CHAPTER 7

MODEL EVALUATION: CASE STUDIES

7.1 Introduction

The purpose of the case studies is to test and make modification to the IT Infrastructure Flexibility (ITIF) Maturity Model according to the real situation in practice. The successful actions of the construction organizations have undergone were examined in a process to bring flexibility infrastructure into the IT systems. These case studies permit deeper analysis of each success factors that are critically used to feed the development of flexible IT infrastructure.

In each case study, information about the basic characteristic of the organizations (includes background and history) were presented, followed by the sequence of events concerning the respective IT system. Each case presents the status of each factor of three dimensions, as presented in the preliminary model.

Three organizations participated - to maintain the anonymity of the organizations, they will be referred to as Organization Bina, Organization Eko, and Organization Taraz. The organizations were all based in Klang Valley in Malaysia –

where major construction activities are taken place in this country. Organization Eko and Taraz are large-sized organizations and Organization Bina is a medium-size company; all are involved in the construction sector with different nature of business – IT consultant for Malaysian construction statutory body, public authority, and construction consultant. The organizations have more than ten years experience in the construction IT sector. Organization Bina and Eko have patented many of their IT systems, and Organization Taraz has won awards in achieving in valuing IT in the organization and local construction industry.

The implementation of System P in Organization Bina has partly been used but is still undergoing major development in order to achieve its complete business objectives. System R in Organization Eko is being used and more improvement is needed relating to its contents and functionality. The implementation of System Q in Organization Taraz is considered to have achieved full success. System P and System R is a combination between existing systems and bespoke developments that utilized in-house expertise with vendor assistance in their system development, while System Q used customized third party packages with full in-house expertise.

The cases are outlined as shown in Figure 7.1. The process started with general comments describing the fact and features of the organizations. Following with that, each case presents the status of the critical success factors (CSF) of ITIF prior to project initiation, the status of the CSF at the current state, and then the targeted level that the organizations desire to be at in the future. During the case study, more than one level might seem to match the organizational situation, however, the most relevant level was carefully selected.

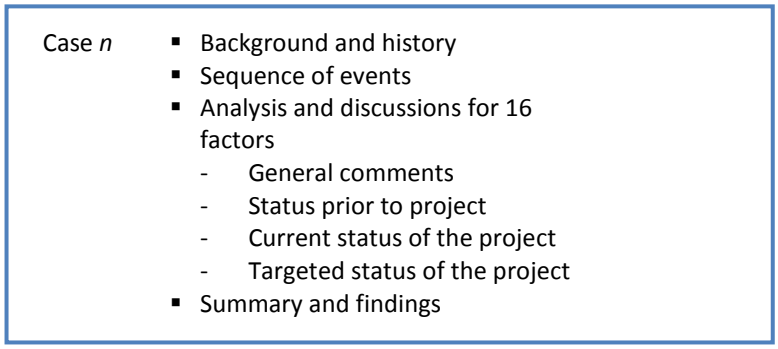

Figure 7.1: The outline for reporting structure for each case

In every section of CSF of ITIF's discussion, a maturity gap between the current and expected organizational capabilities are identified. Smith (2005) described it as a "Discrepancy Gap". By knowing the maturity gap, this could assist organizations to focus on specific areas such as technical, people, or management that need to be addressed in order to create the critical thinking for change to occur. The maturity gap is difference between the current and desires status (Alshawi & Salleh, 2011).

7.2 Case study 1 – Organization Bina

7.2.1 Organization's background

Organization Bina (herewith referred as Bina) is a wholly owned subsidiary of the Malaysian construction statutory body. Located in the central of Kuala Lumpur, Bina was established in year 2001 with the aim to be the leader in IT integration within the national construction industry. In the Malaysian context, Bina runs the government-led IT projects specializing in business-to-business development and operations. The organization has the responsibility as an advisor to the holding body in a context of IT opportunities to the construction economics through multimedia content development and publications. They provide fully integrated IT solutions and developing software

packages and services. Majority of the IT solutions have granted a patent from the Intellectual Property Corporation of Malaysia. Besides developing IT infrastructures for the industry, Bina provides IT training for the construction professionals.

As an IT-driven company, Bina allocated 85 percent from its total annual budget for IT investment. The budget was used to develop IT infrastructure that includes buying hardware and supporting software, maintenance, and for the development of human resources. In total, the organization has hired 43 staff, which includes 28 IT personnel and 3 full-time construction-related personnel (a quantity surveyor, a project manager, and an engineer), 6 temporary outsourced IT personnel, and another 9 administrators. The organizational structure is illustrated in Figure 7.2.

Figure 7.2: Organization Bina's organizational structure

7.2.2 System Implementation

Traditional tendering process has caused many problems throughout the processes (Kong & Gray, 2006). The tender documentation and preparation are paper intensive, not portable, expensive, tedious, and troublesome to produce. At this stage, various problems raised, such as human errors in document production – incomplete information or tender documents, possible mix up of documents, insufficient copies, possible leakage of restricted information, problems in issuing of addendums, and voluminous tender documents. These problems became the main driving force to initiate an electronic tendering system.

System P was initiated in year 2003 with its main purpose to digitalize the tendering processes right from advertising stage, tender submission, tender evaluation and tender award. The organization intended to gain time and cost benefits in the long run. The system flow is illustrated in Figure 7.3. Currently, System P has had two versions - Version 1.0 and Version 2.0. The first version consists of various modules: which are Tender Advertisement, Registration and Purchase Tender, Pricing, and Tender Submission. Version 2.0 contained the existing modules with additional Tender Evaluation and Tender Award modules. System P is being used but development is still on-going to achieve its full business objectives; to cover all types of existing procurement methods for the public projects.

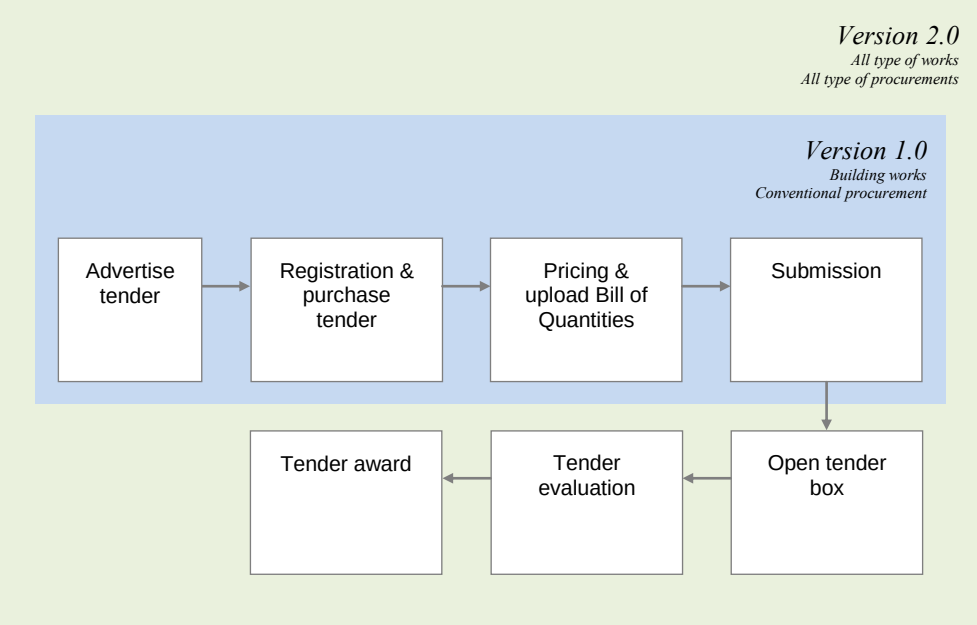

Figure 7.3: A system flow chart for System P modules – Version 1.0 and 2.0.

System P's Version 1.0 took 6 years to develop. The development started the focus at open tenders for conventional construction building contracts only. This version was only compatible in Windows environment, accessible only through Internet Explorer and Mozilla Firefox. It was secured with a firewall, secure sockets layer (SSL), and the digital signature facilities. The disaster contingency system was hosted by the established third party vendor. Version 1.0 also was inspected by an independent and certified security auditor to prevent intrusions.

The Version 1.0 was a result from trial-and-error and ad-hoc decision-makings. The system design for Version 1.0 was not comprehensive and it was set up in a few phases of restructuring among the top management. Bina identified few limitations during the Version 1.0's development; (1) there was a lack of skills and expertise and had limited number of IT personnel. This added to the constraints to the number of

tasks, as well as, the on-time completion of the tasks, (2) IT staff have difficulties to understand the traditional construction tendering processes due to limited knowledge in the construction industry, (3) a dedicated project management team was not established when the project started, and (4) the tenderers, especially the contractors, have no confidence to the e-tendering system security. These reasons made the project's success factors difficult to be determined. This combination of these problems made the Version 1.0 rigid and difficult to be reconfigured. However, after the readiness study completed in 2005, the system design was restructured. This led to a more progressive development until the first launch of Version 1.0 in mid of 2009.

Version 2.0 was started in early 2009. The organization made a major transformation to the project team – they gathered a myriad of IT experts, including a System Architect, to continue developing the intended business objectives of the system. A dedicated project management team was also established. Figure 7.4 shows the organizational chart for System P's project team.

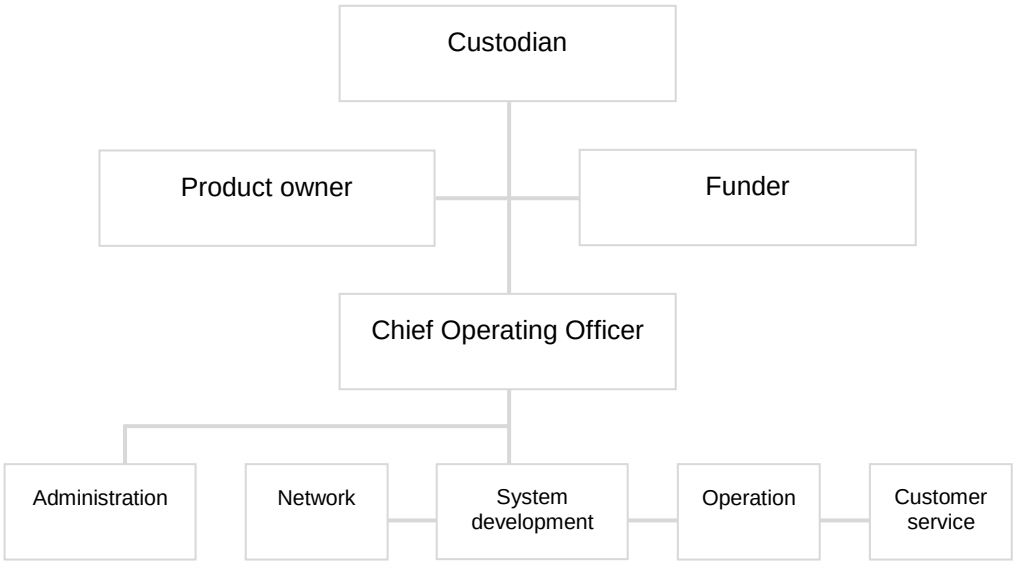

Figure 7.4: System P team organizational chart

A user acceptance test and pilot projects were conducted. System's defects revealed by testing the system to the intended users (contractors and clients) – this resulted to a refined system design that was discusses through a series of workshops. The improvements include system's interfaces, components, and data for a system to satisfy system's requirements. The compatibility of Version 2.0 was improved with higher adaptability for integration and changes. However, in the context of coping with technological change, Bina has made no changes to their management plan. The integration was made based on informal decisions by the top management of Bina. The organization also has outsourced IT personnel to obtain advice in the latest technologies, and Bina started sending internal IT personnel for trainings and seminars to make them aware of the latest inventions in industry. The Version 2.0 was launched in late 2011 with an integrated financial system attached to the system. Latest statistic showed that the system has reached more than one thousand users (up until June 2012). Figure 7.5 shows the sequence of events for System P.

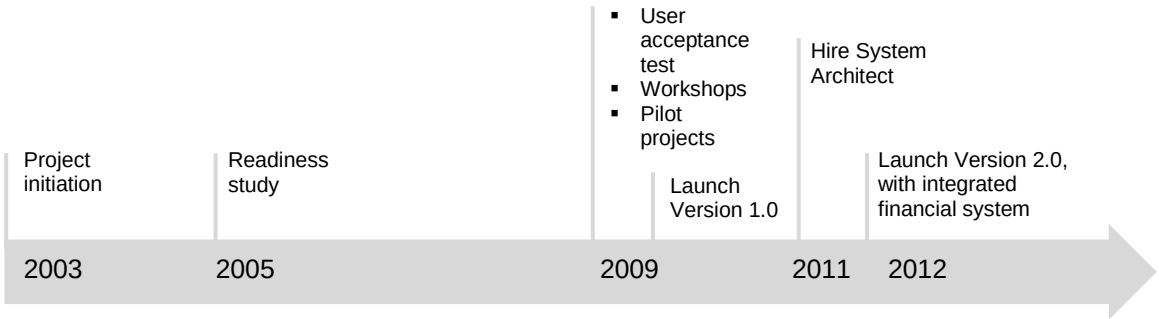

Figure 7.5: System P timeline

7.2.3 Analysis

(i) File format standardization

Previous status

- Figure 7.2 demonstrates that every phase has its own module. They are distinct, but related. Every module manages different file formats. The file format standardization existed only within the module [*Level 2*].
- At the initial stage, System P collected raw data using a manual (human) input. An officer was assigned to gather and manage the both hardcopy and softcopy files; and converts them to the required format using a simple file conversion method [*Level 1*]. For example, they used PDF Converter and Editor to covert a word document to PDF format. In some cases, if Bina does not have an application that is required to open certain softcopy files, the will scan a hardcopy and save it as PDF files.
- The situation limits the compatibility of the system; hence it became a motivation for Bina to develop the standardization tool.

Current status

- A centralized and integrated standardization tool has been established and deployed by System P, which was developed by the in-house team, specifically for System P [*Level 4*].
- The main function of this tool is to standardize all the incoming files in different formats, for example, Extensible Markup Language (.xml), in Word Documents (.doc/.docx), in Drawings (.dwg), in Computer-Aided Design (.cad), and Oracle-based files.

- The tool automates the conversion process from these foreign files to the Portable Document Format (.pdf), which can be easily readable by users. Furthermore, PDF allows file compression, which means that even though the original files might be large, it can be reduced to a much smaller size without losing its contents. This automation offers a quicker integration as opposed to the conversion that was done manually. The conversion usually takes between two to five minutes, and sometimes it is up to ten minutes, depending on the Internet connection speed.
- With the help of this tool, the Version 2.0 has become more flexible where it reduces the complexity to integrate the system to other authorized internal and external systems [*Level 5*].

Targeted future status

- The future plan was to maintain the tool along with extending the integration procedures of System P with other partner's internal or external systems to fit the intended business objectives.
- Bina is satisfied with the current standardization tool they have developed.

Additional comments

- System P carries a high level of data security that involves confidential tender documents electronic transmission. Therefore, systems integration will always take place between System P and other authorized systems.
- The top management is responsible to make thorough system's selection and authorization.

Table 7.1 Organization Bina's maturity for file format standardization

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
File format standardization	←	←		←	•	5

Indicators: • Current status ← Previous status → Future status

(ii) Integration interval

Previous status

- Before the project management team was established, the organization took almost six months to complete integration, especially for complex cases [*Level 1*].
- However, in Version 2.0, the integration interval is improving because of clear procedures and a dedicated team started to resolve any issues.

Current status

- Frequently, System P was required to add on functions by integrating it with other systems, modules, or applications. In average, Organization Bina has taken one month or more to complete [*Level 2*].
- Because of the security reasons, the back-end of the system has restricted accessibility. In every event of changes, the organization needs to make a demonstration for the management team by using a prototype system. Consequently, it has contributed to lengthen the decision-making processes.

Targeted future status

- Bina was hoping to increase the integration interval to less than month (as according to their Annual Report 2011) [*Level 3*]. Additionally, the organization claimed that the integration interval would possibly be less than a

week if the decision workflow is further refined and clarified [*Level 4*]. A faster integration interval will contribute to quicker completion on time.

- The organization does not believe that the integration interval could be as fast as minutes to seconds due on the local situation of bureaucracy that the organization needs to get authorization from many layers of management, and low technology awareness among other non-IT departments.

Table 7.2 Organization Bina's maturity for integration interval

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Integration interval	←	•	→	→		2,3,4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(iii) System design

Previous status

- Bina has no standardized documentation for system designs, especially in Version 1.0 [*Level 2*].
- The functional specification, technical architecture, and other related documentations were prepared in an unplanned approach, and it was only done when requested by top management or the client.
- Bina realized that the current system reflects discontinuity in decision-makings because it was difficult for the project team to map and collate system's requirements requested from time to time.
- Due to these reasons, system design for Version 2.0 was completed using reverse engineering solution.

Current status

- Bina hired a System Architect in early 2011. Since then, the organization has established a standardized and complete set of system design for Version 2.0 [*Level 3*].
- It involves a functional specification, technical architecture, system standards, physical database, system requirement analysis, and technical specification.
- System P Version 2.0 was designed to be amendable, hence, promoting a flexible infrastructure to the system. The system design was updated in every occasion new requirements are implemented [*Level 4*].
- Bina also employed a technical documenter to ensure documentation is produced systematically. This eases project analysis and progress tracking by the project team, top management and clients, hence, improves effective decision-making.

Targeted future status

- Bina will be structuring a plan to implement a computerized tool in developing and updating the system design [*Level 5*]. With this, Bina was hoping to improve the design analysis and drive continuous improvement in the system.
- In addition, Bina also believe that the tool will be very useful to assimilate the system design for the purpose of design usability improvement.

Table 7.3 Organization Bina's maturity for system design

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
System Design		←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(iv) Teamwork

Previous status

- Before the project management team was set up, Bina was faced with a significant problem of manpower shortage, especially during the development of Version 1.0.
- As a consequence, staff did not have a specific job scope and some responsibilities were overlapped; the team was formed in an ad-hoc fashion based on the tasks required [*Level 1*]. The organization disclosed that this situation encouraged unhealthy work environment by putting more work-stress for the staff, resulting to low productivity and poor work quality.

Current status

- Bina set up a project management team for System P in year 2009 [*Level 4*].
- An organization chart was established, consisting the managers and sub-ordinates. The tasks were assigned based on experience, expertise and interests of personnel. Before this, Bina identified core competencies of staff and system requirements that were required for the system [*Level 3*].
- In certain circumstances, the organization often experiences lack of manpower to manage existing workload. This resulted to staff taking responsibilities beyond their job scope description occasionally [*Level 2*]. For an example, Bina experienced a shortage of Graphic Designers, so the Network Engineer was requested to do a graphic design for the system's interface.
- Bina started to have a periodical plan for supporting staff in continuous development.

Targeted future status

- From Bina's Human Resource Planning 2012 excerpt, yearly team-building activities will be carried out to promote teamwork among staff [*Level 5*]. A large amount of fund has been allocated in the 2012 company budget for team building to be conducted consistently.

Table 7.4 Organization Bina's maturity for teamwork

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Teamwork	←	←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(v) Independence & pro-activeness

Previous status

- Majority of the staff have started to work independently, but were still confined in a comfort-working environment.

Current status

- In getting a new task started, staff were called for group briefings about the project requirements. This exercise is important to ensure staff are aware of the intended objectives of the tasks and project [*Level 1*].
- During the briefing, an open table session was carried out to allow staff to discuss about the work strategies through brainstorming and task management planning, with the goals set by the top management [*Level 3*].
- Nevertheless, Bina revealed that the discussions were normally participated at the managerial level; sub-ordinates take action when instructed under standard procedures and methods that was prepared by the IT manager [*Level 2*].

- The organization encouraged staff to be more pro-active by offering monetary bonus based on the performance appraisal. This intensive has inspired only a minority staff, and Bina believes that it will inspire more staff gradually in the future.

Targeted future status

- Bina is taking action to further encourage staff to be more pro-active in proposing new technical solutions and ideas [*Level 4*].
- Besides monetary form, the organization has planned in their 2012 Company's Budget to annually conduct internal discussions at tourism destinations as an effort to de-stress from a workload and as an encouragement for the staff to be more pro-active.
- Bina aims to be an autonomous team, however, due to limited authority as a subsidiary company, this will not be achievable in a short run. Being autonomous offers freedom of decision-making, enhances competitive advantage and profits [*Level 5*].

Table 7.5 Organization Bina's maturity for independence and pro-activeness

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Independence & Pro-activeness	←	←	•	→	→	3,4,5

Indicators: • Current status ← Previous status → Future status

(vi) IT awareness

Previous status

- Bina's management have always encouraged IT awareness among staff [*Level 3*].
- A staff was assigned to do paper cuttings and compile them in categorical file. At the same time, Bina is also registered with an online database in order to get up-to-date with the latest news and issues. Unfortunately, these efforts were discontinued due to lack of manpower and budget constraint during the recession years.

Current status

- Bina strongly believe that knowledge sharing is the most effective way to create technology awareness and trends among staff. Therefore, Bina is now in the process to develop an engine for internal knowledge sharing portal [*Level 5*].
- Bina performs periodical knowledge-sharing activities (presentations and discussions) among IT staff and top management [*Level 4*].
- The knowledge focus was at the construction technologies, and recently Bina venture their interest at other technologies such as mobile technology and technologies in banking and manufacturing.
- Majority of staff have taken self-initiatives to keep them abreast with technological trends [*Level 2*]. They were actively joining online forums, subscribing technology magazines and online RSS feeds.

Targeted future status

- Bina is anticipating to fully utilize the knowledge-sharing portal that is currently under construction.

Additional comments

- Bina has never been at a stage where they are not interested to know about technology due to the nature the organization is operating in; IT in the construction industry [*Level 1*].
- In the Maturity Level 5, Bina believes that a trend analysis is not necessary. This is because they have completed feasibility studies for each IT projects they embarked, where the technology analysis is also included within the study.

Table 7.6 Organization Bina's maturity for IT awareness

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
IT Awareness		←	←	←	●	5

Indicators: • Current status ← Previous status → Future status

(vii) IT learning commitment

Previous status

- The organization was not interested to learn IT or or construction technology [*Level 1*]. Throughout the development of System P, Bina realized that it is important to ensure System P is marketable and reach the world technology benchmark to gain competitive advantage – a commitment towards continuous learning.

Current status

- Bina sends their staff to conferences and trainings to learn about technology process [*Level 3*]. Books, technical manuals and research materials were kept in the common room to allow communal referencing.
- Bina always has informal discussions regarding 'how do latest technology work' among staff and managers [*Level 2*]. However, there were no formal documentation.
- On top of this, the knowledge-sharing portal was aimed to meet this business objective [*Maturity Level 4*].

Targeted future status

- In the future, Bina intends to standardize the knowledge-sharing portal within the organization, not just for the System P project team [*Level 5*].

Table 7.7 Organization Bina's maturity for IT learning commitment

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
IT Learning Commitment	←	←	•	→	→	3,4,5

Indicators: • *Termination/Current status* ← *Previous status* → *Future status*

(viii) Willingness of Change

Previous status

- In early years of Bina, staff were comfortable to work under a common environment, with regular and usual activities were running everyday [*Level 1*].
- Bina believes that the resistance to change among staff was due to insufficient information from the management, portraying to them doubtful systems or approaches [*Level 2*].

- Later, Bina's management started to encourage the staff to be more flexible in learning new approaches but this was not done in a structured manner [*Level 3*]. As a result, staff did not take seriously in improving their ability to work in changing environments.

Current status

- Top management have encouraged staff and enforced policies to accept new knowledge and work approaches. They provided scheduled meetings, one-to-one training and discussion between managers and sub-ordinates to ensure enough information regarding the new system implementation.
- A key performance index (KPI) was set up to assess the ability for being flexible staff in coping changing work approaches.
- Overall, the acceptances among staff towards changing IT system were considered high, but there were individuals with problems with system usability or lack of system usability [*Level 4*]. This shows there was a minority of staff who were not willing to change.

Targeted future status

- Bina will continue to support change among staff until it is embedded into a culture in the organization [*Level 5*].

Table 7.8 Organization Bina's maturity for willingness of change

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Willingness of change	←	←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(ix) Hybrid skills

Previous status

- Before the Subject-Matter Expert (SME) employee was hired, the IT project team took almost three months to get the agreement between Bina and the client.
- For example in System P, client offered unclear guidance about process and procedures in tendering, resulting to incomplete system's requirement prepared [*Level 2*]. As a consequence, the unintended deliverables often occurred due to lack of knowledge about construction among the IT team.

Current status

- The Bina IT project team consists of IT personnel, while the management team was merely construction-related experts. To bridge the gap between the two teams, the SME personnel was hired to be a liaison between both teams. The SME was a qualified Quantity Surveyor with more than ten years experience working in IT projects within the construction industry. He advised the project team to matters relating to construction processes and policies involved. He guided the management team on the strength and limitations of IT. He also worked closely with the IT managers [*Level 3*].
- Bina considered the IT project team understood management needs, but this was not the case [*Level 4*]. It required few meetings and discussions to make both teams aware of complications, problems and possible solutions for both teams.

Targeted future status

- The communication between the System P's IT project team and the management team need to be continuously improved [*Level 5*]. Bina aims to improve and instill harmony and mutual understanding between the teams. A dedicated steering committee has been identified to improve these issues.

Table 7.9 Organization Bina's maturity for hybrid skills

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Hybrid Skills		←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(x) Awareness of critical success factors (CSF)

Previous status

- System P was developed under a 'trial and error' approach, and is still in practice until now.
- Bina acknowledged that the critical success factors were not studied prior to system development [*Level 1*]. For this reason, the CSF of system was not understood among staff.

Current status

- Realizing this shortfall, Bina conducted a User Acceptance Test just before the Version 1.0 launching [*Level 3*]. The test involved the system's users and product clients. From the test's findings, Bina identified the critical success factors and these became additional elementary requirements in the development of Version 2.0.

Targeted future status

- For further refinement of System P's CSF [*Level 5*], Bina is planning to develop a formal strategic plan based on the CSF identification [*Level 4*], starting from the internal project team, and then will invite the construction expert groups, and the intended system's users.
- An internal identification of CSF should be prepared before it is discussed with the bigger group of experts and/or users to be used as a baseline or a framework for the project direction [*Level 2*]

Table 7.10 Organization Bina's maturity for awareness of critical success factors

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Awareness of Critical Success Factors (CSF)	●	→	→	→	→	1,2,3,4,5

Indicators: • *Current status* ← *Previous status* → *Future status*

(xi) Connectivity

Previous and current status

- Bina believes they have an advanced connectivity facility.
- The basic cabled and wireless connectivity are on its place, with fiber optic networks installed [*Level 1 and 2*].
- A fast connectivity is important for System P as it covers various types of heavy data that includes drawings, tender of contracts, and bill of quantities; to be submitted before the tender closing date and time.
- For backups, Bina established a physical interface with few sub-divisions to secure the network if one of their devices is collapse [*Level 3*].

Targeted future status

- Bina is keen on the cloud computing technology, and they intend to execute cloud-networking technology in the next three years [*Level 5*].

Additional comment

- The description in the Level 1 should be changed to 'wireless network'. The reason is because, in a less matured company, the wireless network is widely used because it is cheaper than the cabled network.
- Notwithstanding, cabled networks are more secured and faster; this is the major reason for more mature companies to deploy and absorb extra costs during the installation and maintenance.

Table 7.11 Organization Bina's maturity for connectivity

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Connectivity	←	←	•	→	→	3,4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(xii) IT security management

Previous and current status

- In the early stage of System P's development, the risk and security analysis was performed as it a core issue in digitalizing the tendering process.
- Every computer in the Bina, especially for all computers connected to the System P, is protected with access authorization, firewall, antivirus, and anti-malware [*Level 1*].
- The security system is updated on the regular basis, once in two to three months time. The system is also encrypted [*Level 4*].

- To access the system, access controls has been implemented [*Level 2*].

Targeted future status

- In the long-term, Bina will utilize artificial intelligent technology to direct the system to evaluate its surroundings and take action efficiently and automatically to maximize the security and minimize the chance of system intrusion [*Level 5*].

Table 7.12 Organization Bina's maturity for IT security management

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
IT Security Management	←	←		•	→	4,5

Indicators: • Current status ← Previous status → Future status

(xiii) Data management

Previous status

- In early stage of System P's development, all the data was managed the traditional way – on-the-shelf filing system [*Level 1*]. This presented a major difficulty in data tracking and reporting.

Current status

- A Data Administrator controls data management in System P [*Level 2*].
- The management is completed manually through word processing and spreadsheet applications without assistance of data management tool or software.

Targeted future status

- Organization is considering a third party data management tool to ease current documentation, tracking, and reporting [*Level 3*].
- If Bina have the resources enough manpower to develop a data management tool, they prefer to create an automated stand-alone tool [*Level 4*], and extend it to an integrated tool that connect from data management for System P to other data management for external authorized systems, so that data is accessible by cross-referencing [*Level 5*].

Table 7.13 Organization Bina's maturity for data management

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
Data Management	←	●	→	→	→	2,3,4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(xiv) IT project management

Previous status

- The IT project was unstructured with no formal guidelines [*Level 1*] before the project management team was established.

Current status

- A standard IT project management framework has not been established. However, Bina have improved written procedures, where they now realized that current practice does not promote continuity and consistency between reports [*Level 2*].
- The IT manager monitors the changing needs for System P, but there is no standard documentation to record progress and changes.

Targeted future status

- The project management team is considered 'young', thus, Bina is restructuring their management procedures along with the change management plan [*Level 4 and 5*].

Table 7.14 Organization Bina's maturity for IT project management

Case Study 1	Maturity level					
	1	2	3	4	5	Gaps
IT Project Management		•	→	→	→	2,3,4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

7.2.4 Discussion

Figure 7.6 mapped the current maturity level for Bina and the future targets they aim to achieve.

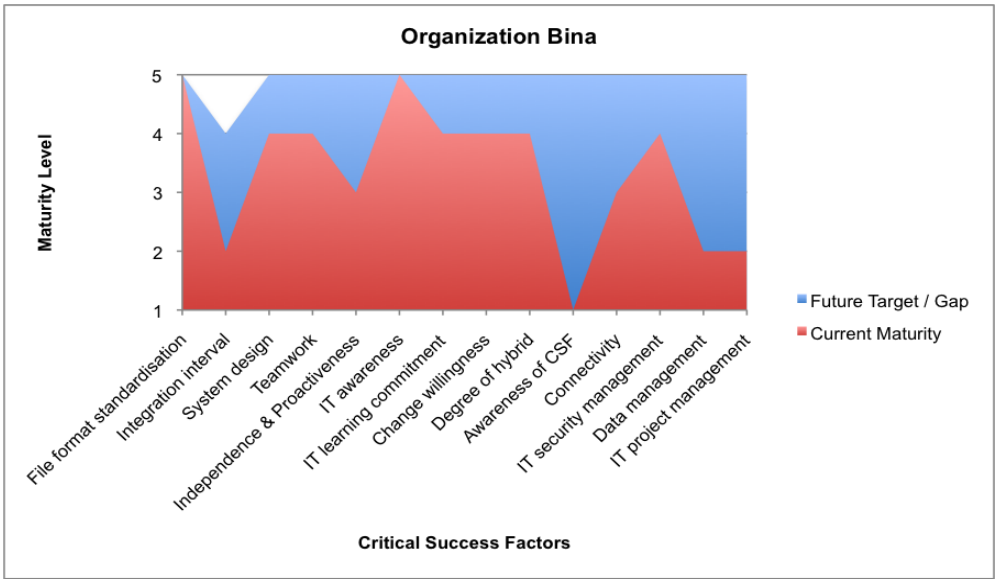

Figure 7.6: IT Infrastructure Flexibility Maturity Grid for Organization Bina

- Under the ***technical*** dimension, File Format Standardization has reached Level 5. This factor has been focused since System P was developed and integrated by many

parties and documentations involved, for examples, drawings from Architects, bill of quantities from Quantity Surveyors, and Contracts Forms from Contractors and Sub-Contractors. Therefore, this factor was matured along continuous enhancement of the system. However, to promote greater compatibility, it is suggested for Bina to consider the use of Extensible Markup Language (XML) (a format that is both human-readable and machine-readable) (Zhang, et al., 2011) and Industry Foundation Classes (IFC) (a data model for building and construction industry), which is now commonly used format for Building Information Modeling (Zhang, et al., 2012), for facilitating interoperability in the system's design.

- Due to limited accessibility of the system, the Integration Interval was at Level 2 of maturity. Since System P is currently used by the public, it should have a 'mirror' system that allow it to automatically maintain multiple copies of data. This is to enable data copies to be used as a trials and do not interrupt the actual operation. From here, it will reduce the integration complications. Both clients and Bina need to reduce bureaucracy in the decision making process, as this was the main factor that delays the process.
- System Design was at Level 4 indicated by its constant improvement and consistent standards and procedures. However, when System Q started to get complex and data heavy, Bina is planning to implement an automated tool to assistance in improving the reliability and usability of the design. The automated processes of the usability inspection reduces manual processes and allows the IT Department focusing on capturing more defects in s shorter period of time. Thus improving the effectiveness of the usability inspection and minimizing defects escapee. Wide variety of testing and inspection tools available in the market, but the IT Department is recommended to develop the automated tool on its own because it can be designed to fit the existing system with higher data security in place.

- From the ***people*** dimension, the team working in Bina should have started to perform team-building activities to improve this factor from Level 4 to Level 5. Even though the IT Department has an established Project Management Team and respects personal competencies, team-building activities help in improving corporate development. For example, it improves the team's ability in problem solving, improves morale and leadership skills, and help to identify a team's strengths and weaknesses.
- An IT Manager or IT Leader plays a significant role in guiding the IT staff; this marks the Independence & Pro-activeness factors as at Level 3. In achieving flexibility, IT staff should be able to suggest new solution rather than follow what have been instructed because this will contribute to conflict of interest. Bina should provide job-orientation and training, evaluate their performance, and implement recommendations for improvement. Over time, when majority of the staff are capable to work independently and pro-actively, the IT team, as a whole will gain autonomy and full trust from the top management.
- IT Awareness was at Level 5. The level of IT awareness was boosted up since the Malaysian Government introduced and enforced IT policies among construction companies. Thus, IT staff were encouraged to be alert with technology trends to ensure their company could provide the latest IT service and gain competitive advantage.
- However, the effort for IT Learning Commitment needs to get better, if Bina were to be considered as matured. An integrated knowledge management system should not only be used as a platform to increase IT awareness, but also as a portal to learn, share and exchange ideas.
- Willingness of Change is not a culture in Organization Bina. The level of maturity for this factor was at Level 4. Change willingness was considered easy, as staff

understood the importance and benefits of the newly introduced approach or technology. Top management has also provided sufficient support and training. To improve the maturity, the top management is providing continuous support and encourages personal development among staff to enable them to be more open and aware to accept changes, and over time be a culture in the organization.

- The openness in discussion should be practiced between the IT team and the management team. This will produce a mutual understanding between both teams, hence achieving the highest maturity level. A representative from the management team should always get involved throughout the development process so that they have knowledge about what is going on with the IT project, on the other hand, IT team can easily deliver their needs them, too. Currently the Hybrid Skill was at Level 4.
- Organization Bina has neglected to determine the CSF of System P. Awareness of CSF helps organization prioritizes and streamlines management tactics. The system was a result from a trial-and-error approach; this makes this factor at Level 1 Maturity. Major changes and efforts were needed to improve this, for example, it should start with an internal study by an in-house team and continue with the evaluation by external experts or industry survey; the findings will provide Bina with a strategic plan. Continuous improvement should be conducted inline with current technology and economic conditions.
- ***Management*** dimension shows a mixture of maturity level 2, 3 and 4 at a current state. The Connectivity factor is at Level 3. A multiple logical interface was established in System P's connectivity, which allows the system to function independently while using interfaces to communicate with other components via associated protocol. To improve, Bina must set up an automatic network that connects to one another wirelessly. This becomes a basic of cloud computing

network establishment. The system can be assessable regardless of geography, hence improving productivity (Deed & Cragg, 2012).

- For a secure connection, IT Security Management needs to be in place. Currently, the status of this factor is at Level 4. System P has a comprehensive IT Security Management mainly to provide security to comply with important legal issues in e-tendering procedures. Bina was recommended to develop an auto-recovery system that will help avoid losing data in the event of system breakdown.
- Both Data Management and Project Management were at maturity Level 2. Bina should have a standard data management system to reduce operative expenses, to offer quick and accurate decision-making based on historical data. For quick reporting and forecasting, it is suggested to Bina to use a data management tool, which is readily available in market. Ideally, to best suit with Bina system's and organization, they could develop an in-house data management tool with high level data integration to suit, multi-system cross-referencing and intelligent search ability across multiple data types and platforms.
- A Project Management Plan should be standardized for all modules of the system to ensure efficiency in project execution. Project monitoring is essential for system's improvement by taking into account constant changing business needs and external factors. On top of this, a change management plan is advisable to be integrated together for quicker and safer integration by considering changes in the form of technology, staffing, users, clients credentials or changes in products or services.

Figure 7.7 presents the areas for Bina to focus on for improvement; and to sustain and keep progressing with the organization's maturity progress. Overall, Bina managed to remark all the fourteen factors for each level. The levels of maturity vary between factors. Major adjustments and changes are needed to improve the maturity gap in

achieving their business objectives, critically in the ***people*** dimension of Awareness of CSF. Equal attention is needed particularly in the area of ***management*** dimension that include Data Management, and Project Management, as well as ***technical*** that are Integration Interval.

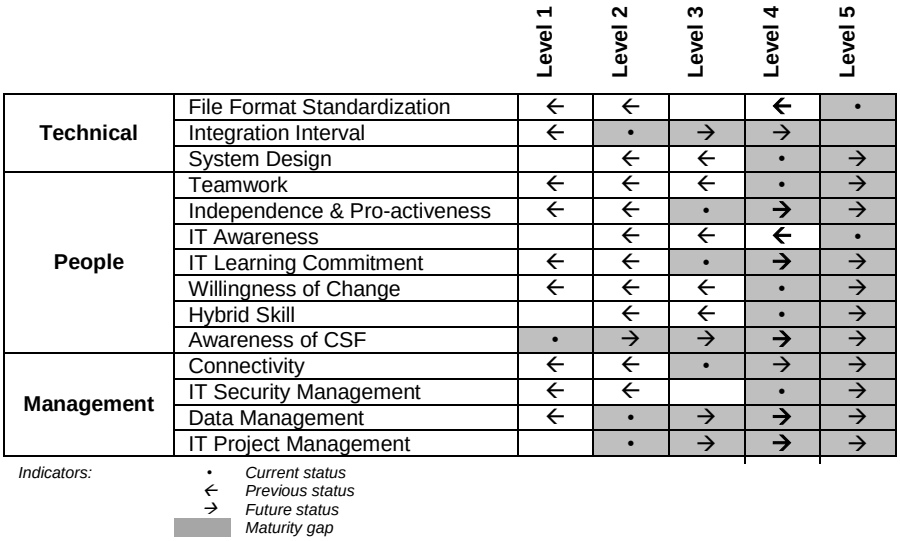

Figure 7.7: The assessment summary for System P implementation

7.3 Case Study 2 – Organization Eko

7.3.1 Organization's background

Organization Eko is branch under the Malaysian authority in public works and was established in 1950. Due to cost fluctuations after World War II, the Eko was accountable for preparing Schedule of Rates for construction works; and their functions were extended to become the main center for costing and contracting for their parent company (national authority). Their current responsibilities are include preparing Bill of Quantities, evaluating variation orders for public projects, and manage cost and contracts from the pre-contract stage to post-contract. Realizing the benefits gained

from IT, the Information and Communication Technology (ICT) Department was established in year 2000.

Since Organization Eko's (hereby referred to as Eko) establishment, the organization has only developed few national IT projects (worth up to USD1.5 million each). Their main clients were public officers and contractors throughout the country. Eko now employs 260 staff, while only 7 staff work in the ICT Department. They are all Quantity Surveyors without formal education in IT but with five to ten years experience working in the IT sector. Figure 7.8 illustrates the organizational chart of Organization Eko.

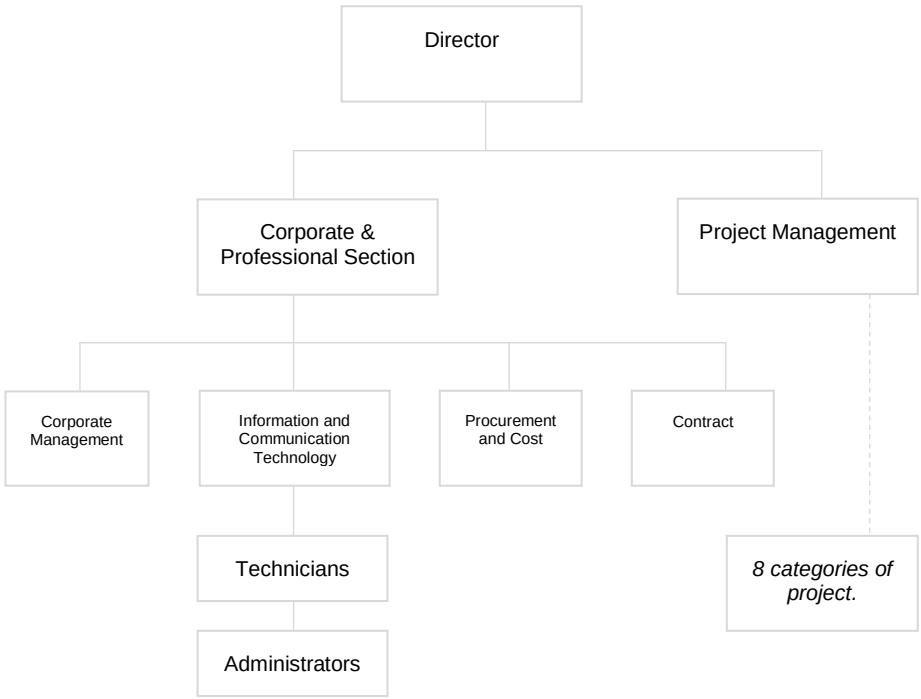

Figure 7.8: Organization Eko's structure.

7.3.2 System implementation

System R is a one-stop-centre for cost database. Inspired by the Kuala Lumpur Stock Exchange database, the idea came when Eko faced with difficulties to find specific information in the cost system, which have a large dataset and many discrete files of information. System R consists of two applications, R-Online and R-PreMo. R-Online keeps historical construction cost information gathered from the shortlisted tender documents, while R-PreMo is a predictor model application that uses cost information from R-Online to forecast the future cost of projects based on identified variables. Three objectives were delineated; the first is to standardize cost information management for infrastructure projects within the organization; secondly to provide reliable predictions; thirdly to digitalize the cost information database that can be manipulated online, and automate cost comparison and reporting. Figure 7.9 shows the flow chart of System R, in overall.

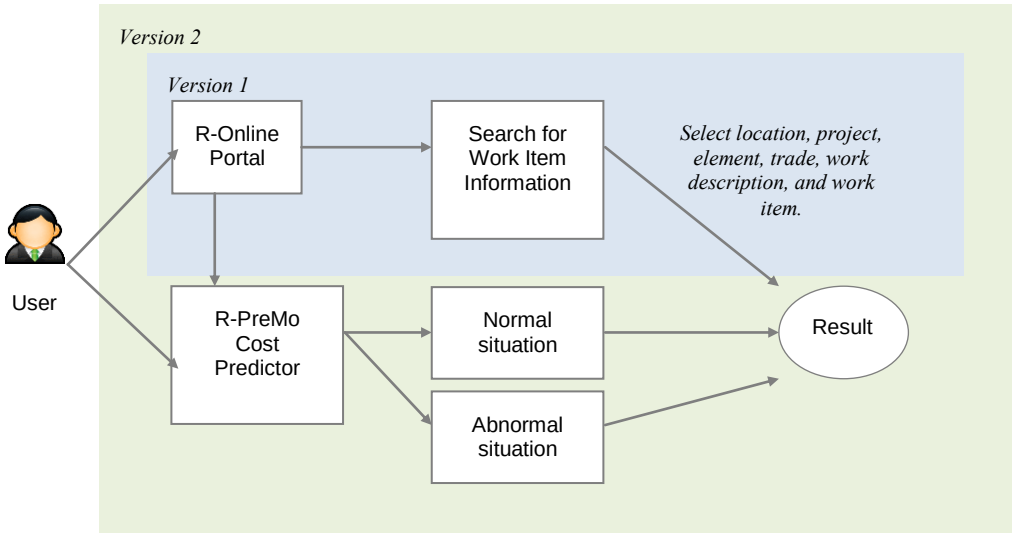

Figure 7.9: A system flow chart for System R.

The development was started in 2004, initiated by Eko's Director, the first version of System R which involved only R-Online, took one year to complete by the in-house IT project team. The application was considered as basic and rigid. The coverage of R-Online began with the construction major work items only, such as, concrete, framework, and brickwork. After five years of implementation, Eko decided to extend and enhance the system - R-Online and R-PreMo were merged. A research team was set up to study the system's requirements and identify the critical success factors based on the (five years) users' experience in using R-Online V.1. On top of this, the variables for prediction were also revised. There were 52 researchers involved with the cost of USD79,000, and a series of workshops were conducted in every state in the country. They found 11 variables for prediction with 38,000 work items identified based on the Standard Method of Measurement II.

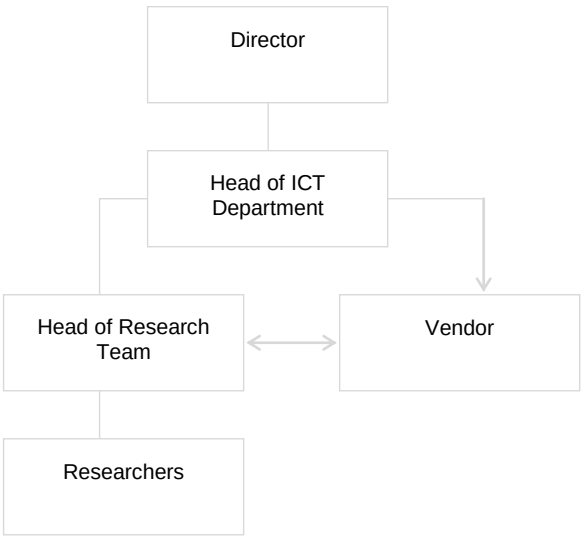

Figure 7.10: System R team organizational chart

Instead of develop it in house, Organization Eko decided to hire am external vendor to build the System R V.2, instead of developing it in-house, due to lack of manpower and expertise they have had. The vendor was appointed based on its capability, credibility and costs to quality ratio they offered. Figure 7.10 above

illustrates the project team chart for System R. The development started in January 2011, based on the existing system design for R-Online, took 11 months to complete. System R V.2 was launched in late 2011. System R reached 19,000 authorized users by June 2012. Figure 7.11 shows the sequence of events for System R during its development.

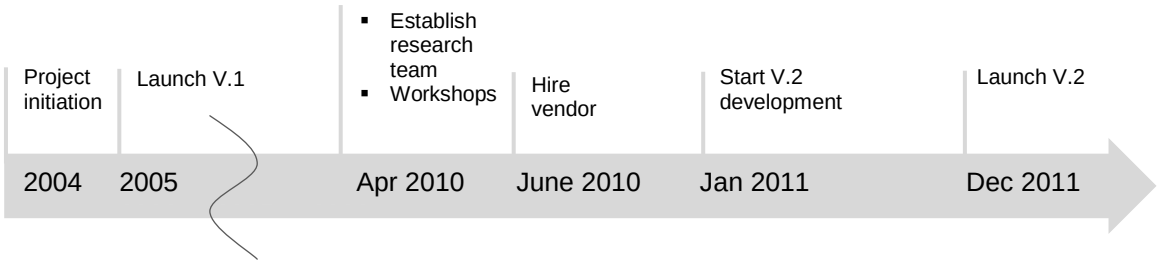

Figure 7.11: System R timeline.

7.3.3 Analysis

(i) File format standardization

Previous and current status

- System R was a stand-alone system.
- It was built to be compatible with Windows and Mac operating systems, and can be browsed using prominent browsers, which include Internet Explorer, Safari, and Firefox.
- In the R-Online module, the data is entered based on the averaged tender values from tender documents that were received in hardcopy and softcopy. There was no standard file format imposed.
- The data is entered onto the system manually by Data Entry Officers, producing one type of formatting [*Level 2*]. The data entry procedures vary between officers.

- R-PreMo extracts the information from R-Online for analysis and for cost prediction. It has the capability to convert from R-Online file formatting to few other formats, such as .xls, .doc, and .pdf as shown in Figure 7.10.
- In overall, System R has a mixture of manual and automated file conversion in standardization [*Level 3*].

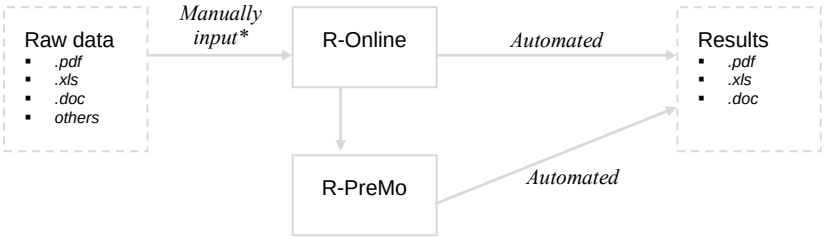

Figure 7.12: Standardization of automation in System R

Targeted future status

- Eko is setting up a standard to be imposed for the tenderers when submitting their softcopy documents of the cost information that is attached with the tender documents. From here, a centralized system will be developed to automate the data transfer from the raw material to R-Online (indicate by * in Figure 7.10) [*Level 4*].
- When all modules of System R are computerized, System R can be integrated with another external system, which the organization is planning to assimilate it with e-tendering system, construction portal, and building information modeling (BIM) [*Level 5*].

Additional comment

- In other simpler non-technical IT projects such as website or online payment engine, the lowest maturity level has normally no standardized format [*Level 1*].

Table 7.15 Organization Eko's maturity for file format standardization

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
File format standardization		←	•	→	→	3,4,5

Indicators: • Current status ← Previous status → Future status

(ii) Integration interval

Previous status

- In early stage, the in-house project team took three to four months to complete integration activities for System R V.1 [*Level 1*].
- When the system's core framework was fully established and the team familiar with the system, the integration process was shorter (between two to three months) [*Level 2*].
- For further enhancement, the management decided to appoint a vendor; only then the integration process was accelerated.

Current status

- Since the external vendor took over the development of System R V.2, the integration process between the system and new modules were much shorted (between a week to a month to accomplish) due to their expertise with related system [*Level 3 and 4*].
- As opposed to the System R V.1, in-house staff could not focus entirely at the development (technical) as their main responsibilities were concentrated on management.

Targeted future status

- Eko expects to reach the highest maturity level when the integration process is completed within two days, as stated in Eko's Research Proposal dated 2010 [*Level 5*]. Besides increase level of expertise, Eko stated that official procedures and bureaucracy would be simplified, as this was identified as the major factor that caused delays in technical integration.

Additional comment

- Eko did not agree with the proposed maturity description in Level 5 – the main business is in construction and IT is only playing a supporting role. Construction companies prefer not to increase spending on IT due to the importance of actual construction works that require more attention and larger investment. This reflects that IT is not considered a partner for the business, but only playing a supporting role.

Table 7.16 Organization Eko's maturity for integration interval

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Integration interval	←	←	←	•	→	4,5

Indicators: •Current status ← Previous status → Future status

(iii) System design

Previous status

- The in-house project team did not produce a detailed system design. It was produced only when requested by top management, and there was discontinuity and time gaps between the system design reports [*Level 2*].

Current status

- System design for System R V.2 was established through series of workshops that was conducted during the period of the research [*Level 3*].
- In-house project team and external experts worked together to identify the system's requirements through brainstorming discussions and presentations during the workshops. The external experts include the expected System R's users around the country.
- The system design was manually updated in every event of changes occurred, or upon new requirements appealed [*Level 4*].

Targeted future status

- Eko looked forward to design a tool that is able to test the usability of the graphic user interface [*Level 5*].
- With this tool, usability test will be able to assist the project team to identify the problems from the mock-up system, hence, saves costs from fixing problems in the actual system.

Table 7.17 Organization Eko's maturity for system design

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
System Design		←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(iv) Teamwork

Previous status

- Before the ICT Department was set up, informal teams were formed to manage IT projects on the project level basis [*Level 1*]. The number of IT projects was limited and the importance of an IT team was not significant at that time.

Current status

- Sixty-two years of establishment brings Organization Eko to the highest maturity of teamwork.
- Eko have comprehensive strategies in place for the enrichment of teamwork among the staff.
- They have identified the core competencies for each individual, putting them into position that allows them to perform best and forming an IT project management team [*Level 3 and 4*].
- Due to shortage of staff in the department, team members often help each other, especially in lending workforce in some occasions, even though the tasks are beyond their expertise [*Level 2*]. For an example, a non-technical officer (the Quantity Surveyor) was assigned to establish a user interface for System R.
- The upper level managers guide their sub-ordinates in every assignment.
- The harmony understanding in Eko and the department is reflected by teamwork trainings, seminars and team building exercise that was conducted by management consistently in the past few years [*Level 5*]. For example, Eko imposes seven compulsory trainings and seminars for staff in a year; on top of other events where the staff's involvement is deemed necessary.

Targeted future status

- The organization is satisfied with the current policy for teamwork enrichment, and they hope to sustain it.

Table 7.18 Organization Eko's maturity for teamwork

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Teamwork	←	←	←	←	●	5

Indicators: • *Current status* ← *Previous status* → *Future status*

(v) Independence & pro-activeness

Previous status

- Previously, the project team merely followed instructions given by the managers [*Level 1*].
- The team's tasks were executed based on the guidelines provided by their managers [*Level 2*]. The managers were required to educate the project team and put the project team under direct supervision.

Current status

- Eko allocates a budget to send project team members to courses and seminars to ensure adequate understanding about the subject matter, for example, as System R involves statistical computation, the team member needs to be acquainted with its theoretical scheming.
- By attending short courses, it helps team members to understand the process of developing the respected application proactively, without relying the third party to interfere with the development.

- As a result, the team members have started to propose a new solutions, hence, getting full mandate from the top management to undertake system analysis and give approval for activities associated to any IT projects [*Level 4*].
- However the goals are limited within the top management agreement [*Level 3*], which means that the top management decide what is the next objective they want to achieve, for the IT team to take actions. The qualities of being proactive and able to work independently are measured through a yearly appraisal report, where staff with a good record will have the opportunity to be promoted in the subsequent year.

Targeted future status

- Even though IT department would be autonomous in the highest maturity level, especially in private organizations, Eko assumes that the IT project team will never be an autonomous team as the goals will always led by the Directors. The organizational structure has never changes since the company's establishment (62 years ago), and they believe that this will remain for many years to come.

Table 7.19 Organization Eko's maturity for independence and pro-activeness

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Independence & Pro-activeness	←	←	←	•		4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(vi) IT awareness

Previous status

- Before the IT initiatives were promoted in late 1990s, very few staff was concern about IT.
- Eko admitted that only very few staff were aware and interested to know about technology trends, only if they were driven by the top management [*Level 1*].

Current status

- Eko conducted periodic knowledge-sharing presentations and discussions among the staff [*Level 4*]. It is compulsory for IT team members to participate, but and for non-IT officers, they are encouraged to join.
- Topics of discussion include recent findings from current attended seminars and conferences, and other self-initiative sources that include online forums, journals, and books [*Level 2 and 3*].
- This activity helps the team to outline potential tools and technology that System R might to adopt. Among the technologies that interest Eko include mobile technologies, electronic tendering, building information modeling, 3-dimensional and 4-dimensional virtualization.

Targeted future status

- Eko was planning to develop a centralized knowledge management system on a standard platform to allow organizational staff to be updated on current information and shared throughout Eko [*Level 5*].

Table 7.20 Organization Eko's maturity for IT awareness

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
IT Awareness	←	←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(vii) IT learning commitment

Previous status

- Eko reached a state where minimal staff were interested to explore and learn about IT, especially before the 1990s – this included the IT project team [*Level 1*].
- When IT was introduced in the construction industry, the staff learnt about technology on their own effort and initiative; only after year 2000 Eko started to allocate a budget for IT-knowledge enrichment [*Level 2*].

Current status

- The critical technology processes for the improvement of System R were documented and filed. Some files were kept in the office library. There are some files that were kept by different officers (that were assigned based on their expertise). The documentation includes technical manuals, conference proceedings, and guidelines [*Level 3*]. The documents have become a reference for the IT team for the system's development and improvement.
- Presentations are scheduled once a week on every Friday; the IT Manager assigned a related topic to the respected officers to present a talk to the staff [*Level 4*].

Targeted future status

- Eko is in the planning stage to create an in-house knowledge portal in order to increase IT awareness and encourage the staff commitment to learn technology processes [*Level 5*].

Table 7.21 Organization Eko's maturity for IT learning commitment

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
IT Learning Commitment	←	←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(viii) Willingness of Change

Previous status

- Staff resisted to change due to past experience; various IT project failures in the past [*Level 1*]. Eko believed that IT did not offer any benefits or competitive advantage. For example, unstable infrastructure commonly contributed to system breakdowns, and it restricts the network and communication. As a result, it incurred the additional expenditure more than the cost raised from non-computerized ways, such as, costs of replacing the failed system, the lost revenue because of the failed system, and the disruption costs.
- Management did not provide facilities for training and education on IT [*Level 2*]. Therefore, the staff easily gave up and discontinued using the system, hence became the main cause for IT projects failures.

Current status

- Establishment of the IT department in Eko have boosted the use of IT within the organization. It was started with enforcement from the top management [*Level 3*].
- Many IT tools and systems were introduced gradually to replace the traditional and non-digitalized way of doing work. Staff had no choice but to cope with the situation, as they were value assessed through the Annual Appraisal Report.
- To nurture the ability of change willingness within staff, the management provided hands-on trainings for the newly implemented systems.

Targeted future status

- The younger employees are more tech-savvy; they cope with changes relatively easier in a comparison with the older generation (Walling, 2012). Looking at this situation, Eko believed that the willingness of change attitude would become a positive culture in the future [*Level 5*]. An action plan is in the process of being established to achieve this objective.

Table 7.22 Organization Eko's maturity for willingness of change

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Willingness of change	←	←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(ix) Hybrid skills

Previous status

- Before the hybrid manager existed, the agreement between the management/vendor and the IT team took almost half a year to achieve; this is very much due to misunderstandings and lack of information on the subject area [*Level 2*].
- In this situation, there was no guidance for staff to undertake their responsibilities [*Level 1*].

Current status

- In the development of System R (and other few IT projects), a hybrid manager led the project team. He has more than seven years experience working in construction IT; a Quantity Surveyor graduate and completed his Masters and PhD in construction IT. For this reason, he is very knowledgeable in construction studies and has in-depth understanding in IT. He was an important interface between the management team to understand the needs and complications faced but the IT team, and vice versa [*Level 3*].
- However, hybrid skills among the sub-ordinates varies, with majority of them were still require close supervision.

Targeted future status

- An action plan was set up to improve the staff's ability in being hybrid [*Level 4*], with a long term plan to set up the organizational environment where mutual understanding exists between the management and IT teams [*Level 5*]. One of the plans was to provide continuous training to keep the staff informed with the latest information in both subjects – IT and management.

Table 7.23 Organization Eko's maturity for hybrid skills

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Hybrid Skills	←	←	•	→	→	3,4,5

Indicators: • Current status ← Previous status → Future status

(x) Awareness of critical success factors (CSF)

Previous activities of the system development

- The unclear requirements and critical success factors in System R-Online V.1 were identified as the main cause of system restriction. [*Level 1*].
- The ad hoc technical plan looked into the short-term objectives, hence making the system difficult to be reconfigured.
- The first version acted as a basic prototype for the Vendor to test enhancement and functional extension in producing System R V.2.

Current status

- The project team leader initiated a study to identify system requirements and CSF based on the previous users' experience with System R V.1. This started with the identification of CSF among the in-house project team members [*Level 2*].
- The findings the in-house study was turned into a framework to be discussed with the users and external experts. A series of roadshows were conducted to validate the preliminary findings of system requirements and CSF [*Level 3*].
- From this stage, a strategic plan and a metric taskforce for CSF were prepared for further action in achieving the long-term objective of the system that include the system's infrastructure flexibility. Eko executed CSF analysis

regularly in order to revise the CSF to suit with the current technology and legislation needs [*Level 5*].

- The overall process of CSF identification involved everyone in the project team so that they were fully aware with the CSF and acknowledge the project goals.

Targeted future status

- Eko claimed that the have reached the highest maturity level as they have no further plans regarding this matter. They will sustain the current approach in identifying CSF.

Table 7.24 Organization Eko's maturity for awareness of critical success factors

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Awareness of Critical Success Factors (CSF)	←	←	←	←	•	5

Indicators: *• Current status* *← Previous status* *→ Future status*

(xi) Connectivity

Previous and current status

- From the beginning, Eko employed cabled and wireless network using one local service provider [*Level 2*].
- The maturity of the connectivity progressed based on the latest facilities offered by the service provider in Malaysia – starting with the dial-up networks to the most recent technology, which was fiber optic broadband.
- A number of backup networks were established to secure communication during any disasters that might cause a failure to one of the networks [*Level 3*].

Targeted future status

- Eko is planning to set up an automatic wireless network [*Level 4*], where the staff can roam across different wireless networks to access System R.
- In the next phase, Eko has started to consider cloud-networking technology for System R; however, its implementation will depend on Governmental policy [*Level 5*].

Additional comment

- In the lowest maturity level, the wireless network is a basic network connectivity that most of the companies have. It is cheap and has a wide coverage, but the connection will be decreased during high traffic volume [*Level 1*].

Table 7.25 Organization Eko's maturity for connectivity

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Connectivity	←	←	•	→	→	3,4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(xii) IT security management

Previous and current status

- All personal computers used in the organization were protected with access authorization, third-party firewall, antivirus, and anti-malware [*Level 1*]. The third party security licenses were updated and renewed every year.
- System R-Online is accessible by anyone – internal and external users. On the other hand, system R-PreMo utilizes access control levels where only authorized officers can access the system. This is especially important for top

management as they have full access to the system, while middle managers have limited access to the system. [*Level 2*].

- A statistical database was created to track the traffic accessing both system R-Online and R-PreMo [*Level 3*].
- On top of this, the Eko has had a framework in-place to establish risk and security analysis, but more work is being put into the framework. [*Level 4*].

Targeted future status

- The project team will focus to refine the risk and security analysis by considering changing technology and economic environments with advanced cyber attack prevention.
- Eko would use data encryption technology. Few benefits Eko is expecting to gain are, (1) data is secure, accessible and protected against unauthorized access, (2) the identity of the system is protected in the event of a cyber attack (hacking), and (3) to enable retrievable data to be extracted from a decommissioned computer.
- In a long term, the Eko is planning to apply intrusion detection system to enhance the system's security. This will allow the system to detect intruders and problems, and then heals by itself.
- Eko is also considering employing fingerprint recognition technology to log in to System R [*Level 5*]. Currently, the project team has started to study the particular matter in order to increase the understanding and learn about the technology.

Table 7.26 Organization Eko's maturity for IT security management

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
IT Security Management	←	←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(xiii) Data management

Previous status

- Eko was in a stage where all the documentations were in paper form and continued with the usage of floppy disks in their early transformation from paper-intensive to paperless [*Level 1*].

Current status

- Documentation is kept in both hardcopy and softcopy. Hardcopy documents were kept on the shelf, as records shall System R do not working [*Level 1*].
- The majority of documentation is completed through the computer; hence softcopy documents are essential. Few data clerks were hired to manage this large volume of data [*Level 2*].
- System R utilizes a stand-alone automated data analysis tool to produce simple reporting such as descriptive analysis and graphs [*Level 4*].

Targeted future status

- The stand-alone automated data analysis tool will be upgraded to an integrated system with extensive search ability between System R and other IT projects within the organization [*Level 5*].

Table 7.27 Organization Eko's maturity for data management

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
Data Management	←	←		●	→	4,5

Indicators: • Current status ← Previous status → Future status

(xiv) IT project management

Previous status

- An informal and unstructured approach was used for IT projects at early stage of IT introduction in Eko [*Level 1*].

Current status

- Eko established a standardized guideline as a framework to manage IT projects, however, the guideline is not complete and many ad hoc activities were conducted – this produced inconsistent activities on different projects [*Level 2*].

Targeted future status

- An IT project management plan will be prepared prior to IT project development – this is an initiative from the project team [*Level 3*].
- In refining the development process, the project management plans will be monitored to track progress [*Level 4*]. Throughout the development, the change management plan would be considered to smoothen the system integration progress [*Level 5*].

Table 7.28 Organization Eko's maturity for IT project management

Case Study 2	Maturity level					
	1	2	3	4	5	Gaps
IT Project Management	←	•	→	→	→	2,3,4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

7.3.4 Discussion

Eko aims to reach the highest maturity level in all factors except Independence & Pro-activeness. Figure 7.13 illustrates the current status and future target of this organization.

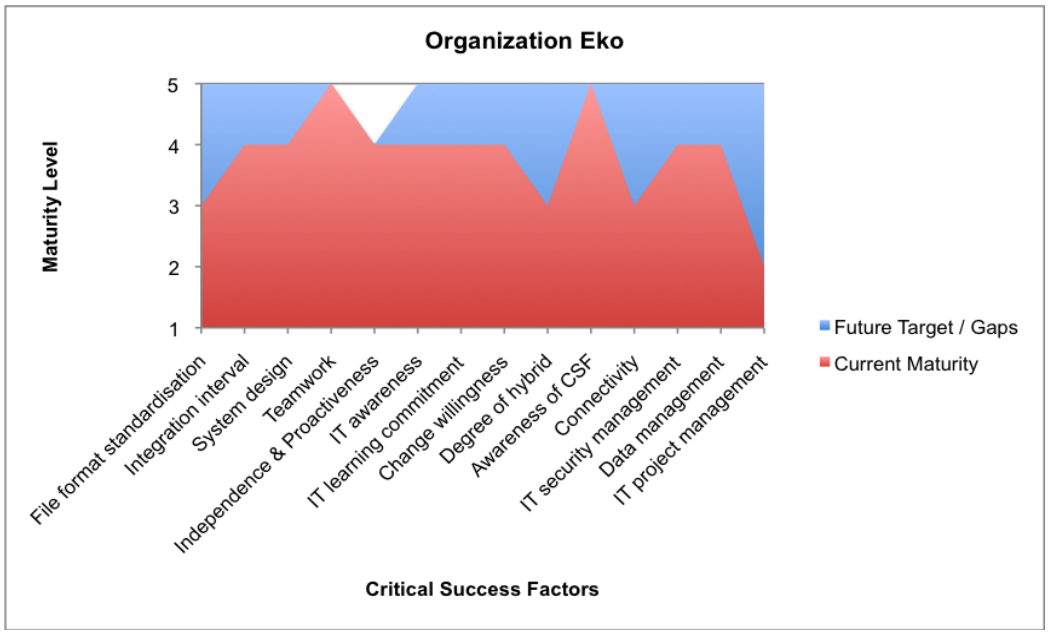

Figure 7.13: IT Infrastructure Flexibility Maturity Grid for Organization Eko

- A sudden improvement occurred since the external vendor overtook the System R V.2 development in 2010. Eko decided to appoint an external vendor mainly as it would benefit the organization with the vendor producing higher-quality products, enhanced interoperability, reduced development costs, and faster time-to-market –

Eko have a shortage of human resources and expertise to manage the project. Additionally, the vendor's performance was monitored by regular reviews and improvement in processes, communications, and interaction between them and Eko.

- The factors under the ***technical*** dimension have reached Level 3 and 4. System R was at Level 3 as it has had a standardized file formats. An automated and centralized system would benefit Eko with greater time savings. With this in place, System R could have an integrated system to standardize file formats for higher compatibility with other authorized systems.
- In a normal situation, the systems integration will take less than a week, which means that the factor has reached Level 4. Penalty costs were activated for any delays caused by the vendor; this pushed to a faster and more efficient integration process. In addition, the capability and experience of the external vendor could ensure better efficiency (as this is their core service). The main problem that caused integration delays was mainly due to bureaucracy in getting approvals. To achieve Level 5 maturity, Eko was suggested process simplification and allow the IT Department decides on technical matters.
- System Design was formalized and updated on a regular basis. For an improvement to Level 5, Eko should utilize the simulation tool to assure the system's usability.
- For ***people*** dimension, Eko scored the highest maturity level for Teamwork and Awareness of CSF. The teamwork were developed and matured over 62 years. The staff, especially in the IT Department, have performed a teamwork function. They not only have IT responsibilities, but also management rolls. This allows IT managers to teach, coach, develop, and facilitate other staff, rather than simply direct and control. This encouraged continuous improvement of the team's competencies.
- The CSF for System R resulted from four measures; (1) internal organization needs and changes, (2) economic or technological change, (3) construction industry

characteristics, and (4) competitive strategy of the business. Continuous improvement is very important at this stage to track the system's performance and constantly be able to meet the business goals and objectives.

- Eko anticipated that there was no room for improvements for the IT project team to be autonomous based, on the organization's policy that has never changed in 62 years. The maturity level for Independence & Pro-activeness would remain at Level 4.
- Efforts put for IT Awareness and IT Learning Commitment were equal, with both at Level 4. Eko is now planning to enhance the current knowledge management system to become a centralized and integrated system.
- Staff were assessed through an Annual Appraisal Report; this acts as an encouragement for staff to develop the ability of change willingly. Currently, Eko has Level 4 maturity. Eko is now preparing an action plan to employ new tech-savvy staff. With that in place, Eko would gradually nurture this attitude as a working culture.
- At Level 3 maturity, staff were relying on the IT Manager to determine their goals. Eko is playing catching up to create hybrid capabilities among majority of their staff. In a long run, Eko is anticipating that a mutual understanding between IT Department and the management team would exist. A continuous training framework is established between involved both parties.
- Under ***management*** dimension, the Connectivity was at Level 3, as Eko is heading towards utilizing cloud networking onto System R. A protocol for automated connection is now under development towards utilizing cloud networking onto System R.
- Eko have a comprehensive plan to improve IT Security Management and Data Management from Level 4 to Level 5 maturity. The system encryption would be

performed using existing technology and they were planning to operate an artificial intelligent technology in IT security. Later, an in-house data management tool would be produced.

- IT Project Management is the least matured among other factors, at Level 2. Despite being more advanced in construction project management, Eko started to realize that IT project management is actually different from the way construction projects are managed. Major changes and work are needed to refine their IT project management approach. Eko is now considering a change management plan to increase the successful delivery of business objective for System R.

Overall, all fourteen factors were tested based on Eko's experience, and each maturity level for every factor were verified and remarked. Figure 7.14 shows the maturity gap for System R implementation. Almost all factors will need to be improved and the main focus should be on management dimension, especially at IT Project Management and Connectivity, and also technical aspect which is File Format Standardization to further improve and leverage the maturity of the organization as a whole.

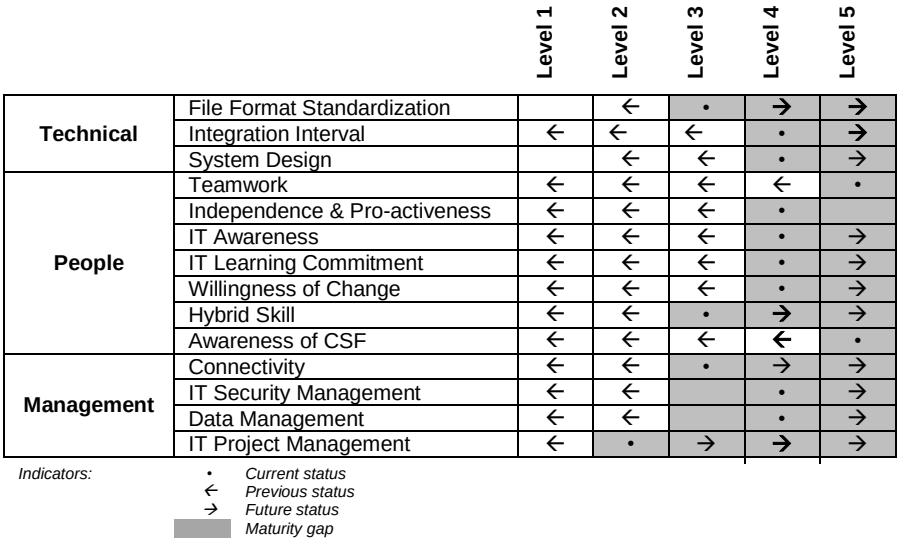

Figure 7.14: The assessment summary for System R implementation

7.4 Case Study 3 – Organization Taraz

7.4.1 Organization's background

Organization Taraz (now hereby referred as Taraz), established in 1976, is a quantity surveying (QS) company in the country. It operates throughout Malaysia from its four main offices in Petaling Jaya, Penang, Johor Bahru, and Kota Kinabalu, employing 136 staff. Taraz is involved in many sectors of construction ranging from residential, commercial, healthcare, hotels, shopping complexes, transportation, and infrastructure, as shown in Figure 7.15.

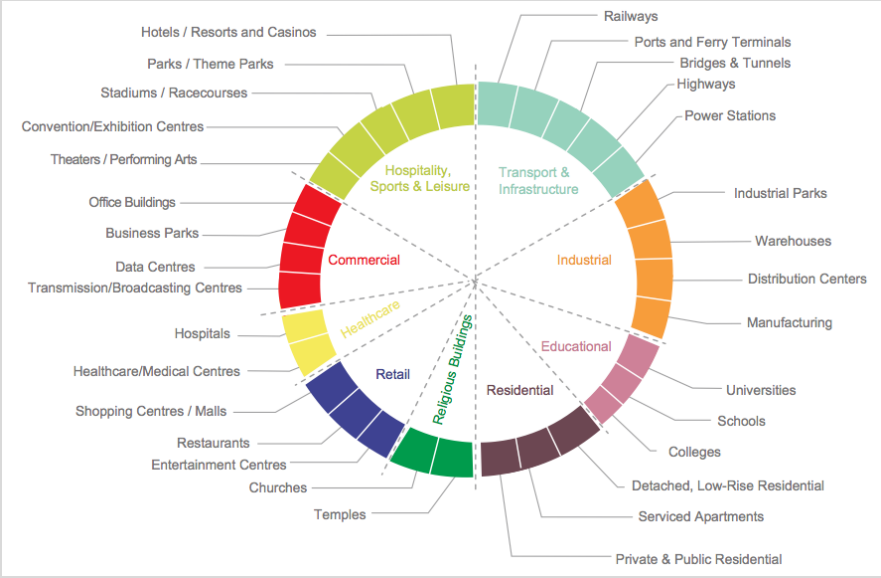

Figure 7.15: The sectors in which Organization Taraz operates (Source: The organization's website)

Since its establishment, Taraz has won various awards – they were awarded the Board of Quantity Surveyors Malaysia (BQSM)'s Excellent Organization Award, which highlighted Taraz's contribution to the Malaysian construction industry; Taraz was also the first recipient of the BQSM Special Award, which recognized their contribution in the development of QS profession through BQSM's professional institutions, working

environment of the office, staff development and welfare, and the comprehensive use of IT in the organization. Taraz was the first QS company to be accredited and awarded the MS ISO 9001 Certificate by Standards and Industrial Research Institute of Malaysia (SIRIM) in 1995. The organizational structured is shown in Figure 7.16.

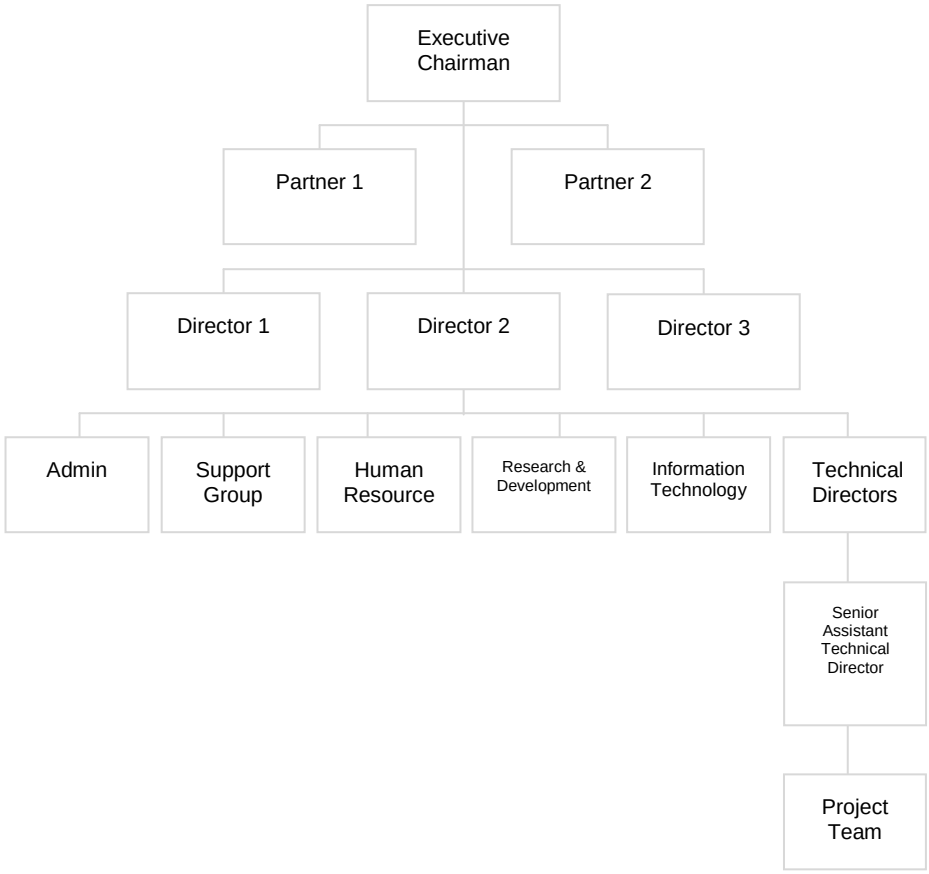

Figure 7.16: Organization Taraz's organizational structure

Taraz have started to computerize the QS works since the 1970's and established an independent software consultancy in 1997. They have developed two completed systems, System X and System Q. System X is used the production of estimates, tender documentation, cost analyses, and other construction management's functions. The second one is, System Q – a collaboration tool for office documentation system through the Intranet, which was further discussed.

7.4.2 System implementation

A manual document management system was in place in early years of IT implementation in Taraz. The Microsoft Outlook application was often used to store thousands of emails. The problem was that Outlook is directed at individuals and there was no automated method to locate all emails relevant to a particular subject or project across the organization. Users or staff must know the name of the file and the location of the document being stored. Taraz's staff were fairly efficient at finding their own documents, but searching for a document created by another colleague can take a significant amount of time and frustrating. In many cases, documents were stored in the wrong place by accident, forgotten the document name, or even 'moving the folder or directory to a new location without even being aware of it. Difficulties start when other colleagues try to find the documents. When staff left their role or the organization, the documents will be 'lost' and difficult to retrieve. These problems are the major reason of System Qs initiation in 1997. System Q is expected to give Taraz better control over document security and access. The system was developed by the IT Department team with six technical groups, as shown in Figure 7.17.

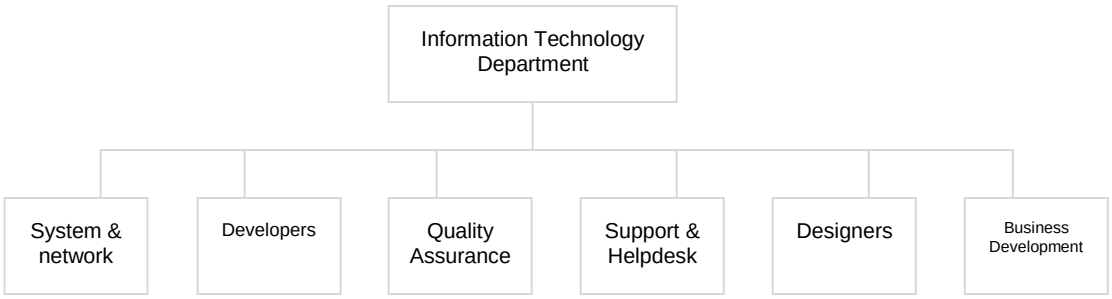

Figure 7.17: IT development team organizational chart

System Q is a web-based workspace collaboration platform for project management, knowledge management, office management, workflow management, and document management technologies into a single solution. System Q enables secure access to the Intranet and features a wide range of administrative tools, as shown in Figure 7.18. Few business objectives were delineated for implementing System Q there are (1) to establish a matter-centric approach, (2) to provide a greater speed of document retrieval, (3) to minimize human error, (4) to gain control over document access, (5) for email integration, and (6) to centralize administration index.

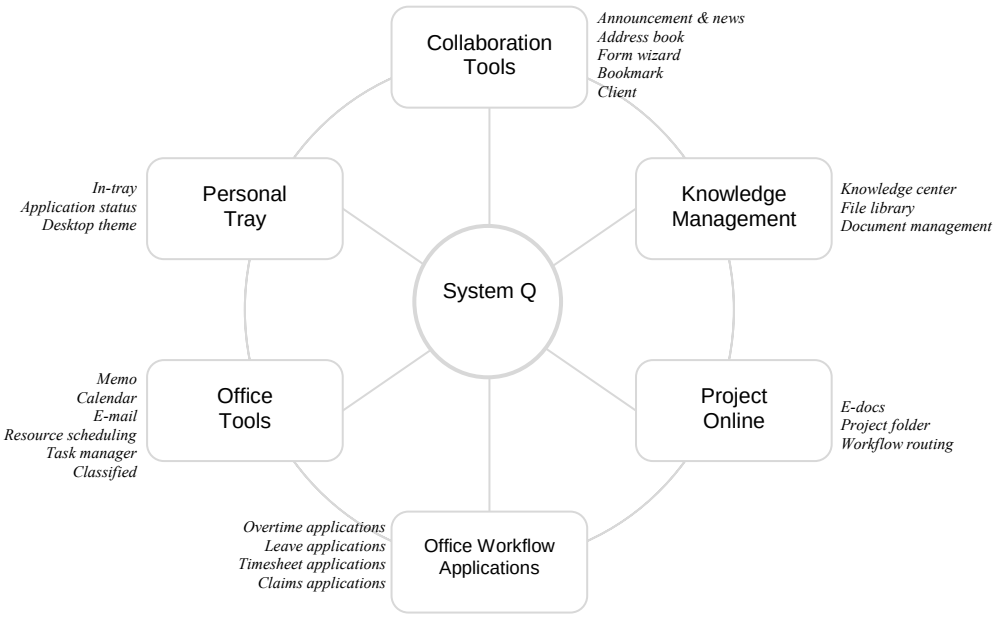

Figure 7.18: System design for System Q

System Q was originally a third party system that was bought in the market, the development team took four years to prepare a complete prototype. This prototype is called System Q First Generation (Gen-1), launched in 2001, was used by all Taraz staff. System enhancements and updates were done progressively according to the feedback received from staff during the initial stage of implementation. In 2002, Taraz

launched System Q Second Generation (Gen-2) and this is being used until today with more than three hundreds users. The system design was updated on a regular basis. In the near future, System Q will be switched to the Third Generation (Gen-3) as Taraz is now planning to adopt the cloud and mobile technologies. Figure 7.19 shows the progress of System Q

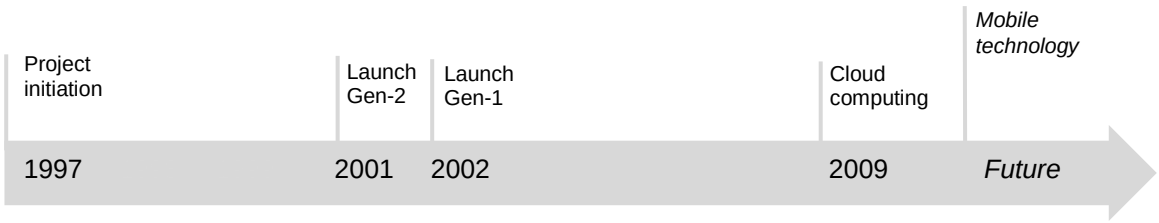

Figure 7.19: System Q timeline.

7.4.3 Analysis

(i) File format standardization

Previous status

- A centralized standardization tool was a part the system that Taraz planned to develop at the initial stage. Before the tool was established, file conversions were completed manually [*Level 1*]. For example, the project team received raw data by softcopy documents in various formats, mostly in PDF, Word Documents and Excel.
- An IT officer was given the responsibility to convert all the files to PDF, as this format is compatible in majority of the existing platforms.
- At the same time, the project team was setting up standardization procedures based on their experience with manual conversion process [*Level 2*].

- From this procedure, the standardization tool was developed and initially covered one module, which was Knowledge Management module [*Level 3*].

Current status

- In about two years, the centralized standardization tool is completed and it coved all the intended modules in System Q [*Level 4*].
- The tool now accepts raw data from various file formats including .html to be converted to PDF before it gets the authorization to be published. The tool allows the files to be accessed from many operating systems and prominent browsers, which include Windows and Mac, Safari, Internet Explorer, Google Chrome, and Firefox.
- On top of that, the tool also automatically converts a whole document of a file to standard fax cover sheets.

Targeted future status

- The plan was to enhance the speed of automatic conversion by increasing the file size and network capacity. Taraz do not intend to integrate System Q with other external systems as this is in internal system.

Table 7.29 Organization Taraz's maturity for file format standardization

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
File format standardization	←	←	←	•		4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(ii) Integration interval

Previous status

- During the period of system's establishment, Taraz considered changes were difficult to resolve. In most cases, they took more than 3 months and up to one year to integrate the new solutions with the existing [*Level 1*].
- The lack of expertise and incomplete system were the main reasons for delay. In addition, the current rigid system forced the project team to reverse-engineer various processes, which are very time and resource consuming.

Current status

- According to few periodic minute meetings, the integration took less than 3 months to complete for major changes [*Level 2*], and for common changes, the project team normally took 2 to 3 weeks to complete [*Level 3*].
- Faster integration duration was mainly due the use of common and open standards, especially in System Q Gen-2.

Targeted future status

- The latest work policy introduced by the project team indicated that integration work could be completed within one week [*Level 4*]. They believe that it is achievable if resources and efficient tools are readily available.
- From this development, Taraz is anticipating to complete integration works between 2 to 3 days [*Level 5*].

Additional comment

- From the construction industry context, it is impossible to integrate systems within minutes or seconds, as IT is not the main business model for the

organization. Organizational resources will not be focused merely in IT but in other construction activities; therefore, if an organization could complete integration duration between 2 to 3 days, the organization can be considered it as fully matured.

Table 7.30 Organization Taraz's maturity for integration interval

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Integration interval	←	←	•	→	→	3,4,5

Indicators: • Current status ← Previous status → Future status

(iii) System design

Previous status

- Informal and separated system design was common during the initial stage of System's Q implementation [*Level 2*].
- The project team acknowledged that the informal processes presented difficulties in refining systen design; hence the project team started to establish a formal design standard, which was developed by the senior management.

Current status

- The past formal standards are still been used. Unfortunately, it was not refined to the most current system design [*Level 3*].
- Even though, it was
- System design was updated from time to time when requested by management or only when required. For example the system designs are updated when the new products are introduced in the market [*Level 4*].

- An alias machine was used for testing the usability of the design [*Maturity Level 5*].

Targeted future status

- The system update should be aligned with the standard system documentation; this will help the project team in refining the system designs.

Table 7.31 Organization Taraz's maturity for system design

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
System Design		←	←	←	●	5

Indicators: • Current status ← Previous status → Future status

(iv) Teamwork

Previous status

- Before 1997, the project team was an informal team formed on a project-by-project basis [*Level 1*].
- At that time, there was only a small number of IT projects and only two to three staff were assigned in each unique team. When IT was booming in the construction industry, Taraz decided to establish an IT Department, and consequently the IT project team was formed.

Current status

- The Human Resource Department carefully selects candidates to be employed, guided by a staffing management plan established by the top management [*Level 2*].

- Besides the experience and expertise, staff must have the capability to work in a team and to think 'outside the box'. The candidates were tested on these skills before they were hired.
- The IT Department is divided into six groups, as shown in Figure 7.9, and all the staff were appointed based on core competencies, expertise and interest - established through Taraz's Staffing Management Plan [*Level 3*].
- Under technical group, two project management teams were formed (including one team for System Q) [*Level 4*].
- Once a year, it is compulsory for all the IT staff to attend team-building activities. On top of this, Taraz also conduct a Teamwork Training Courses every four months [*Level 5*]. Taraz claimed that these approaches have managed to nurture harmony and teamwork between the IT team members and between other department too.

Targeted future status

- Taraz is satisfied with their IT team, as evidence, Taraz was awarded with the BQSM Special Award where they were commended on their working environment, by taking teamwork as one of the main assessment.

Table 7.32 Organization Taraz's maturity for teamwork

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Teamwork	←	←	←	←	●	5

Indicators: • *Current status* ← *Previous status* → *Future status*

(v) Independence & pro-activeness

Previous and current status

- In every decision, team members were involved in all meetings, discussions and brainstorming; and groundwork activities for their dedicated IT projects. They were divided into ad-hoc teams and were assigned to propose a solution, either a new solution or taking previous cases as an example [*Level 3*].
- Majority of the staff were reliable and do not need a leader to guide them throughout the process [*Level 4*].
- Their findings were discussed in a workshop to decide a list of actions to be undertaken. All staff were made aware of the objectives of System Q [*Level 1*].
- For newly employed staff, a leader or a manager will assist in setting goals and guide for them to achieve it. Due to high level of self-directedness, they were coping fast to work with their own initiative to achieve the goals [*Level 2*].
- Taraz provides monetary rewards for staff whom show pro-activeness and the ability to working independently.
- The project team is an autonomous team [*Level 5*]. For example, the management team will notify the IT project team of any issues, difficulty or suggestions, which they think IT could provide a better or more efficient solution; the IT project team will than provide suggestions and propose solutions. The management team usually involved in determining the requirements only.
- Continuous and mutual communication between the IT project team and the management team were constantly encouraged, as Taraz believes it will contribute to better ideas and more efficient way of working.

Targeted future status

- Taraz claimed that they are satisfied with their current status and was hoping to continuously support and sustain the current situation.

Table 7.33 Organization Taraz's maturity for independence and pro-activeness

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Independence & Pro-activeness	←	←	←	←	•	5

Indicators: *• Termination/Current status* *← Previous status* *→ Future status*

(vi) IT awareness

Previous status

- In early stages, Taraz did not realized the importance of being aware about IT products and its management. The desire to know about the latest technology was stagnant among individuals [*Level 2*].
- A few years after the establishment of the IT Department, management began to allocate funding for activities to increase IT awareness [*Level 3*]. Taraz recognizes the importance of IT awareness to protect the organization from being using outdated technologies, especially in IT.

Current status

- Taraz has begun their knowledge-sharing activities to increase and spread IT awareness among the staff [*Level 4*]. Presentations among staff were held once a week.
- A committee from the Research and Development Department was responsible to place the latest developments about IT and construction related news on the notice board and also to the IT Department, which then posts them onto System Q's portal.

- On top of that, Taraz established an internal online forum (as part of the System's modules) and an external professional online forum [*Level 5*]. Staff have signed-up to many RSS feeds to obtain the latest technology update.
- In addition, the IT Department has completed a technology analysis and reported to the top management annually. The results form the analysis will help the project team to decide on the latest technology to be implemented in the future.

Targeted future status

- At current state, Taraz do not have any plans to improve the awareness of IT among their staff. The current approach now was considered satisfying and has been working well in ensuring that the latest technology is adopted.

Table 7.34 Organization Taraz's maturity for IT awareness

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
IT Awareness		←	←	←	•	5

Indicators: *• Current status* *← Previous status* *→ Future status*

(vii) IT learning commitment

Previous status

- Taraz was at a state where there were no interest to learn about technology [*Level 1*]. There were no funding or incentive for those who want to learn more.
- At that time, Taraz focused on the management of the organization, they did very little to impose technology into their working routines until the period of IT boom.

- The enthusiasm to learn about IT is reflected only on individuals although the IT Department was established [*Level 2*].
- There was no documentation at that stage.

Current status

- Along with the awareness of IT, Taraz is encouraging IT staff to gain knowledge about IT and technology. Staff were given permission and funding to participate in training, trials, demonstration, or conferences that would benefit the organization, but participation is limited to five events per year.
- All the documentation, guidelines and manuals obtained by staff are filed and kept on the library's shelf and were made accessible to anyone in the organization [*Level 4*].
- 1 or 2 days in-house trainings were conducted to allow IT staff to share and spread the information among IT staff.
- Recently, most of the documents, old and new, were uploaded in System Q and are available online [*Level 5*].

Targeted future status

- In the future, Taraz is aiming to become a pioneer and a trendsetter in technology, particularly IT in construction industry. This was stated in the recent published IT Vision of Taraz.

Table 7.35 Organization Taraz's maturity for IT learning commitment

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
IT Learning Commitment	←	←	←	←	•	5

Indicators: • *Current status* ← *Previous status* → *Future status*

(viii) Willingness of Change

Previous status

- Before the benefits of IT were recognized, majority of staff resisted change in their normal of working style. There was no push from the top management as they also did not see change as important [*Level 2*].
- When the IT Department was established, top management started to enforce new methods of working to all staff; for activities as leave applications, expenses claims, and overtime applications to be completed online [*Level 3*].
- At the beginning, the staff acceptance varied with the majority reluctant to use. Top management and the IT team received continuous complaints, as a result, the new online methods was place as an alternative to the traditional paper method.

Current status

- In overcoming the problems, the IT Department is aiming to develop more user-friendly systems and conduct in-house trainings for new technologies or updates in the organization [*Level 4*].
- The training syllabus includes hands-on training, detailed user information for new/updated system, and to show the benefits the users will gain. Attendance is compulsory for staff whom utilizes the system.
- Based on the BQSM Special Award they received, which was evaluated on comprehensive and most recent use of IT in the local construction industry, Taraz rated their staff as easy coping with changes in implementing the latest technology [*Level 5*].

- A high degree of change willingness among staff is now a culture in Taraz, especially in the IT Department. Staff expect changes in technology everyday as technology evolves and improve everyday.

Targeted future status

- The Human Resource Department is planning to coordinate a course for the staff in order to encourage and nurture the staff in willingness of change, that is anticipated to be a requirement during the induction period of newly employed staff. This relates to the recent published staffing management plan.

Table 7.36 Organization Taraz's maturity for willingness of change

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Willingness of Change		←	←	←	•	5

Indicators: • Current status ← Previous status → Future status

(ix) Hybrid skills

Previous status

- IT staff were struggling to understand the needs of the management team. The IT team has high proficiency in IT but lacking experience in the construction industry and have low understanding in construction processes.
- Top management did not provide guidance to the IT team, resulting to incomplete functions for System Q Gen-1 [*Level 1*].

Current status

- The management team started to provide some guidance during the system design of System Q Gen-2. With a positive working attitude towards open

discussions, the IT Department claimed that a mutual understanding between the management and IT team has ben forged [*Level 5*].

- The IT team got the management team directly involved in the early phase of the system development, especially during the requirement analysis phase. Therefore, the management team understood the system's abilities and limitations - both teams were guided each other and were well informed of its progress. Both teams held various open discussions to nurture an idea to be better. Any problems resolved within two days.
- The IT Manager played a significant role to deliver the right message and information to his sub-ordinates [*Level 3*].
- The IT staff's willingness of change were considered to be in Level 5 maturity - their acceptance and understanding about management needs were easily adopted, especially among the senior staff [*Level 4*].
- Junior staff were assigned to a leader to gain direct guidance and supervision.

Targeted future status

- Taraz is planning to train the management staff to being hybrid employees as they have now recognized the importance of IT in daily working routines.

Table 7.37 Organization Taraz's maturity for hybrid skills

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Hybrid Skills	←	←	←		●	5

Indicators: • *Current status* ← *Previous status* → *Future status*

(x) Awareness of critical success factors (CSF)

Previous status

- The in-house project team has established a standard form of CSF as a guideline to develop an IT system [*Level 2*]. This was used in all IT projects undertaken by the IT Department.

Current status

- In the context of System Q, the identification of CSF was only carried out in the second-generation development. The CSF for Gen-2 were determined by the external committee from their other officers around the world [*Level 3*].
- The results were than used to develop a task workforce and a strategic plan [*Level 4*]. Unfortunately, these were not updated since it was established in 2001.

Targeted future status

- The IT Department was planning to refine and formalize the CSF based on current trends. Revisions need to be done regularly to adapt with current needs and technology trends [*Level 5*].

Table 7.38 Organization Taraz's maturity for awareness of critical success factors

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Awareness of Critical Success Factors (CSF)		←	←	•	→	4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

(xi) Connectivity

Previous status

- Taraz had a dial-up connectivity when it was first introduced in Malaysia. In the next phase, the wireless network was introduced by the speed was slow and unstable.

Current status

- Taraz used both cabled network and Internet broadband for internal [*Level 2*].
- Within the office compound, wireless networks were used but only non-staff members. High-speed network was implemented to enable faster data transfer and parallel networks are used for saving data if one of the network may failed [*Level 3*].
- To allow the staff access System Q from the remote, an automatic wireless network was established so that they can roam across different wireless networks without the need to reconfigure the network connection settings on the computer for each location [*Level 4*].
- System Q is based on cloud networking technology [*Level 5*]. Devices such as Personal Computer is automatically connected to System Q's server, thus cloud allow staff to work from anywhere around the world.

Targeted future status

- Following the current technology trend, Taraz is ready to extend the System Q's modules to be inline or in the similar technology platform in the marketplace.

Additional comment

- In today's environment, wireless networks are basic and affordable [*Level 1*].

Table 7.39 Organization Taraz's maturity for connectivity

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Connectivity	←	←	←	←	•	5

Indicators: *• Current status* *← Previous status* *→ Future status*

(xii) IT security management

Previous and current status

- All Personal Computer must be processed and formatted by IT Department before it could be used by staff. Each PC was protected with a third-party firewall, anti-virus, anti-malware and access authorization control [*Level 1 and 2*]. This enables the IT Department to trace and detect virus or attacks, and assist users.
- IT risk and security analysis were performed regularly to check the number of incidents, testing, and auditing of queries by controlling the amount of information released [*Level 3*].
- Every module in System Q comes with access control. Selected data modules were encrypted as a preventive measure to protect sensitive data at any event of attacks, malicious malware or hacking activities [*Level 4*].
- An auto-recovery system is also built-in to selected modules [*Level 5*].

Targeted future status

- The auto-recovery system would be implemented for the entire system.

Table 7.40 Organization Taraz's maturity for IT security management

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
IT Security Management	←	←	←	←	•	5

Indicators: • Current status ← Previous status → Future status

(xiii) Data management

Previous status

- Data was managed using the on-the-shelf filing system – Taraz was slowly moving towards paperless environment [*Level 1*].
- A third party data management software was used but was dropped by Taraz as it was not capable to manage IT projects for the construction industry [*Level 3*].

Current status

- The paper-intensive data management system still being practiced. The practice remains as clients, especially the government, required Taraz to have both hardcopy and softcopy documentation.
- A Project Data group was established under the Support and Helpdesk Division to manage IT project data [*Level 2*]. An internal librarian from the Research and Development Department work closely with this group to manage knowledge sharing within Taraz. The in-house IT team developed a data management tool to assist in preparing reports and analysis [*Level 4*].
- The tool has search capabilities across all the modules in System Q, as well as across other systems for multiple data types [*Level 5*].

Table 7.41 Organization Taraz's maturity for data management

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
Data Management	←	←	←	←	•	5

Indicators: • Current status ← Previous status → Future status

(xiv) IT project management

Previous and current status

- IT management procedures existed since System Q was proposed but the coverage was not comprehensive due to the lack of system refinement. The standard procedures were inconsistent from one task to another with many ad hoc plans involved [*Level 1 and 2*].

Targeted future status

- The IT Department is in a middle of refining the project team and the IT project management plan – this is to roll out a consistent approach and act as a roadmap to be followed; also a procedure to lead and ensure project completion [*Level 3*].
- Taraz believes that the project management plan takes into account flexibility and risk assessment – that are the greatest benefits of the plan. Continuous project management plan monitoring could lead to a new and improved direction for the team and department [*Level 4*].

Additional comment

- The organization claimed that they did not need to predict future capability as they were satisfied to manage change accordingly when the changes occurred [*Level 5*].

Table 7.42 Organization Taraz's maturity for IT project management

Case Study 3	Maturity level					
	1	2	3	4	5	Gaps
IT Project Management	←	•	→	→		2,3,4,5

Indicators: *• Current status* *← Previous status* *→ Future status*

7.4.4 Discussion

Figure 7.20 presents the current maturity status, and the targeted maturity status that Taraz was planning to achieve.

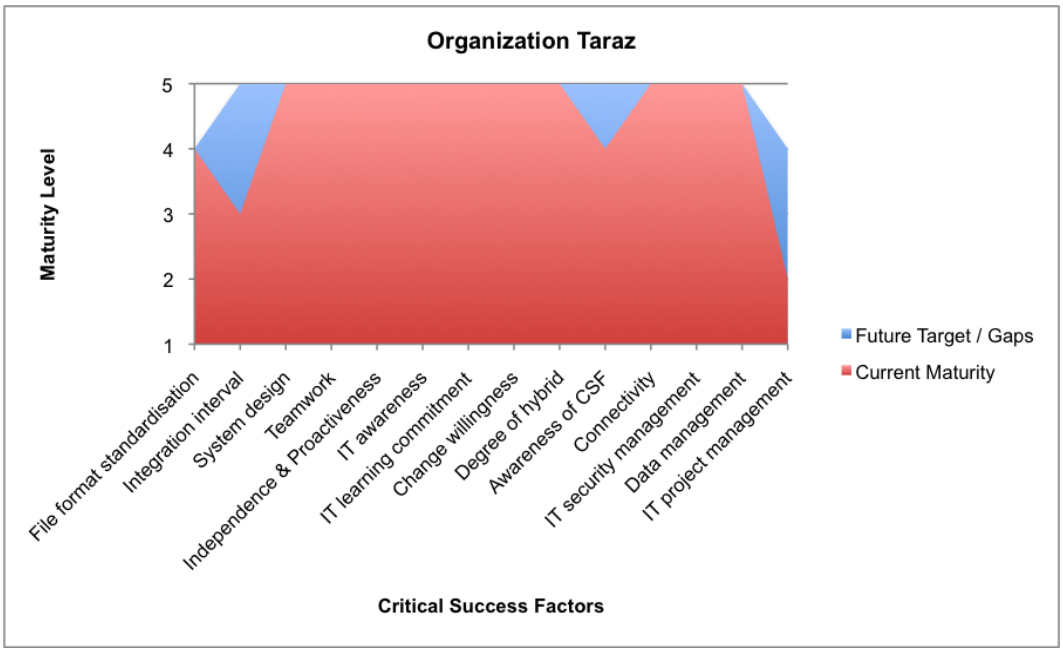

Figure 7.20: IT Infrastructure Flexibility Maturity Grid for Organization Taraz

- Compatibility measures under ***technical dimension*** are at Level 4 maturity for File Format Standardization, and Level 3 for Integration Speed. Taraz have no intention to integrate the centralized file system due to System's Q confidentiality and security. Therefore, this factor will remain at this level.
- For Integration Interval, Taraz is close to achieving the next level of maturity. The IT Department has strategized resources and tools, and awaiting budget approval from

top management. Taraz is not an IT company by nature, hence, IT investments need to be carefully selected by top management to ensure the positive return of investment (ROI).

- System Q was design to be reconfigurable; hence the System Design is adaptable to changes. The use of alias machine for testing is a brilliant approach to assimilate the actual performance of System Q and promoting the system's continuous improvement.
- Taraz has reached Level 5 of maturity in most of the factors under the ***people*** dimension. As a private company, staff play a key role in driving the success of the business. Accordingly, Taraz has put continuous effort for 36 years to have a strong people strategy, resulting to a matured human resources framework and an agile organization. Their future plans looked towards revitalizing their maturity and continuous improvement ensures the legacy of the organization in the industry.
- The CSF Awareness was at Level 4. Taraz has planned the IT *Refinement Strategy 2012* to give continuous revision in CSF framework to ensure the success of the system and promoting sustainable growth for the organization. This indicates that the Taraz is reaching towards the highest maturity of Level 5.
- In ***management*** dimension, Taraz reached the highest maturity for technical-related factors, which are Connectivity, IT Security Management, and Data Management. As the company continue to grow, successful organizational and operational management, and growth is essential for Taraz to stay ahead of its competitors. In recognizing IT as a key driver in the business, Taraz has established systems and resources in place to successfully handle and manage connectivity, IT security, and data management.
- Unfortunately, Taraz overlooked the IT Project Management section. At current state, they are at Level 2. Taraz now realized that a comprehensive IT project

management will keep costs low, shortened timeframes, adequate resources, and reduce project failing, Taraz are re-structuring a strategic plan to refine the IT Project Management Plan; they are targeting the highest level of maturity to achieve flexibility in IT infrastructure.

- Taraz should establish a consistent standard approach in their IT projects. This will help then in assigning scarce resources to work on strategic activities and improving IT project predictability. A consistent standard and procedure will continuously improve identification, reduction and elimination of sub-optimal processes. These improvements are based on a large number of small changes, rather than the radical overhaul of the development process, or in the form of ideas or suggestions from the IT team, users, or top management. To achieve the next level of maturity, the change management plan should be in place. The change management plan will benefit Taraz in time savings needed to implement change and reduce risks.

Figure 7.21 shows the summary assessment for System Q with maturity gaps. The priority for Taraz now should be the completion and implementation of IT Project Management as it achieved the lowest maturity in the organization. All the fourteen factors were also triangulated during this case study.

		Level 1	Level 2	Level 3	Level 4	Level 5
Technical	File Format Standardization	←	←	←	•	
	Integration Interval	←	←	•	→	→
	System Design		←	←	←	•
People	Teamwork	←	←	←	←	•
	Independence & Pro-activeness	←	←	←	←	•
	IT Awareness		←	←	←	•
	IT Learning Commitment	←	←	←	←	•
	Willingness of Change		←	←	←	•
	Hybrid Skill	←	←	←		•
	Awareness of CSF		←	←	•	→
Management	Connectivity	←	←	←	←	•
	IT Security Management	←	←	←	←	•
	Data Management	←	←	←	←	•
	IT Project Management	←	•	→	→	

Indicators:
- • *Current status*
- ← *Previous status*
- → *Future status*
- *Maturity gap*

Figure 7.21: The assessment summary for System Q implementation

7.5 Summary

- Overall, the initiatives and functions of the three cases in this study varied but the maturity progress for all of the cases were consistently. All factors in each level were triangulated as represented in Table 7.43.
- Figure 7.22 shows the overall results of IT Infrastructure Flexibility maturity levels between all case studies. The findings identify the organization's current capability by assessing different construction organizations for equivalent comparison. It sets a clear benchmark where the organization is standing today. They could use this graph to self-evaluate and to set where the organization plans to be. For example, Organization Bina was left behind in Awareness of CSF as opposed to other organizations; hence they could prioritize their current strategy to improve in this aspect so that they would remain competitive in the industry. The graph also helps the organization to put on balance between technical, people, and management dimension so that the effort could be optimized in achieving flexibility in their IT infrastructure.

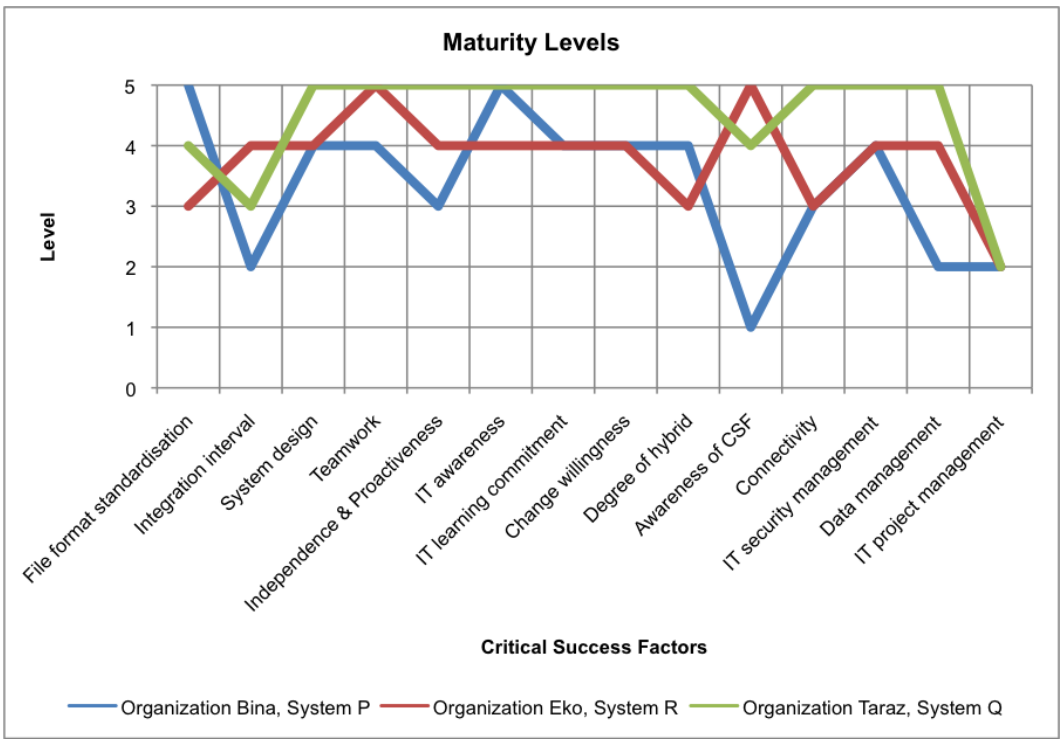

Figure 7.22: Comparison of maturity levels between case studies.

7.5.1 Technical dimension

- File format standardization is the key to increase compatibility and allow systems, application and software to be interoperable across different platforms. All systems implementation had unstructured file format in early stage of its development. For example, in System P and System Q, each of the modules has different file formats and do not support automatic file conversion. As this factor plays a big role in system compatibility, all case studies demonstrated sufficient maturity for file format standardization, System P and System Q moved from manual file conversion to an automatic and centralized tool for file conversion. System R implemented a standard file format with not automation. System P, System Q, and System R uses PDF files

as they are highly flexible and can be opened from almost any computer. PDF files could also reduce the original file size without losing any content or format. Automation in standardized file formats allows flexibility in choosing the various file types and information the users prefer. This could accelerate the conversion process and avoid human-error in processing the files.

- In the event of new a module, application, or technology is employed; the integration interval for technical configuration depends on the organizational decision-making process; as IT is not the main business priority in construction organizations. System P, System Q, and System R witnessed delays that were caused by slow and bureaucratic internal processes in their respected organization. However, System R experienced faster integration interval after a vendor took over the system development.

- System design for System P, System Q, and System R were updated and revised in ensuring the modularity of system design. System Q used a computerized system to assess the usability and impact of a revised system.

7.5.2 People dimension

- As the company grows, Organization Bina, Organization Eko, and Organization Taraz have refined and improved their human resources framework. Eko and Taraz have an established teamwork for System R and System Q's development team. Core competencies in every team member were recognized and teamwork as apparent in the organization.
- Level of maturity for having independence and pro-active staff were different between three organizations. System P's development team was reliable in completing the tasks but require a leader to guide the project team throughout the

project. System R's development team has earned the authority to decide project goals with support from the top management. In another hand, System Q's development team reached the highest maturity level by being an autonomous team. Being independent and pro-active give the team freedom to generate ideas in perceived challenges, hence allowing them to be the first innovators in the market.

- IT awareness and learning could be brought together. The levels of maturity for both factors were almost equal in Bina, Eko, and Taraz. They have outlined significant activities to ensure IT awareness among the staff is reached to all; activities include presentations, discussions, and demonstrations. System Q has deployed a knowledge-sharing portal with current information and knowledge about technology. With a high level of awareness and knowledge on IT, it helps the staff in generating fresh and innovative IT solutions.
- Changes need to be enforced by top management in Bina and Eko. Staff were provided with trainings and assessed by performance appraisals. In Taraz, willingness of change is embedded into organizational culture, as the organization require new staff to have a high degree of change capabilities before being employed. Taraz also believed that enforcement was a good step to create a positive change willingness environment in the organization.
- Hybrid staff have a high level of both technical and organizational skills. System Q's development team has had a matured team of hybrid staff where they have created an environment of mutual understanding and open communication between the technical and management teams. As a result, decisions were easy to make and well understood. In the case of System P, two-ways understanding has not exist. In System Q, the development team has high technical skill but only the leaders understand the management needs. However, the leaders need to define progressive goals for their sub-ordinates as the project progresses. Appointing a vendor was a

good alternative to overcome this limitation, as the vendor's expertise assisted in improving understanding in the implications of changes.

- CSF for System Q and System R were identified and allowed both organizations to focus on building the system's capabilities. Unlike in the first version of System P, Bina overlooked the importance of CS; as a result, reverse engineering was required in the second version.

7.5.3 Management dimension

- All organizations have employed wireless and cabled networks, all the systems examined in the case studies have secured its connectivity with few backup networks. System Q have implemented cloud networking and this permits the system to be accessed from remote offices anywhere around the world through the Internet.
- In all cases, computers and networks were protected with IT security, including access control levels. Statistical data security systems were executed to continuously check numbers of incidents, testing, and auditing queries. Data in systems were encrypted. System Q has taken extra precaution by utilizing an auto-recovery system.
- A centralized data management tool is used in organizing and managing data for System Q and System R. Besides storage, the tool is also used for auto-reporting and analysis as well. System Q has the ability to search across multiple platforms. System P is still managing project data without any additional tools. Major works are being planned to improve the data management from being an isolated system to an integrated and automated approach.
- All organizations recognize the importance of IT project management. Unfortunately, all cases reported maturity Level 2 where the organizations do not have a consistent approach or procedures for their responsibilities. Major progress is

needed to establish and refine a IT project management standard to ensure a standard procedure and consistent approach in executing the IT project, thus, ensuring the project is within the allocation budget and time, and in good management.

7.6 Conclusion

The summary of overall findings for three case studies was listed in Table 7.44. The findings in all three case studies are sufficient to triangulate the CSF of ITIF in a context of the preliminary ITIF Maturity Model development; with each level for each factor was discussed through all case studies. In order to refine the preliminary ITIF Maturity Model, few words and phrases were modified to fit with the construction industry environment. The modifications and new ITIF Maturity Model will be discussed in the next chapter.

Table 7.43: Summary for factors triangulation completion

Critical Success Factors	Cases	Maturity Levels				
		1	2	3	4	5
[1] File format standardization	Case Study 1	←	←		←	•
	Case Study 2		←	•	→	→
	Case Study 3	←	←	←	•	
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[2] Integration speed	Case Study 1	←	•	→	→	
	Case Study 2	←	←	←	•	→
	Case Study 3	←	←	•	→	→
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[3] System design	Case Study 1	←	←	←	•	→
	Case Study 2		←	←	•	→
	Case Study 3	←	←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[4] Teamwork	Case Study 1	←	←	←	•	→
	Case Study 2	←	←	←	<-	•
	Case Study 3	←	←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[5] Independence and pro-activeness	Case Study 1	←	←	•	→	→
	Case Study 2	←	←	•	→	→
	Case Study 3	←	←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[6] IT awareness	Case Study 1		←	←	←	•
	Case Study 2	←	←	←	•	→
	Case Study 3		←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[7] IT learning commitment	Case Study 1	←	←	←	•	→
	Case Study 2	←	←	←	•	→
	Case Study 3	←	←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[8] Willingness of Change	Case Study 1	←	←	←	•	→
	Case Study 2	←	←	←	•	→
	Case Study 3		←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[9] Hybrid skill	Case Study 1		←	←	•	→
	Case Study 2	←	←	•	→	→
	Case Study 3	←	←	←		•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[10] Awareness of CSF	Case Study 1	•	→	→	→	→
	Case Study 2	←	←	←	←	•
	Case Study 3		←	←	•	→
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[11] Connectivity	Case Study 1	←	←	•	→	→
	Case Study 2	←	←	•	→	→
	Case Study 3	←	←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[12] IT security management	Case Study 1	←	←		•	→
	Case Study 2	←	←		•	→
	Case Study 3	←	←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[13] Data management	Case Study 1	←	•	→	→	→
	Case Study 2	←	←		•	→
	Case Study 3	←	←	←	←	•
	Factors triangulation	Checked	Checked	Checked	Checked	Checked
[14] IT project management	Case Study 1		•	→	→	→
	Case Study 2	←	•	→	→	→
	Case Study 3	←	•	→	→	→
	Factors triangulation	Checked	Checked	Checked	Checked	Checked

Indicators: *• Current status* *← Previous status* *→ Future status*

Table 7.44: Summary of systems understudy

Factor	Status	System P - Organization Bina	System R - Organization Eko	System Q - Organization Taraz
File format standardization	Previous	No standardization	-	Standard
	Current	Integrated tool	Standard	Centralized tool
	Future	-	Automated tool	Integrated tool
Integration interval	Previous	Less than 6 months	2 – 3 months	More than 3 months
	Current	1 – 2 months	1 – 4 weeks	2 – 3 weeks
	Future	Less than 1 week	Few days	Less than 1 week
System design	Previous	Unplanned	Unplanned	Unplanned
	Current	Standard, updated	Standard, updated	Computerized, updated
	Future	Computerized	Computerized	-
Teamwork	Previous	Ad hoc	Ad hoc	Adhoc
	Current	Project team	Project team, team building	Project team, team building
	Future	Team building	-	-
Independence & pro-activeness	Previous	Comfort zone	Follower	-
	Current	Guided	Reliable	Autonomous
	Future	Free, autonomous	Free	-
IT awareness	Previous	Paper cutting, RSS	Not aware	Individual effort
	Current	Knowledge portal	Discussions, presentations	Knowledge portal
	Future	-	Knowledge portal	-
IT learning commitment	Previous	Not interested	Own initiative	Own initiative, conferences, presentations
	Current	Conferences, presentations	Conferences, presentations	Knowledge portal
	Future	Knowledge portal	Knowledge portal	-
Willingness of Change	Previous	Enforcement, no intensive	Individual effort	Enforce, no intensive, no guidance
	Current	Enforcement, intensive, KPI	Enforcement, intensive	Encourage, culture
	Future	Encourage, culture	Encourage, culture	-
Degree of hybrid	Previous	Minimal guidance	Minimal guidance	Unguided
	Current	Hybrid, not mutual	Leader only	Mutual
	Future	Mutual	Mutual	-
Awareness of CSF	Previous	Not identified	Not identified	In-house involvement
	Current	External involvement	Internal & external involvement, refined list	External involvement
	Future	Refined list	-	Refined and updated list
Connectivity	Previous	Wireless, cabled, fiber optics	Wireless, cabled, fiber optics	Wireless
	Current	Multiple logical interface	Multiple logical interface	Cabled, cloud
	Future	Cloud	Cloud	-
IT security management	Previous	PC & network protected	PC & network protected	PC & network protected
	Current	Encryption	Encryption	Encryption, Auto-security
	Future	Auto-security	Auto-security	-
Data management	Previous	Paper-heavy	Paper-heavy	Paper-heavy
	Current	Computerized	Data management tool	Data management tool, integrated
	Future	Data management tool, integrated	Integrated	-
IT project management	Previous	Ad hoc	Ad hoc	Ad hoc
	Current	Structured, inconsistent	Structured, inconsistent	Structured, inconsistent
	Future	Consistent, change management plan	Consistent, change management plan	Consistent, change management plan

Reference

Alshawi, M., & Arif, M. (2011). ***Cases on e-readiness and information systems management in organisations: Tools for maximizing strategic alignment*****. United Kingdom: IGI Global.**

Alshawi, M., & Salleh, H. (2011). IT/IS Readiness Maturity Model. In M. Alshawi & M. Arif (Eds.), ***Cases on E-Readiness and Information Systems Management in Organizations: Tools for Maximizing Strategic Alignment*** **(pp. 1-14). Salford: IGI Global Publication.**

Deed, C., & Cragg, P. (2012). Business Impacts of Cloud Computing. In B. A & A. K. Aggarwal (Eds.), ***Cloud Computing Service and Deployment Models: Layers and Management*** **(pp. 274-288): IGI-Global.**

Kong, A. T., & Gray, J. (2006). ***Problems with traditional procurement in the Malaysian construction industry - a survey.*** **Paper presented at the Proceedings Australian Universities Building Educators Association Annual Conference, University of Technology, Sydney.**

Smith, I. (2005). Achieving readiness for organizational change. ***Library Management, 26*****(6/7), 408-412.**

Walling, D. R. (2012). The tech-savvy triangle. ***TechTrends, 56*****(4), 42-46.**

Zhang, S., Teizer, J., Lee, J.-K., Eastman, C. M., & Venugopal, M. (2012). Building Information Modeling (BIM) and Safety: Automatic Safety Checking of Construction Models and Schedules. ***Automation in Construction, 29*****(January), 183-195.**

Zhang, Z., Cui, Y., Zhang, P., Luo, X., Xu, X., & Jin, Y. (2011, December 5-7). ***High flexibility XML-based configuration system of fibre channel avionics environment.*** **Paper presented at the 10th International Conference on Optical Communications and Networks, Guangzhou, China.**