politics, then they could bring about a cohesive, step-by-step movement towards achieving the ends. He also stated that only by this comprehensive process could top management secure the support needed from the agricultural extension officers, as the process of achieving the desired end-result was unambiguous and became clearer for them.

Because of the extensive responsibility of top management who had to possess leadership qualities to drive the organisation, they also had to possess the skills to manage the various ramifications of the business, such as; the diverse culture of the organisation, the communication

atmosphere, the external departmental interface and resistance to change towards new innovation. This tough act of balancing such assorted issues was usually the exclusive role of top management in most organisations.

Ward and Willis (1990**)** also discovered another essential prerequisite for successful implementation, viz., employees must be able to see that top management was committed to the success of the innovation decision. Top management must be seen to be playing a visible role throughout the implementation process. This would be evident, notably through the leaders developing a vision of what should be achieved, then mobilise the organisation towards accepting that vision and finally, working towards achieving the vision of the new decision (Tichy and Ulrich, 1987).

It was crucial that top management ensured the successful implementation of strategies as money, time and resources were allocated for them. Top management could ensure its success by encouraging idea-generation as a key part of the job requirements of their subordinates. Reid (1999) pointed out that major opportunities would be missed if those closely involved with the end-users did not contribute their ideas. He said that the ideas as generated by the agricultural extension officers could be turned into successful diffusion strategies as they were the most knowledgeable in their area of operations. Hence top management had to be highly committed to encourage ideas from this group of people, so as to augment the rate of successfully implementing the IPM innovation.

Another key role of top management was in controlling resources, which were needed for the diffusion of new innovation and technology. Top management had to utilise their position to ensure that sufficient funds were made available to the agricultural extension officers so that they would have the confidence to successfully implement the innovation, without hiccups (Alexander, 1985). Additionally, according to Bertodo (1990), rewards and motivation should be set in place by top management for their subordinates, so as to stimulate certain behaviours which would encourage the adoption of the new technology. This was also shared by Klein and Knight (2005) in their study on successfully implementing innovations and the challenges this process faced. They concluded that for the innovation to be successfully implemented, top management has to create the existence of reward or encouragements notably to the target users. This would definitely enable the innovation's success.

Sufficient training regarding aspects of the new innovation was also within the top management's ambit of responsibility. According to Goldstein (1991) the training process was a systematic acquisition of attitudes, concepts, knowledge, rules and skills that resulted in improved understanding of the innovation and technology. These training sessions would enable to augment the knowledge, attitude and practices level of the agricultural extension officers. Moreover, the training sessions could be used as a platform for effective two-way communication and feedback system for the adopters, giving a pensive insight into the ramifications of the new technological advancements (Martin, 1979).

Furthermore, Chakravartky and Lorange (1984) suggested that the style of top management should be compatible with the structure and systems used in the organisation, whereas

Khandwalla (1976) reiterated that their skills should match the structure of the organisation. In addition, top management should encourage the successful adoption of the innovation by creating the perception that a decentralised decision making system was in place, indicating that the change agents had a choice as to when they could use the new innovation rather than feel that they were forced to use the new innovation and technology.

If top management failed in their respective responsibility of providing the needed commitment towards the new innovation through the provision of resources, time and leadership, then there was a great probability that the innovation would not be implemented successfully. Therefore, it was hoped that a supportive and committed top management would endeavour to augment the level of KAP of the agricultural extension officers who in turn would promote the diffusion of innovation to the rice farmers. In conclusion, the role of top management cannot be relegated, rather it played an integral part in the successful implementation of IPM innovation and technology.

2.4.2 Structure and Culture

Another critical success factor that facilitated the diffusion of innovations in an organisation was the prevalent culture and organisational structure. According to Rogers (1986), most organisational structure and culture were naturally resistant to change, viz., in accepting new technology. Ridderstrale (2000) said that organisational structure needed to move away from the bureaucratic model in order to facilitate a better environment where new innovations could be shared easily. He made recommendations on the importance of a shared vision, values,

ownership and culture. His prescription for an organisational architecture favourable to effective diffusion of innovation was a flatter and decentralised structure allowing decisions to be taken where critical issues were located and flexibility in structure which allowed the movement of personnel between sections to respond quickly with the correct needed support.

Muller (2011) in his research described the desirable infrastructure required by an organisation so as to develop and execute a strategy of change and transformation. This framework created and used would be able to leverage on the technology and innovation within the organisation so as to create business value, generate revenue, increase profits and improve customer relationships. The framework also facilitated the staff within organisations to stay ahead and seize opportunities that lead to success.

Salaman (2000) described in his book that organisational structure need to change and match the needs of the new workflow. He suggests that there may be resistance when there is a re-inventing of the organisational structure and this may even lead to an end to the classical form of structures within organisations, such as the bureaucratic structure.

Moreover, many organisations according to Griffith (2010) are forced to change their internal processes and structures so as to adapt and address the new external environmental changes. Some of new structures and processes introduced include the work flow process, the decision making process, the interpersonal process, the use of teamwork, the leadership structure, among others.

In addition, a study conducted by Kamaruddeen, et. al., (2011) focussed on some of the key factors that enhanced innovation within an organisation. From their research, the findings indicated that the structure and culture within the organisation had to be changed so as to address or react to the external factors such as government regulations on innovation, environmental uncertainty and market competition. The quest to be an innovative firm had led to major changes in the structure and culture of the organisation.

Moreover, in their research, Motwani et. al., (2005) found that for successful implementation of ERP innovation systems, the organisation had to modify the bureaucratic-structured implementation process with careful change management strategies, so as to facilitate successful implementation of the new innovation system. Ansoff & McDonnell (1990) in their research, encouraged organisational structure to be multi-faceted so that optimal fit could be achieved between the diffusion of innovations and structure. In the business world, it was evident that the traditional hierarchical organisations handling business were poorly equipped to respond to the various issues such as relationships, resources and motivation, as shown in Table 2.1 (Tapscott and Caston , 1993).

Table 2.1: Comparison of Traditional Hierarchical and Open Networked Organisations

	Traditional	New Open Networked
Structure	Hierarchical/Centralized	Distributed/Networked
Resource Focus	Capital	Human, Information
Motivation	Reward/Punishment	Commitment

Relationships	Competitive ("turf defending")	Cooperative
Basis of Action	Control, Standard Operating Procedures	Empowered to Act

Modified from Tapscott and Caston (1993)

From the above table, it was recommended that organisations endorsing new innovations should invoke the new organisational structure of being open-networked. This organisational structure exhibited flexibility, responsiveness, adaptability, extensive cross-functional collaboration, rapid and effective decision-making with highly committed employees who were empowered to take action. All these were the necessary ingredients for guaranteeing the improvement in the level of KAP of the agricultural extension officers. In addition, Zaltman & Duncan (1977) also proposed that for innovations to be implemented successfully, the structure of organisations should shift to a lower degree of complexity so as to facilitate the diffusion process.

Besides structure being an integral ingredient for successful strategy implementation in an organisation, the proper culture for change was also critical. Motwani et. al., (2005) researched and discovered that organisations that intended to implement the new technology and innovation of ERP successfully had to ensure they had a degree of cultural readiness. This proved to have positive impact on several ERP implementations.

In their study of IT Infrastructure Library software system, Tan et. al., (2007) found that the organization's culture was one of the hardest type of change to manage despite culture being one

of the key factors that enabled the successful adoption of the new innovation in the organization. In a study in 1997 carried out by the Ernst and Young Centre for Innovation found that changing peoples' behaviour was seen as the biggest difficulty in managing knowledge. The study also discovered that the biggest impediment to the translation of knowledge into practice was the prevalent culture within the organisation. It was added that the culture should encourage the subordinates to be open to change and committed to change. Organisations needed to create a culture that was more suited to welcoming new innovations, so that management could build a conducive culture of consensus, genuine participation and commitment from those who had 'their noses to the ground', unequivocally, the agricultural extension officers.

Hence, the organisational culture needed to have flexibility, looseness and simplicity, such that new technology and innovation can be adopted with greater ease and less resistance (Swanson-Fisher, 2004). Furthermore, this type of culture was essential in encouraging the adoption of new innovations as and when they were introduced (Greenwood and Thomas, 1981). Organisations that were most likely to respond quickly to the latest technology were the ones that had a culture of creativity and innovation. Conducive structure would stimulate the generation of new ideas of diffusion from those who had complete knowledge about the products and technology, in this case, the agricultural extension officers.

Reid (1989) suggested that organisations could promulgate a supportive culture that welcomed innovation with the aid of McKinsey's 7-S Framework which was also advocated by Peters and Waterman (1982). They suggested that management should concentrate more on the 'soft S's' (style, skills, staff and shared values) as these were most effective in encouraging the

implementation of new innovations. This was because organisations were held together by shared values. Such a supportive culture would create a more congenial climate suitable to eliciting support, cooperation or acquiescence from the agricultural extension officers, such that the proposed strategy could be diffused with success.

Finally, it could be concluded that an encouraging and supportive structure would boost the level of KAP of the agricultural extension officers who in turn would promote the diffusion of innovation to the end-users viz., the rice farmers. Conversely, the presence of a 'resistance to change' culture and a highly traditional bureaucratic structure would deem the successful adoption of the IPM innovation and technology, virtually impossible.

2.4.3 Social System

Another positive contributing factor to the success of innovation diffusion was the social system. Rogers (1995) defined the social system as one that encompassed a set of interrelated units engaged in joint problem solving to accomplish a common goal. The members or units of the social system were usually individuals, informal groups, organisations or subsystems.

In Pollard and Carter-Steel's findings, (2009) they too shared that the social system was one of the critical success factors that enabled the successful implementation of the IT Infrastructure Library system. In their social system, there was a strong collaboration of consultants, trainers and software personnel who were selected, to ensure the successful implementation of the system.

Creating an organizational climate characterized by a strong social system that comprised both the management and employees helped to enhance their level of interaction with one another. This proved to be one of the critical success factors in the study undertaken by Lin (2011). Hence the success and effectiveness of driving the knowledge management initiatives depended on a strong social system. Lin (2011) also recommended that managers should strive to enable employees to propose ideas for new opportunities and foster a positive interaction culture that would result in successfully implemented knowledge management initiatives. Similarly, Freeman (1988) saw the key role that institutions played in the production and appropriation of economic synergies from the processes that generated learning and innovation. One of the key pillars of the adoption, diffusion and spread of knowledge was the argument on path dependence. Hence, linkages among the components of the system were seen to be one of the first key steps in the sequence of promoting learning and innovation to be adopted and diffused among the social system members or components, successfully.

In Pollard and Carter-Steel's research (2009) they concluded that staff awareness across various departments helped to foster great interdepartmental communication and collaboration. This was seen to be one of the critical success factors for the successful implementation of their new innovation software for the IT Infrastructure Library in United States and Australia. From their study they discovered that interdepartmental communication and collaboration expanded beyond the organizational boundaries when a handful of IT service managers from various local organisations who were implementing the IT Infrastructure Library system, began meeting on a

regular basis. The key reason behind their meeting was to provide support and advice to each other, culminating in very open, honest communication.

In addition, Schiffman and Kanuk (2004) found that when there was a strong positive attitude among the members of the social system, this enabled the successful implementation or diffusion of strategies and innovation within an organization. Their research showed that when the values and norms characteristics within the social system were similar, this was indicative of a high level of compatibility among the members of the social system, due to the homogeneity. This led to a positive attitude of members of the social system towards changes, towards progressive technologies, towards science and education. Consequently, this led to a high level of compatibility of innovation and the social system, rendering a higher level of success in the implementation and diffusion of innovation and technology.

According to Burke, et. al., (2001) continuous effort had to be expended to all the components of the social system so that all the parties concerned had a clear vision of the end-result and were aligned, ensuring a higher probability of successful adoption of the innovation. To be successful in achieving the goal of the social system, the members should be embedded in a network of relationships that collectively defined and administered the norms by which dyadic relationships were conducted. According to Granovetter (1973) the strength of the relationships among the social system members was defined by the frequency, reciprocity, emotional intensity and intimacy of those relationships.

Coleman (1988), Granovetter (1992), Burt and Knez (1995) arrived at similar conclusions regarding density (entire network members being highly interconnected) and trust among the members. Density facilitated the voluntary diffusion of shared information (DiMaggio and Powell, 1983; Meyer and Rowan, 1977; Pfeffer and Salancik, 1978), because highly interconnected environments provided relational channels through which information could be diffused easily. Macneil (1978) also observed that the more relational the members were, the more it took on the properties of "a mini society".

In a strong relationship, cooperation, trust, intimacy, and empathy were developed between the parties (Granovetter, 1973). Interaction was frequent and each party reciprocated the trust such that strong, mutually trusting relationships were built incrementally over time. Trusting each social system member was critical as the element of trust had to be built up and continuously re-enforced as it formed the underlying thread that held all the members together until the successful innovation diffusion was achieved. Hence, effort was expended to ensure that little or no breakage in the trust factor occurred and any impending damage was repaired swiftly. On the contrary, casual acquaintances, represented by infrequent interaction and indifference among members were characteristic of weak ties. Information exchanges between members of a less dense network were impeded by sparse, fragmented systems and were more likely to exhibit multiple conflicting social system members.

According to Lorange and Murphy (1984) some social systems did not work efficiently if the prevalent power structure among the social system members was strong. The new innovation would be implemented successfully only when the powerful members 'politically' accepted it.

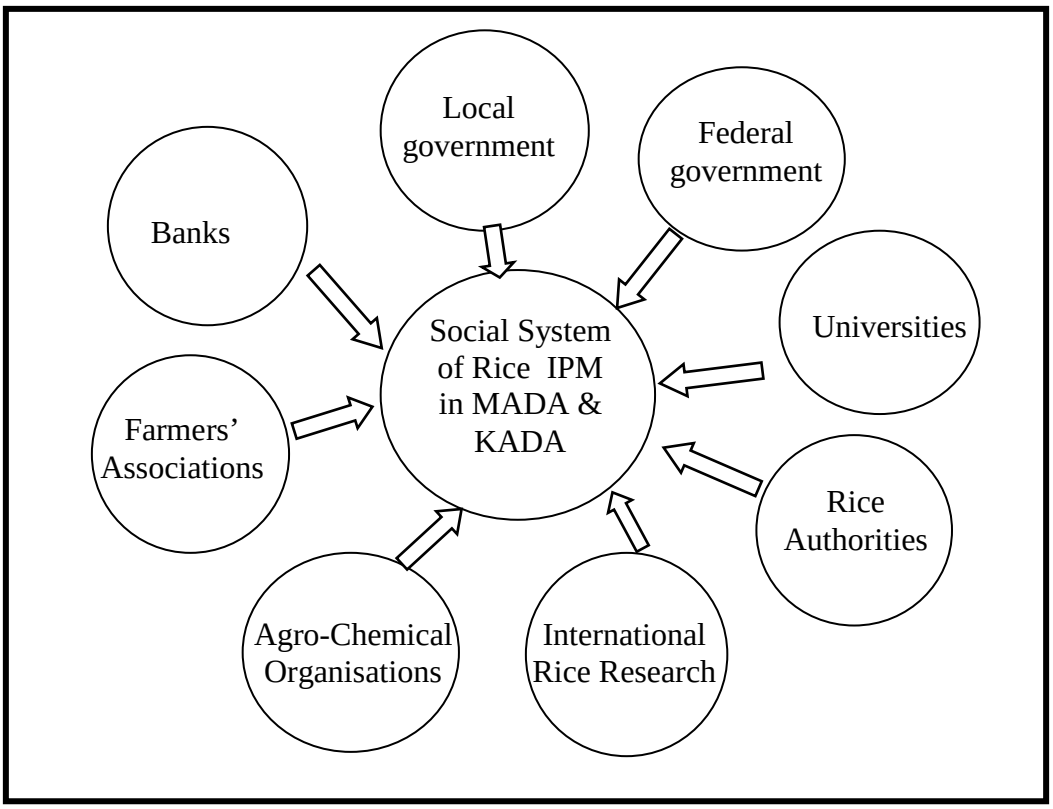
Otherwise, it would be viewed as potentially disruptive to the relative power coalitions in the social system which consequently would lead to the non-adoption of the innovation. In addition, Green & Hevner (2000) researched and instituted in their model that successful diffusion of technology was greatly dependent on an encouraging environment that had the support from all the relevant authorities, which also constituted a boundary within which the innovation was implemented.

In MADA and KADA, some of the members of the IPM social system included; the University Research Units, Centres of Excellence, Technical Standards Organisations, Agrochemical Organisations, Rice Industry Associations, Financial Institutions, Labour Organisations, Local Governments, Federal Government and Communities which supplied Knowledge and Skilled Workers. A pictorial image of the social system was presented in Figure 2.3 below. It displayed all the inter-related organisations involved actively in promoting the diffusion of IPM innovation and technology to the end-users (rice farmers) through the agricultural extension officers. When an effective linkage between the component members was present, they leveraged on each other's expertise and strengths as they were in a better status to promote the adoption of the IPM innovation and technology.

One of the key component members of the IPM social system in this research study was the government, as it provided access to expertise, technology, laboratories, research facilities and financing. A social system that was fabricated with strong components was more likely to enhance the KAP level of the agricultural extension officers, as contrasted with a weakly-linked social system. Governments can create or strengthen the institutions to promote collaboration efforts. Governments can also screen particular clusters and identify bottlenecks, gaps and

weaknesses to ease, fill and ameliorate these problems. Some of these bottlenecks could take the form of critical basic infrastructure, high tech infrastructure, or supplier firms.

Figure 2.3: The IPM Social System in MADA and KADA



2.4.4 Communication System

Good communication systems played an important factor in determining the success of diffusion and adoption of innovations. Communication system variables like the number of IPM meetings held and attended proved to be statistically significant predictors of the intensity of IPM adoption. According to Maru (2002) and Rolling (1988), communication systems were critical sources of information in the agricultural industry, notably when new research findings had to be disseminated throughout the industry players.

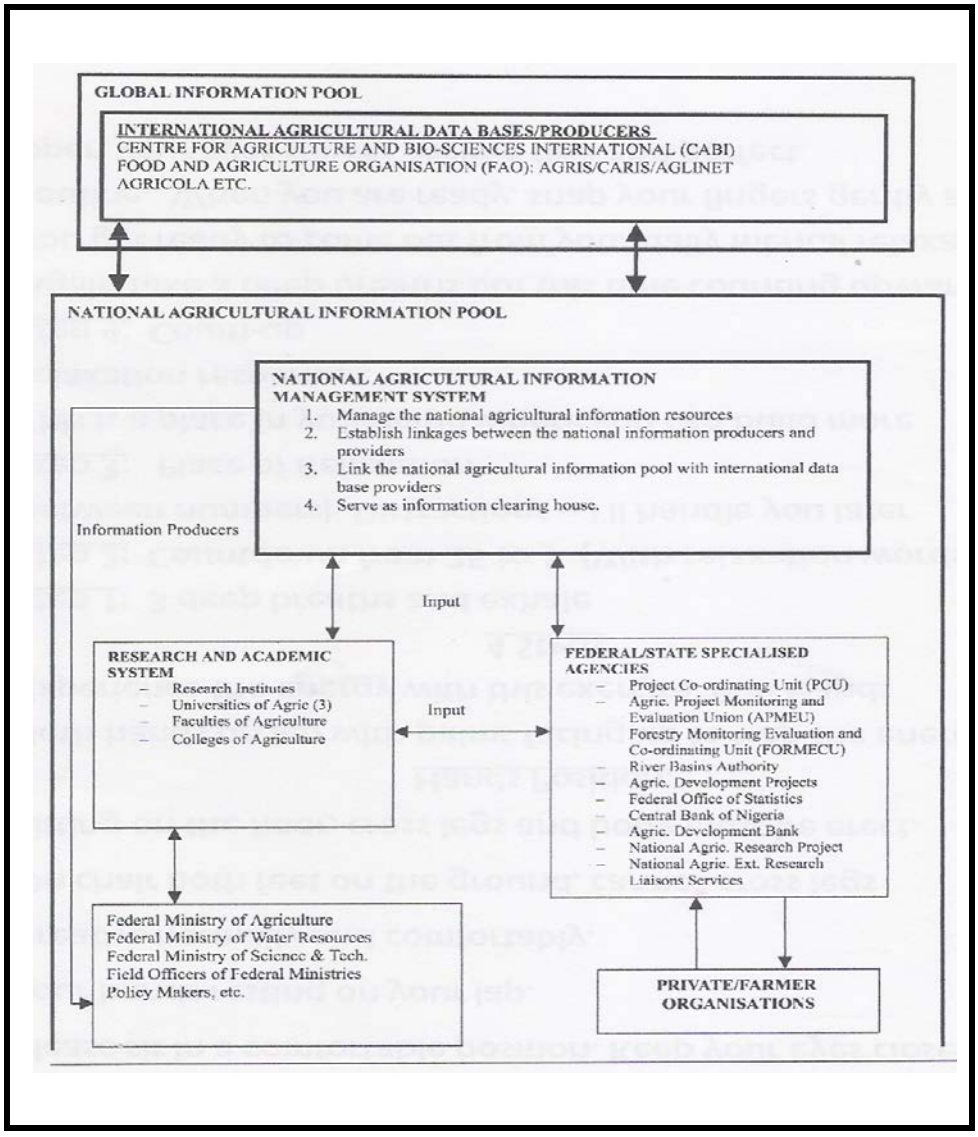
In generic terms, communication systems referred to the processes by which individuals created and shared information with one another in order to reach a mutual understanding. According to Carayannis and Campbell (2006), communication channels were the main means of sharing knowledge from one location to another notably through 'glocalising' (global/local). This term referred to a network theory that used extensive networks of international and national carriers in the most efficient way to create and disseminate knowledge. In their research, they also found that the diffusion of innovation through the mass media was the main agent to disseminate knowledge to people, using a top-down approach. Mass media channels (radio, bulletins, and brochures) were primarily excellent creators of awareness of knowledge of new innovations.

Even in the field of web-based supply-chain management systems, an exploratory research methodology was used by Ngai, et. al., (2004), that studied the critical success factors. Their study revealed the major key success factors, among them being communication. Additionally, other research by Lamb, et. al., (2004) and Wright (2006) revealed that constant communication needed to exists in order to augment the probability of successfully implementing a project. The linkages of communication should be between the leadership of the organization and the members of the innovation implementation team, between them and the parties outside the organization which included its intermediaries and between consumers or consumer groups, among others. Moreover, according to Solomon, et. al., (2002) and Bakanauskas (2006), correct communication channels needed to be used during the process of diffusion. These channels had to ensure that there were clearly understandable communication messages that were oriented towards the behavior patterns and preferences of the target category of adopters and also the target consumer segment.

In the world of agriculture, an agricultural information system could be defined as “a system in which agricultural information was generated, transferred, consolidated, received and fed-back in such a manner that this process functioned synergistically to underpin knowledge utilisation by agricultural producers” (Rolling, 1988). Zaman (2002) believed that agricultural information system was an essential input to the agricultural education, research and development as well as the extension activities. He reiterated that different types of information were required by different users for their varied purposes. Some of these myriad users included; government decision-makers, policy-makers, researchers, program managers, field workers and farmers.

An example of an agricultural communication system was extracted from the national agricultural information management system in Nigeria, as shown in the Figure 2.2 below. In this case, a systematic documentation was made of all agriculture information resources of the nation’s research institutes, universities of agriculture, faculties of agriculture of other universities and other major agricultural information producers. Hence there was an evolution of a functional linkage between all producers, providers and consumers of agricultural information.

Figure 2.4: Agricultural Information Management System in Nigeria



From Roger's study (1995) it was evidenced that farmer's adoption of new technology in agriculture had often been framed within the traditional adoption-diffusion model of innovation in which a few "innovators" would initially adopt the technology, then the majority of the farmers, followed by the remaining "laggards". Better communication and active dialogues between scientists, agricultural extension officers and farmers would help increase the utility and reliability of the information generated as the participatory process would involve the

identification of the community needs, the constraints, and the plans for the execution of the innovation (Carayannis and Campbell, 2006).

Additionally, McCorkle (1989), Saver (1990) and Kloppenburg (1991) reiterated that a system of direct communication channels was needed by the farmers that could be used as a source of knowledge input, rather than as passive receivers of information. Hence for successful innovation adoption, top management needed to create an environment where open, honest dialogue and communication could take place (Carpenter, 1986). Nutt (1987) argued that unsuccessful innovation implementation was due to inadequate and ambiguous communication of the exact processes that had to be done in the implementation process of the innovation. To overcome this, Alexander (1985) proposed from his study of 93 firms that a two-way communication feedback system had to be created. This system permitted and solicited questions from implementers who encountered problems during the adoption process.

Additionally, top management was encouraged to be highly committed in stimulating a strong and effective communication system as it was warranted for influencing, forming, changing attitudes and persuading the implementers to adopt new innovations. The ideal communication system especially when there was a great degree of promotion required for the adoption of an innovation (Bero et. al., 1998) was through interpersonal networks, strong social systems and face-to-face exchanges. Geoghegan (1994) also stressed that an enhanced communication level between members of the social system was critical and there was a need for all the independent organisations within the system to have a platform to meet regularly. A series of regular, scheduled and consistent meetings between the members of the social system would help create a

sense of ownership and would improve their chances of buying into the new technology (Pfeffer, 1978). Another point to note was that the validation process that was commonly used to evaluate an innovation was rarely based on scientific research, but more powerfully, based on the subjective evaluation of their peers who had adopted the innovation (Peay, 1997).

One of the key stumbling communication blocks in the IPM innovation implementation process was the on-going battle on the numerous interpretations of the term 'IPM'. Through a good system of communication, this matter could be resolved among the academics, researchers and implementers who had multitudes of interpretations for the concept of IPM. This semantics battle had gone on for decades without really resolving the argument. Meanwhile the real problems that the rice farmers faced continued to receive little attention. Therefore it seemed necessary for policy makers, researchers and implementers of IPM programs to address this so that all the parties concerned would be communicating along a similar frequency of language.

Another pending issue to be addressed was that within the social system, there were several organisations charged with goals related to enhancing prudent IPM practices. For instance, it was common to have research carried out by one set of organisations, such as Universities, International Rice Research Institute and the private sector. However, another set of organisations were charged with the responsibility of executing the extension work or delivering the findings to the Extension Departments, NGOs as well as to the Farmers' Cooperatives. Although the goals of each set of organisations were very different, their target-client was the same, the rice farmers. Hence, an excellent system of communication between these sets of organisations had to be upheld. Furthermore, the individual sets of organisations, including the

agricultural extension officers, should be empowered and given the authority to make decisions, as this would reinforce their leadership roles and facilitate the smooth and successful innovation diffusion process.

Finally, a clearly understood system of communication protocol would enable a more successful transmission of ideas from various aspects. For example, the benefits from the IPM innovation would be disseminated to all the members in the social system. This would help to improve their understanding of the IPM innovation leading to a higher achievement rate of successful implementation coupled with higher performance indicators. Additionally, the success of the innovation being diffused could be monitored and propelled correctly by the users of the IPM technology as the communication system would facilitate systems of checking and feedback that would enable speedier correction and a higher level of successful implementation. Lastly, a good communication system could provide the necessary support that enabled the decision towards adoption of the innovation to be re-affirmed, validated and confirmed by the social system members, leading to a greater chance of better implementation of the IPM technology and innovation (Peay, 1997).

2.4.5 Intermediaries' Role

This group of people were identified to be critical to the successful diffusion of innovation process. The two groups of people who fell into this category of intermediaries were the change agents and the early adopters. According to Rogers' 1995 model of diffusion, the change agents were the key people who acted as intermediaries between the sources of information from the

researchers and diffused it to the ultimate end-users. The change agents in this research case study were the agricultural extension officers who disseminated information on the innovation to the rice farmers.

In their study on the change agents' perspectives Rodriguez, et. al., (2009), found that change agents played a key role in influencing the farmers to adopt the new technology and innovation; however, they needed to be well prepared to provide accurate information about the benefits of implementation of the innovation as well as possess strong technical knowledge of the technology and innovation to be diffused. Then they will be able to furnish good details on the technical side of how the innovation is to be implemented to the end- users, the fatmers.

Chaudhuri (1994) experimented and research an innovation project in Indonesia and discovered that if the change agents' effort was strong in influencing the early adopters and early majority notably in the early stages of the diffusion process, then the rate of diffusion will be enhanced significantly. Change agents must communicate to the early adopters and early majority a convincing argument in favor of the innovation that accentuates the compatibility of the innovation with system norms. The early adopters and early majority will then be able to use this argument, which will hopefully resonate with the masses, to support their own adoption decision.

Successful efforts to diffuse an innovation depend largely on characteristics of the situation. In the case of wanting to eliminate a deficit of awareness of an innovation, then the most appropriate method would be through the use of mass media channels. Additionally, if the case was to change the prevailing attitudes among the end-users about an innovation, then the best

recommended practice would be to persuade the early adopters and early majority groups. The change agents play a more critical role in the earlier stages of technology and innovation diffusion. It is at this stage that they need to undertake a more aggressive action plan and target the early adopters and the early majority groups for their prompt response action.

According to Burke, et. al. (2001), an underlying implementation success factor was hinged on the human factors of the social system. They defined some of these human characteristics to be the interpersonal skills of the change agents who were involved with the innovation dissemination process, viz., their individual abilities to work together towards a common goal despite the conflicts, competition, status differences, that may arise (McEwen, 1988). In this specific research study, the interpersonal skills of the agricultural extension officers were critical, notably with respect to having the same goal of successfully aiding the IPM innovation. Only when this attribute or characteristic was evident, then the probability of successful implementation of the IPM technology and innovation could be enhanced, pushing up the successor performance indicators.

It was critical that the change agents or the agricultural extension officers were continuously kept highly motivated and excited about new research findings and applications. They had to be updated on how the new innovations were going to elevate and improve their daily job functions through the benefits of the new IPM technology. Geoghegan (1994) echoed that the chances of successfully "selling" an innovation to the pragmatic users would significantly increase if the change agents or early adopters were made a part of the planning and policy making process. Otherwise, attempts to "convert" them to the point of view of the innovators were likely to be

sluggish. In other words, the new innovation had to be sold to them first. Through this it was hoped that a higher percentage of users or rice farmers would benefit from the new technology (Rogers, 1995). Consequently, this would enhance the KAP level of the agricultural extension officers, who in turn would promote the new IPM technology to the rice farmers. When the adoption level among the farmers increases, this would inevitably raise the successful implementation of IPM innovation performance indicators.

The change agents had another important role to play in the research process, notably with the problem definition aspect as the problem could be properly articulated by those who had their noses to the ground, viz. the agricultural extension officers. With the valuable input solicited from the agricultural extension officers, the researchers would become more precise in their endeavour of generating innovations that would address the needs of the end-users more accurately. The agricultural extension officers would provide "hand-holding" activities to the rice farmers during the diffusion process as assistance and encouragement would be warranted by these farmers who were adopting these IPM innovation and technology for the first time. The KAP among the agricultural extension officers would be enhanced to a deeper knowledge level, resulting in a higher level of success in the performance of the IPM innovation.

Rogers (1995) wrote that the adoption of innovations may widen the gap between high and low socioeconomic groups. Change agents favoured adopters with higher levels of education because advanced education, combined with innovativeness, led to higher rates of adoption success. With respect to the early adopters, Rogers (1995) announced that they were individuals or groups of people who were willing to take the risks of adopting the new innovation that was still not widely

used among their peers. The early adopters in this research study were the rice farmer leaders. They represented the opinion leaders who served as role-models for members in their social system. Some unique characteristics of the early adopters were; they had more social participation, were highly connected within their interpersonal networks, had greater contact with the change agents or agricultural extension officers, had greater exposure to mass media channels, had greater publicity to interpersonal communication channels, engaged in more active information seeking activities, had greater knowledge of innovations and a higher degree of opinion leadership.

This led the change agents to give the early adopters or rice farmer leaders, an advance notice of new innovation and technology. Since the endorsement of peers was a critical element in the widespread adoption of innovation and technology, the early adopters formed the platform on which practical evidence was drawn for all the others, notably the sceptics, to see. They were the living testimony that the new innovation did work and brought about abundant benefits to them. An increased understanding of the IPM technology helped the early adopters reduce the non-adoption risk and was instrumental in getting an innovation to the point of critical mass adoption by shrinking the numbers of the group called the 'late adopters' (Wilson et. al., 1996). Hence they played an essential role in the successful diffusion of an innovation.

Green & Hevner (2000) researched and instituted in their information technology model that successful diffusion of technology required the direct involvement of the early adopters. The more involved the adopters were in the decision process, the more likely they would perceive they had a choice over when to apply the new technology leading to a perceived control over how

to use the innovation. This would increase their level of knowledge, attitude and practice and promote the diffusion of innovation to the late adopters.

Additionally, the rice farmers who were more educated seemed to have a higher level of income. Hence their financial status enabled them to be more unencumbered with money issues and therefore, they could use their funds more readily to explore and undertake experiments on the IPM innovation. Armed with the results from their experiments, they were more inclined to ensure that the IPM innovations were utilised, more profitably. This inevitably helped to ensure the successful implementation of the IPM innovation and technology.

2.4.6 Innovation Attributes

In the adoption of innovation, another critical success factor was the innovation attributes. The characteristics and attributes of the innovation were seen to be crucial in the rate of adoption of the innovation, as identified by their study (*Rodriguez, et. al., 2009*). These characteristics and attributes of the technology and innovation, serve to act as indicators of future rates of adoption. The success of innovations diffusion depends largely on the extent to which these traits are present. Additionally, other criteria regarding the new technology and innovation are equally critical, such as, the compatibility of the innovation to the existing values and beliefs held in the social system, the nature of the social system, the effectiveness of communication channels, the benefits provided by innovation are clearly seen, clear visibility of the innovation in the society, clear and uncomplicated use of the innovation, possibility of trying out the new technology and innovation, as well as the efforts of the change agents.

As described below are the five desired attributes of the new technology and innovation. Their strong presence and existence would help boost the success rate of the innovation being adopted (Rogers, 1995). These attributes are;

1. Trialability

This referred to the degree to which an innovation could be experimented with or could be tested out, on a limited basis. This helped to mitigate the uncertainty of the innovation to the potential adopters as they could learn by doing. This was verified by Swanson-Fisher (2004) in his research findings that a limited cost-benefit trial of an innovation promoted faith that the evidence on the innovation was correct and that its implementation was logistically possible. Chaudhuri (1994)'s research showed that if the innovation was easily tried and tested, then the rate of diffusion will be enhanced.

2. Observability

Swanson-Fisher (2004) observed that the degree to which the results of an innovation were visible to others would act as a spring-board to their buying-in. The observation would stimulate peer discussion of the new innovation as neighbours of the early adopters would often seek each other's evaluation. Furthermore, if the early adopters were a more charismatic group, then a larger volume of individuals would adopt the advocated innovation. Chaudhuri (1994)'s research showed that if the innovation was easily observable in use, then the rate of diffusion will be enhanced.

3. Relative Advantage

Relative advantage referred to the degree to which an innovation was perceived better than the innovation it superseded, in terms of social prestige, convenience and satisfaction (Rogers, 1995). The farmers had to acquire the knowledge of the IPM and its advantages before they appreciated the relative advantage and increase their willingness to adopt the IPM practices as a long-term pest control strategy. If the agricultural extension officers needed to 'sell' the IPM innovation to the farmers, one of the best ways was to emphasise its relative advantages, as it proved to be one of the most active source for them. Additionally, the relative advantage may not be in absolute terms, however, the perception of the potential adopters was more relevant as it comprised a number of farming practices factors which could be reduced to economic benefit for the farmers. If an innovation recommended a certain reaction or behaviour and this behaviour was perceived to increase the revenue of the potential adopters, then the probability of the innovation being adopted, was high. Chaudhuri (1994)'s research showed that if the innovation had a relative advantage that is clearly superior to existing products, then the rate of diffusion will be enhanced.

4. Complexity

Geoghegan (1994) in his research findings referred to complexity as the degree to which an innovation was perceived to be difficult to understand and complicated to use. New innovation that was easily understood would be adopted more rapidly so as to reap early success, as compared to innovations that required the adopter to develop new skills and enhanced

understanding. This was notably true for the immediate adopter who was able to see the result of the trials as the innovation was open to observation with respect to its methodology as well as the results obtained. This was also echoed by Wilson et al., (1996) who stated that it would be easier to accept and integrate if success was experienced initially and subsequently built upon. Chaudhuri (1994)'s research showed that if the innovation was less complex than existing products, then the rate of diffusion will be enhanced.

5. Compatibility

Swanson-Fisher (2004) explained compatibility to be the 'fit' of the innovation into the circumstance into which it was being adopted. It was the degree to which an innovation was perceived by its potential adopters as being consistent with their existing values, past experiences and current needs. The more compatible it was, the more rapid was the rate of adoption. The innovation being proposed must address an issue that was being perceived as a problem by the potential adopters.

Thus, Rogers (2003) postulates a two-step model as the diffusion paradigm and diffusion is essentially a social process in which new ideas are communicated through interpersonal networks. Diffusion is seen as a process in which participants create and share information with one another through interpersonal networks, exchanges and social modeling between those who adopt and those who will adopt. Specifically, the two-step model suggests that information about the innovation is first obtained by opinion leaders in the social system who then pass the information on to the rest of the community. Chaudhuri (1994)'s research showed that if the

innovation was compatible with the values of the target market, then the rate of diffusion will be enhanced.

The existence of all these five attributes of the new technology and innovation in their favourable side as compared to the prevalent technology and innovation, would be an indicator as to its successful diffusion and implementation. If it is prevalent, then this would enable and facilitate the upgrading of the KAP levels of the change agents and early adopters to ensure a higher rate of success of diffusion of the IPM innovation.

2.5 Variables influenced by the 6 Key Factors

In a study conducted by Ash (1997), it was revealed that organizational factors were important predictors for diffusion of technology and innovations. These organisational factors seemed to have different effects on the diffusion process of technology and innovation. Some of them were supportive while others did not possess the same effect. Hua and Zhang (2010) also concluded from their study that knowledge flow success among supply chain enterprises was found to be associated with several key variables. After considering the fact that different characteristics of knowledge flow could exist in different types of supply chain enterprises, they conducted their study on the manufacture and IT supply chain enterprise. From their study they revealed that certain right variables were needed for the process of knowledge flow before the knowledge flow was deemed to be successful.

Ahmad (2008) in her research on the influence that teachers had on the learning capability of the students, concluded that the success of any learning and teaching situation depended a great deal on the teachers ability to influence the students. Hence to improve the ability of the students to understand what they learnt, was strongly influenced by the teacher who was their 'change agent' or influencer.

In this exploratory research, the researcher identified six key variables from the literature that indicated that their presence had a positive correlation to the successful diffusion of technology and innovation in organisations. In order to explore this research further, the target respondents were identified. They were the agricultural extension officers from the two largest rice granaries in Malaysia, MADA (Muda Agricultural Development Authority) and KADA (Kemubu Agricultural Development Authority). They were the key change agents or influencers who were in a strong position to influence the behaviour changes and also the decisions made by the end-users, namely the rice farmers. The key reason being that they possessed the knowledge, attitude and practices (KAP) of the new IPM technology and innovation that the rice farmers were strongly encouraged and influenced to adopt in their daily farming initiatives.

This was corroborated by Heong (1992), who concluded in his research that the KAP level was deemed to be a strong influencing variable as these agricultural extension officers represented the change agents who were the front-liners to the end-users, viz., the rice farmers. They were empowered to encourage a change in thinking among the rice farmers such that it amounted to a paradigm shift in mindset and helped prepare them for a level of readiness and capacity to learn new approaches to IPM technology and innovation.

Being the primary responsibility of the agricultural extension officers to explain and facilitate the learning process of the rice farmers towards IPM, these officers were regarded as workplace instructors and trainers who took the technical material produced by the agricultural science and translated it into digestible learning material for the farmers. Stonecipher (1966) in his research stated that the agricultural extension officers had the tasks of bringing about the maximum number of desirable changes among the rice farmers. These officers should skilfully manipulate the elements of the learning situation and provide satisfactory learning experiences by developing the interests of the farmers and arousing their desire so that they are stimulated to take action.

According to a study conducted by Gagne (1972), the process of learning new information was characterised as a multi-dimensional activity that embraced motor skills, verbal information, intellectual skills, cognitive processing and the shaping of attitudes towards producing a mindset appropriate to the tasks and needs. All these attributes were evident in the learning of IPM and applying the knowledge and skills needed to deal with the problems of pest management.

Numerous researches in various fields incorporated the influencing variables of KAP in their studies. These included; Abdul Rahman (1998)'s study on the KAP level of the agricultural extension officers on the importance of insect pest of date palm in the Riyadh region in Saudi Arabia; Hailu et. al., (2009) on the know-how of primary eye care among the health extension workers in Southern Ethiopia; Ogunfowora et. al., (2006) on the KAP level of the community health workers in Nigeria regarding neonatal jaundice management; Onwuzurike et. al., (2001) on the KAP level of the family planning health workers in Nigeria and the research study

conducted by the team of Salameh et. al., (2003), on the KAP level of studying pesticides usage in Lebanon.

After identifying the six key influencing variables from the literature that would promote or hinder the successful implementation or diffusion of technology and innovation, the target respondents were identified to be the agricultural extension officers. The researcher then identified the key influencing variables of KAP. Next the researcher utilised exploratory research techniques to identify the strength of the influencing variables of Knowledge, Attitude and Practice among the agricultural extension officers at both the rice granaries.

Using exploratory research techniques, the researcher attempted to study the relationship and extent to which the six key variables had an effect on the strength of the influencing variables of KAP. It is believed that when the strength of the KAP is significantly high, then the agricultural extension officers' power of influencing the rice farmers will be strong and the IPM innovation would be diffused successfully, as the knowledge of the agricultural extension officers would be transferred directly to the rice farmers as they were the last link in the communication chain to the farmers.

Moreover, the attitude of the agricultural extension officers would be a strong influencing factor to convince the rice farmers to adopt the new IPM technology or innovation. Likewise, the practices adopted by the agricultural extension officers would act as a strong motivator to the rice farmers. Conversely, if the strength of the KAP among the agricultural extension officers is

weak, then they will not be able to play a strong change agent role, thus leading to a failure in the diffusion of new IPM technology and innovation.

2.6 Performance Indicators of Successful Innovation Diffusion

In this section, an attempt was made to enumerate the various success indicators for the diffusion of IPM innovations. These performance indicators were used in this research as evidence that the rice farmers decision making process had changed. This was because they were influenced by the agricultural extension officers whose KAP levels were strong enough to influence them to change and adopt the new and better IPM technology and innovation. The performance indicators that were selected for this analysis were the following;

- Yield per granary area
- Major pest outbreaks
- Herbicides usage levels
- Insecticides usage levels
- Rodenticides usage levels

A comparative analysis of the above mentioned indicators would be undertaken with the objective that it would provide an insight into whether the strength of the influencing variables KAP, managed to bring about desirable results in the performance indicators as listed above. If there were significant changes in the results of the performance indicators, then it could be

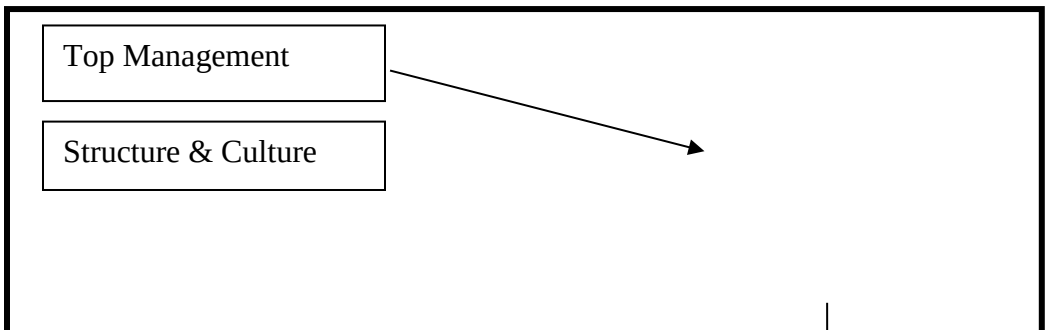
concluded that the agricultural extension officers' level of knowledge, attitude and practices played a strong influencing role in bringing about a change in the KAP of the rice farmers. The reverse would be held true if there were no significant changes in the results of the performance indicators at both the rice granaries of MADA and KADA.

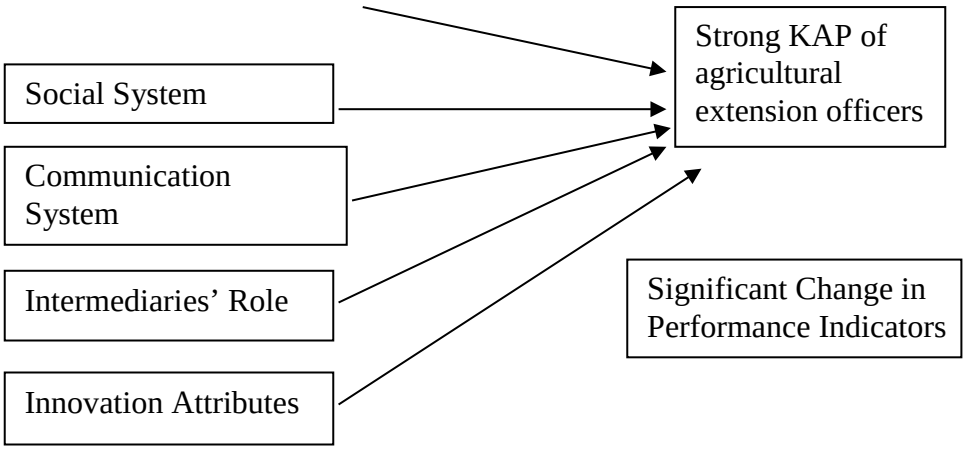
2.7 The Exploratory Framework

The above discussion was indicative of an attempt at incorporating many of the six key variables for the successful implementation of new IPM innovation diffusion, with the objective of improving its efficacy. The various factors were summarised into an exploratory framework as displayed in Figure **2.5** below. The exploratory framework summarised the relationships between the six variables that would lead to an enhancement of the KAP level of the agricultural extension officers. Subsequently changes in the selected performance indicators would be analysed to study if there is any relationship that connects the KAP level of the agricultural extension officers to the performance indicators. From this exploratory framework, a hypothesis could be formulated and used in the exploratory study of this IPM innovation diffusion research. The hypothesis would be;

If the six key variables influenced the strength of the KAP level of the agricultural extension officers, then this would lead to a change in the decision making process of the farmers and thus affect the successful diffusion of IPM innovation process, as shown by the changes in the selected performance indicators

Figure **2.5** : Exploratory Framework





2.8 Chapter Summary

The above discussion was indicative of the general theory found in the literature with respect to the key variables constructive to enhancing the strength of the KAP of the agricultural extension officers, leading to the successful diffusion of IPM innovation. These variables had been collated and formulated into a exploratory framework for the purpose of this research study. The six key variables were critical in affecting the strength of the influencing variable, viz., the KAP level of the agricultural extension officers. Additionally a number of selected performance indicators were used as a yardstick to evaluate if there were any significant changes. If there were, then they would be indicative that the farmers' decision making in adopting IPM innovation had changed due to the strong influence from the agricultural extension officers who had a high level of KAP. This exploratory framework provided the backbone to the design of the research methodology that was to be adopted, and elaborated in the following chapter.