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STRATEGIC IMPLEMENTATION OF IT/IS PROJECTS IN CONSTRUCTION: A CASE STUDY

Abstract

The need for improved implementation of Information Technology (IT) and Information Systems (IS) has been emphasised in both empirical and prescriptive research studies. This problem is magnified in the construction industry, which has been slow to embrace and utilise new technologies with negative consequences on productivity and innovation. This paper presents a strategic implementation framework for IT/IS projects in construction. The framework builds upon recent published works and encompasses well-documented predictors for effective IT/IS implementation. A case study with a large multi-national construction organisation is used to demonstrate the strategic implementation of a Project Management Information System (PMIS) used for the construction of a mobile phone telecommunications network in the South East of Queensland, Australia.

Keywords: Information Technology; Information Systems; Strategic implementation; SWOT analysis; Analytical Hierarchy Process

1. Introduction

The successful implementation of new and innovative Information Technology (IT) and Information Systems (IS) in construction requires the development of strategic implementation plans prior to IT/IS project commencement [1]. Unfortunately, little regard has been given to the future potential of IT/IS within the

construction industry giving rise to a large gap between output and expectation from these IT/IS investments [2,3]. Only recently, there has been growing interest in developing planning frameworks to aid the strategic implementation of IT/IS in construction. Leslie [4] identified five 'streams' or responsibilities that identify and separate the information needs of the Architecture, Engineering and Construction (AEC) industry from those of the technologies that will be required to satisfy them: (1) project application; (2) project resources; (3) industry conventions; (4) process re-engineering; and (5) communications and computing. A study by Myllymaki [5] concerning the planning and implementation of new IS in Finnish construction companies, identified three 'cornerstones' of a successful implementation: (1) vision; (2) commitment; and (3) re-engineering possibilities. Miozzo et al. [6] derived an IT/IS-enabled process strategy for construction. Their research looks at a number of construction processes and ‘blocking’ sources to their efficiency. Jung and Gibson [7] developed a framework for measuring and assessing Computer Integrated Construction (CIC) planning. They detailed five measures for CIC planning: (1) corporate strategy; (2) management; (3) computer systems; (4) IT, and (5) incremental investment. Pena-Mora et al. [8] developed a strategic IT planning framework for the AEC industry, particularly focusing on large-scale construction projects. The first step in this framework is to understand the businesses of the AEC project as well as the dynamics of the overall economic environment in which the project operates. The second step is to analyse the relevant processes and functions within the AEC project. Finally, the third step is to develop an IT investment model that can be integrated into the overall strategic planning framework to devise the generic dynamic strategic plan.

This paper attempts to build on the above mentioned frameworks by introducing a strategic IT/IS implementation framework which is based on a critical assessment of market opportunities and threats, and organisational strengths and weaknesses (see **Fig. 1**). The paper presents the framework in a detailed step-by-step methodology supported by the ten well-documented predictors for effective IT/IS implementation [9]. A case study is also introduced where the proposed framework is used for the implementation of a new Project Management Information System (PMIS) by a large multi-national construction organisation in Australia.

To oversee the implementation of the proposed framework, the paper suggests establishing a cross-functional team of staff members to form the IT/IS Review Committee (RC). This is to bridge the differing worldviews of senior managers and IT/IS professionals and to reinforce the message that all employees are working for the same goal: to achieve corporate objectives [3].

(INSERT FIG. 1)

Fig. 1. Strategic IT/IS implementation framework

2. STEP 1: SWOT Factors

Central to this step is the incorporation of the *scale of values* of the corporate management of the organisation (eg. objectives, perceptions, beliefs and challenges). This activity is important because it defines the way the organisation is managed and the criteria under which strategies are evaluated. Keeping in mind the *scale of values* of the organisation's corporate management, the RC needs to undertake an external and internal analysis. The former examines the environment in which the organisation is participating to study the potential opportunities and threats whereas the latter identifies the weaknesses and strengths of the organisation. Combining the results of the external and internal analysis and taking into account the *scale of values*, the SWOT (Strengths, Weaknesses, Opportunities, and Threats) factors are identified.

2.1 External environment analysis

The changing business environment and increased IT/IS capabilities are translating into more focused emphasis on strategic integration [10]. Increased global competition on one hand and availability of communication-tools on the other, have enhanced opportunities for design and construction organisations to establish joint ventures, partnering and long-term relationships with clients and/or suppliers. Also, integrations between planning, design and construction organisations are gaining increased attention from practitioners and researchers alike focusing

upon increased productivity and improved quality of construction [1]. Therefore, the main purpose of this analysis is to identify IT/IS-enabled integration and alliancing opportunities/threats.

It is not sufficient though to concentrate the external analysis at the macroscopic level of the industry alone [8]. This is because even at the microscopic level of construction projects, IT/IS spending has grown rapidly with operations and maintenance costs dominating the budget. In addition, an external analysis can capture the dynamic nature of project participants in a large-scale construction project. To better understand the relationship of all components of an IT/IS strategy on construction projects and within strategic business units of an organisation, it is helpful to examine the strategy in a systematic way, looking at the various investments, and the tangible as well as intangible returns from these investments [11].

2.2 Internal environment analysis

Several researchers have articulated the need to consider how the internal organisational environment is determinant of the strategic IT/IS implementation planning process. For example, the organisation's corporate culture can facilitate its strategic IT/IS planning by being congruent with it [12]. The organisation's planning and control style, is perhaps in part a function of corporate culture, similarly influences strategic IT/IS implementation planning [13]. Likewise, organisational size, organisational structure (mechanistic vs. organic) and management style (entrepreneurial vs. conservative) may influence strategic IT/IS implementation planning [14].

The primary role of the internal analysis is to identify the weaknesses and strengths of the organisation. Responding to the internal strengths and weaknesses is therefore an essential component of the strategic management process [15]. By collating all the opportunities and threats obtained through external analysis, combined with strengths and weaknesses obtained through internal analysis the organisation can undertake SWOT analysis as explained below.

3. STEP 2: SWOT Analysis

Internal strengths and weaknesses, as well as external opportunities and threats obtained in step one form the foundation of SWOT analysis. SWOT analysis is a commonly used tool for analysing internal and external environments in order to attain a systematic approach and support for a design situation [16]. There is no standard list of factors that apply for all construction organisations because of the specificity of each set. However, strengths tend to relate to the competitive advantages and other distinguishing competencies, which can be exploited by the organisation on the market. Weaknesses are limitations which hinder the process of an organisation in a certain direction. Opportunities relate, for example, to the technology enabled advantages that can be obtained by the uptake of IT/IS. Threats relate to an array of macroscopic and microscopic problems that exist or may arise which can potentially jeopardise the successful implementation of proposed IT/IS projects.

If used correctly, SWOT can provide a good basis for successful IT/IS implementation strategy formulation [17]. When undertaking SWOT, the analysis lacks the possibility of comprehensively appraising the strategic decision-making situation; merely pinpointing the number of factors in strength, weakness, opportunity or threat groups. In addition, SWOT includes no means of analytically determining the importance of factors or of assessing the fit between SWOT factors and decision alternatives. In a study by Hill and Westbrook [17], they found that none of the 20 case companies prioritised individual SWOT factors. In addition, the expression of individual factors was of a very general nature and brief. Thus, it can be concluded that the result of SWOT analysis is too often only a superficial and imprecise listing or an incomplete qualitative examination of internal and external factors. This gives rise to the need of a more efficient use of SWOT as argued by McDonald [18].

The Analytical Hierarchy Process (AHP) is deemed the most appropriate analytical method for development of a hybrid method with SWOT. AHP is an effective tool in structuring and modelling multi-criteria problems and has been successfully used in a variety of construction management applications [19-20]. The idea in utilising

AHP within a SWOT framework is to systematically evaluate SWOT factors and commensurate their intensities, adding value to SWOT analysis. This value can be achieved by pairwise comparison between SWOT factors and analysing them by means of the eigenvalue technique as applied in AHP. This offers a good basis for examining the present or anticipated situation more comprehensively. After carrying out these comparisons, decision-makers will have quantitative information about the decision-making situation; for example, whether there is a specific weakness requiring all the attention, or if the organisation is expected to be faced with future threats exceeding the organisation's combined opportunities. The reported case study details the use of the AHP/SWOT hybrid model to weight strategic SWOT factors.

4. STEP 3: IT/IS Diffusion Strategy 'Story Telling'

To develop an effective IT/IS diffusion strategy, the information sought and gathered in the previous step must be carefully analysed, and recommendations that result from this analysis must be reviewed by all that have a vested interest in those recommendations. Moreover, stakeholders should be asked to find problems or weaknesses in the proposed IT/IS system.

One powerful tool for structuring this critical analysis is called 'story telling'. Proponents suggest that story telling forces planners to think through their recommendations and helps build support for the implementation efforts that are to follow [21]. The work of Goldratt, studied by both scholars and practitioners underscores the power of a story. Although fictional, and not written as a strategic plan treatise per se, *The Goal* [22], and *It's Not Luck* [23] illustrate the heuristic power of a drama depicting human foibles in the pursuit of organisational excellence. This same heuristic power can be created when teams are brought together to plan for the integration of IT/IS [3]. Story telling provides both a method and a forum for the team to think through the changes necessary to facilitate implementing the IT/IS system and at the same time, address the resistance to change that might be encountered.

The story should clearly describe how the proposed project will benefit the organisation (tie-in to the organisations strategy and plans), how organisational assets and processes will be affected by the new IT/IS project and what changes will be necessary to take full advantage of the IT/IS project's capabilities (substitution, enhancement, transformation). Also, the story must convey not just proposals for changes in structure, people and tasks deemed necessary to make best use of the system, but the logic behind their recommendations. Having to write such stories will force the team to clearly think through the recommendations, make it easier for others to understand why changes are being made and finally, build support for the changes that are sought [3].

Story telling builds on external and internal factors examined in SWOT analysis by treating strategy as an evolving drama incorporating the most likely forces affecting the intended outcome of the story ie. goal. This process will force senior management to be heavily involved in the development efforts and in so doing, help overcome hidden phobias, thereby reducing their resistance to changes. These well-written stories can be developed into an operational strategy considering each decision-making tier of the construction organisation.

5. STEP 4: Operational Strategy

From the IT/IS diffusion strategy, the operational strategy is derived. Stories formulated in the previous step are developed into a more detailed operational strategy, which considers each decision-making tier of the construction organisation (ie. project, business unit and enterprise tiers). Development of an operational strategy corresponds to what Mintzberg [24] calls codification ie. the clarification and expression of strategies in terms sufficiently clear to render them formally operational. In developing an operational strategy, the chosen scenarios established by 'story telling' should be analysed in terms of functions (business systems), hierarchies and responsibilities (organisational structure), as well as in terms of the technical architecture required for the building of IT/IS systems that would support the alternative growth strategies. Hence, in this step various models of the target organisation should be elaborated: a functional model depicting IT/IS deployment; an organisational

model depicting the responsibilities and hierarchies; and a technical model depicting IT/IS specifications ie. network requirements, software and hardware requirements, security, etc.

The following step in the proposed methodology corresponds to elaboration and conversion of the operational strategy, where elaboration is defined as the breaking down of codified strategies into substrategies and *ad hoc* programs as well as action plans, and conversion is the consideration of effects of the changes on the organisation's operations.

6. STEP 5: Implementation Strategy 'Action Plans'

The implementation strategy is the most detailed component of the proposed strategic IT/IS implementation framework. This step requires the definition of robust actions, the evaluation of budgetary requirements, the study of time and organisational constraints, the elaboration of human resource issues, management and plan coordination, migration and diffusion etc. In addition, the action plans need to be examined concerning its risks, strategic importance and harmonised integration within the overall evolution of the specific organisation. There are three main stages to the development of the implementation strategy: (1) definition of action plan elements, (2) elaboration of action plan, and (3) risk mitigation and coping strategies.

6.1 Definition of action plans

Action plans must be clearly defined before elaboration of these plans can take place. Activities that need to be undertaken in this stage include: (1) inventory of actions for strategic IT/IS implementation, (2) study of implementation procedures (budgetary constraints, organisational constraints, types of financing etc.), and (3) action prioritisation with reference to strategic importance. The RC may determine that other aspects discovered in the previous steps require definition.

6.2 Elaboration of action plans

Once the definition and role of action plans are established, the action plans can be detailed. Activities that need to be undertaken in this stage include: (1) study of each action element (objectives, work breakdown structure, anticipated results etc.), (2) time dimension (constraints, precedence, control points etc.), (3) cost dimension (purchase costs, development costs, maintenance costs etc.), (4) Analysis of human resource issues (training, support, etc.), and (5) IT/IS management and coordination structure. Elaboration of action plans will ensure that the IT/IS implementation strategy is well documented and can be readily followed.

6.3 Risk mitigation and coping strategies

Risk factors or weaknesses need to be mitigated in the strategic planning process. By developing coping strategies for envisaged risk factors, an organisation can reduce the process and outcome gap [25]. Risk factors alter the nature of the planning process from its intended state. This ‘process gap’ results in a realised process which contains some intended elements as well as some which emerge as a consequence of the risk factor(s) leading to intended and emergent planning outcomes. In other words, actual planning outcomes may exhibit some, all or none of the benefits outlined previously. This difference is termed ‘outcome gap’ and is a direct by-product of the ‘process gap’. Within the process of IT/IS strategic planning, it is the responsibility of the RC to narrow the process gap, through a collection of pre-determined actions ‘coping strategies’, so that realised processes and outcomes are those intended.

7. STEP 6: Monitoring plan

Developing a strategic implementation plan for IT/IS projects does not guarantee their successful implementation. Consideration should be given to the continual performance monitoring of the implemented IT/IS project over its lifecycle. The IT/IS monitoring plan should consider performance measures and data

collection strategies required for each IT/IS project implemented by the organisation. A number of theoretical and practical IT/IS performance monitoring and evaluation frameworks are recommended for this purpose [26-30].

Applying the measurement concept to construction is not as straightforward as it is for the manufacturing sector where a clear 'bottom line' exists. To assess IT/IS-induced performance improvement, one must select an easily definable and limited number of performance measures with a mix of short and long-term goals. Traditionally, managers have only focused on the economic returns of an IT/IS investment [27,31]. However, when developing performance measures, it is important to include a mix of quantitative and qualitative measures [32]. Although quantitative measures provide more objectivity than qualitative measures, they both must be considered. Following Kaplan and Norton [33], three principles have to be complied with in order to develop a monitoring strategy that is more than a group of isolated and eventually conflicting strategies and measures: (1) build in cause-and-effect relationships; (2) include sufficient performance drivers and outcome measures; and (3) linkage to financial measures.

For each data collection requirement – whether qualitative or quantitative, the organisation should develop either manual or IT/IS-enabled tools to reduce the burden of collecting performance information. Examples of tools include personal observation, formal performance measurement reports, customer satisfaction surveys and interview questions, reviews of records and documents, and automated hardware and software productivity data collection tools. Where existing quantitative and qualitative data is readily available within the organisation, it may be used to support the monitoring efforts with little or no change.

8. Case Study

8.1 Description

ABC is one of Australia's leading providers of power, transport, defence and telecommunications infrastructure with an annual turnover in excess of AUD$1.7 billion. ABC was awarded the A$20 million contract to supply and construct an 1800 mobile phone network in the region stretching from the city of Gold Coast to Brisbane, in Queensland, Australia. This contract involved the site acquisition, design, supply and building of approximately 120 antenna sites throughout this region. The numerous sites being managed necessitated a better information management system to handle the large quantity of text and visual information associated with each site location. In order to facilitate more effective management of project information and to address project communication requirements, the telecommunications division of ABC proposed to implement a Project Management Information System (PMIS) on this project. The proposed PMIS can be used to instantly share, visualise and communicate project information amongst project participants including staff, clients, consultants, subcontractors, suppliers and authorities. The aim of this case study is to report on adopting the proposed framework to facilitate implementation of the PMIS.

ABC established an IT/IS Review Committee (RC) consisting of seven members: (1) project manager; (2) civil engineer; (3) structural engineer; (4) electrical engineer; (5) finance manager; (6) planning manager; and (7) IT professional. A diverse cross-functional team was established to ensure that all the strategic SWOT factors associated with the PMIS would be addressed prior to implementation.

8.2 Step 1: SWOT factors

The first meeting was convened to address the strategic factors associated with the proposed PMIS. Firstly, the group collated a list of relevant external opportunity and threat factors, considering the macroscopic level of the construction industry and the microscopic level of construction projects. Secondly, the group examined the organisation's internal strengths and weaknesses, which may enhance or hinder the efficient and effective implementation of the proposed PMIS. A total of 28 strategic factors were collated and grouped into four categories: strengths, weaknesses, opportunities and threats (see **Table 1**).

8.3 Step 2: SWOT analysis

In the subsequent meeting, the list of SWOT factors was analysed using the developed hybrid SWOT/AHP technique mentioned previously to establish the priority of each factor. The priorities of the factors included in the SWOT analysis were estimated by pairwise comparisons and are shown in **Table 1**. These comparisons were undertaken by the RC using the ratio scale 1,3,5,7 and 9 developed by Saaty [34]. Computation of eigenvalues was achieved using Expert Choice [35] AHP software to derive the relative and global (overall) priorities of factors. The highlighted 10 factors in **Table 1** represent those with the highest priorities and constitutes about 75% of the total priority of all 28 factors.

(INSERT TABLE 1)

The whole situation is easily observed by referring to **Fig. 2** where the cumulative overall factors are plotted in the different quadrants. **Fig. 2** demonstrates that the positive factors predominated (seven out of ten of the highest overall priorities represented opportunities and at present there are only three specific threats or weaknesses that could be detrimental to the new strategy). These dominant factors can be picked out to form the basis for the formulation of the PMIS diffusion strategy.

(INSERT FIGURE 2)

Fig. 2. Graphical representation of the results of pairwise comparisons of SWOT groups and factors

8.4 Step 3: IT/IS diffusion strategy ‘story telling’

The next task of the RC was to develop a diffusion strategy that elaborates on the significant SWOT factors detailed previously. The diffusion strategy describes how the proposed project will benefit the organisation, how

organisational assets and processes will be affected by the new PMIS and what changes will be necessary to take full advantage of the PMIS capabilities. The ten well-documented predictors for strategic IT/IS implementation detailed in **Fig. 1** were addressed when analysing these benefits, processes and changes required. This is in order to facilitate IT implementation and to encourage the uptake of IT by departments and staff within the organisation. Firstly, the perceived benefits to the organisation derived from the PMIS were identified against predictors such as 1) relevance to the organisation, 2) project environment, and 3) user utility. These are listed as follows:

- Reduced travel to the 120 sites to gather information. This is achieved by the PMIS storing electronic copies of site information ie. digital photographs, site visit reports, surveys etc;
- Electronic storage of site information reduces data re-entry, administrative costs and provides a more efficient document control and reporting system;
- All employees will have access to e-mail, Intranet and Internet. This access will be available to site office staff using fixed personal computers and field staff using remote laptops and mobile phone networking.
- Utilisation of traditional communication means such as fax, telephone, courier, mail etc. will be reduced leading to lower project overheads;
- Client satisfaction is more likely to increase due to faster reporting processes, easier access to information and instantaneous document/drawing transmittal; and
- Knowledge gained on this project will not be lost through archiving of paper-based files at project completion. The PMIS can be easily accessed at a later date to gather project information to combat conflict, bid for new projects and learn from the past.

Secondly, organisational assets and processes that will be affected by the new PMIS were identified in order to 1) assign responsibilities, 2) increase user involvement, and 3) better utilise available resources as follows:

- Improved field environment through the provision of remote networked access to the PMIS;
- Digital cameras and palm top computers supplied to field staff gathering site information;
- Reduced reliance on paper-based information to ensure maximum utilisation of PMIS;
- Re-engineering of project tasks to suit PMIS requirements. For example, design consultants will be able to access the PMIS to gather design information and all design calculations are scanned and stored on the PMIS;
- Field staff will be responsible for the storage and retrieval of all project information via the PMIS;
- Progress claims will be e-mailed directly to the client to aid quick approval; and

Lastly, the required changes to take full advantage of the PMIS were highlighted with the view to ensure 1) management support, 2) minimal resistance, and maximum user understanding of the PMIS functional and technical features. These are as follows:

- Awareness sessions to familiarise project staff of the PMIS and its benefits in an attempt to reduce resistance from the potential users;
- The project team will be given specific tasks and responsibilities to eliminate multiple data entry;
- A full-time IT professional will be dedicated to this contract to manage IT/IS hardware and software;
- The project's management hierarchy needs to be refined to reflect the re-engineered communication and reporting processes; and
- A dedicated IT/IS training program to ensure maximum utilisation of PMIS. Users will need to be familiar with all PMIS modules, remote networking and word processing packages prior to project commencement.

The above mentioned diffusion strategy was instrumental in mitigating the effects of the perceived threats to the successful PMIS implementation, particularly the significant threat of financial losses if the PMIS is mismanaged.

8.5 Step 4: Operational strategy

The diffusion strategy mentioned above was then codified in terms sufficiently clear to render them formally operational. The diffusion strategy was analysed in terms of functions (business systems), hierarchies and responsibilities (organisational structure), as well as in terms of the technical architecture required for the building of the PMIS and associated tools. The RC determined that the best way to detail the operational strategy was to align the construction project implementation strategy with the PMIS implementation strategy, see **Fig. 3**. The four components of the construction project implementation strategy include (1) project conception, (2) planning, (3) design, and (4) construction and commissioning. Assigned to each of these components was an operational strategy for the PMIS detailing the required business functions, hierarchies and technical architecture mentioned previously (see **Fig. 3**).

(INSERT FIGURE 3)

Fig. 3. Operational strategy for proposed PMIS

8.6 Step 5: Implementation strategy 'action plans'

In a subsequent meeting, the RC developed action plans for each function or element of the operational strategy. After defining the implementation requirements, the RC began to elaborate on the objectives, timing, cost, resources and coordination dimensions of these functions. The action plan for the first function detailed in **Fig. 3** (see highlighted function) labelled 'installation and networking of PMIS' is shown in **Table 2**. Similarly, an action plan for other functions detailed in the operational strategy were developed by the RC.

(INSERT TABLE 2)

In addition to well-documented action plans, the RC developed coping strategies for envisaged risk factors in an attempt to reduce the process and outcome gap. The RC identified a number of risk factors that could be detrimental to the efficient and effective implementation of the PMIS (see **Table 3**). The developed action plans and mitigation of risk factors through coping strategies has ensured that the realised processes and outcomes are those intended by the RC.

(INSERT TABLE 3)

8.7 Step 6: Monitoring plan

Finally, the RC decided to implement a performance-monitoring plan to continually evaluate the implementation and usage of the PMIS. A limited number of IT/IS performance indicators and associated measures were selected to serve this purpose, see **Table 4** for a selection of these indicators. Measurement collection tools were also detailed for each measure developed by the RC. Data collection has been undertaken continually throughout the construction period and summarised at the end of the project. The majority of indicators and measures proved that the plan had no major deficiencies. However, it has been noted that the PMIS has not provided any significant reduction in the project's overhead costs, compared to business as usual. The authors contend that this is a lagging indicator, where significant savings in project overhead costs, will only be realised after the PMIS has been utilised on future construction projects. Since this was the first project using the PMIS, the implementation results obtained on this project would serve as a benchmark to evaluate any further IT/IS-induced performance improvement on future projects. As a final note, the six-step IT/IS implementation and monitoring strategy, detailed herein, should not be considered fixed. Organisations are expected to adopt the general layout of the framework but structure individual components to suit their unique organisational requirements.

(INSERT TABLE 4)

9. Conclusion

The importance of IT/IS to the world economy is self-evident. Few of the structural changes in our economy would have come about without advances in IT/IS. In the airline industry, for example, IT/IS has helped some organisations prosper and led to the demise of others. It is therefore surprising that after over 40 years since the introduction of IT/IS in the construction industry, organisations still are unable to obtain the many benefits of IT/IS investment until many years after expenditures have been incurred. Furthermore, the construction industry is slow to embrace innovative IT/IS applications such as e-commerce, e-conferencing, Intranets and the Internet partially due to the limited strategic planning by construction organisations.

The proposed strategic IT/IS implementation framework suggested herein serves to accelerate the rate at which changes in people, tasks and organisational structure will take place. In so doing, the gap between the rates at which the technology and the other three components change will be reduced or eliminated. The case study with a multi-national construction organisation reports on the application of the proposed strategic IT/IS implementation framework to facilitate strategic implementation of a PMIS for the project management of telecommunications infrastructure in the South East of Queensland, Australia.

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Table 1 Priorities and Comparisons of the SWOT Groups and Factors

SWOT Group	Group Priority	SWOT Factors	Factor priority within the group	Overall factor priority
Strengths	0.072	1. Skilled/experienced staff, workforce	0.102	0.007
		2. Market leader in the provision of operations and maintenance and facilities management services	0.171	0.012
		3. Top project managers with high commitment to innovative IT/IS	0.064	0.005
		4. High value of projects, increases IT/IS budgets	0.156	0.011
		5. Extensive IT/IS support	0.109	0.008
		6. Diversified company	0.176	0.013
		7. Strong business development team	0.222	0.016
Weaknesses	0.130	8. User resistance to change	0.176	0.023
		9. IT/IS staff turnover: quality staff being poached by other companies	0.105	0.014
		10. External contractors having low IT/IS capability	0.148	0.019
		11. Changing technologies requiring staff to be retrained	0.124	0.016
		12. Short construction timeframes preventing PMIS training	**0.355**	**0.046**
		13. Poor relationship between divisions of organisation	0.050	0.007
		14. Lack of corporate management direction/orientation	0.042	0.006
Opportunities	0.493	**15. Facilitates international strategic alliances**	**0.139**	**0.069**
		16. International access to project information	**0.112**	**0.055**
		17. Improved communication and coordination between project participants/divisions/managers	**0.096**	**0.047**
		18. Ability to attract more local and international projects	**0.134**	**0.066**
		19. Electronic storage of project information from conception to completion	**0.150**	**0.074**
		20. Improve the document control process which reduces administration costs	**0.150**	**0.074**
		21. IT/IS-induced rapid mobilisation of workforce on projects	0.022	0.011
		22. Paperless office reducing administrative overheads	**0.197**	**0.097**
Threats	0.305	23. Very competitive industry	0.080	0.025
		24. Possible financial losses if PMIS project is mismanaged	**0.457**	**0.139**
		25. Depressed economy causing IT/IS budget cuts	0.056	0.017
		26. Increasing hardware/software costs	0.043	0.013
		27. PMIS budget blow-out	**0.249**	**0.076**
		28. Negative image created if PMIS fails to deliver improved construction procurement	0.115	0.034

Table 2 Action Plan for 'Installation and Networking of PMIS'

(1) Action Element: Installation and networking of PMIS

- Installation of PMIS on 25 office-based computers, 10 laptops and 5 external computers (consultant, client).
- Networking of all machines in the main office.
- Remote network setup for laptops using remote connection.
- Setup password for external access to PMIS (consultant, client etc). Restrict access to certain areas.

(2) Time Dimension:

- This activity should be included in the 'site establishment' activity of the construction program.
- Estimated activity period is 40 hours (installation and networking).

(3) Cost Dimension:

- The IT professional dedicated to the project will be responsible for installation of the PMIS.
- The PMIS has been developed internally by the organisation and has no direct cost to the project.
- Budget allocated for IT contractor to assist IT professional (16 hours @ $120/hr).

(4) Human Resources

- The IT professional dedicated to the project is allocated to this task.
- An external IT contractor may be employed if necessary to complete the task on time.

(5) IT/IS Management and Coordination Structure

- The project manager is responsible for organising the activity (time and cost).
- The IT professional is responsible for undertaking the activity in the specified time period.

Table 3 Risk factors and coping strategies: PMIS project

Risk factor	Process gap	Outcome gap	Coping strategies
Possible financial losses if PMIS is mismanaged	Poor management of PMIS on project	• Management decides not to use PMIS on future projects • Increased project overhead costs • Resort to traditional document management procedures	• Dedicated IT/IS professionals on project • Heighten status of IT/IS professional • Development of an extensive PMIS implementation strategy at project conception
PMIS budget blow-out on project	Poor management of IT/IS budget on the project	• Management decides not to use PMIS on future projects • Increased project overhead costs • Negative sentiment towards technology by management	• Improved financial management of IT/IS budget • Development of an extensive IT/IS budget at project conception
Short construction timeframes preventing PMIS training	Project managers ignoring IT/IS training commitments to focus on short term project issues	• Lost opportunities for re-engineering tasks • Poor utilisation of proposed PMIS • Resort to traditional document management procedures	• Dedicated IT/IS professionals on project • Heighten status of IT/IS professional • Develop an extensive IT/IS training program at project conception • Integrate IT/IS training program with construction program
User resistance to PMIS	PMIS implementation strategy resisted by project participants	• Lost opportunities for re-engineering tasks • Poor utilisation of proposed PMIS • Resort to traditional document management procedures	• Awareness sessions for project participants • Extensive IT/IS training programs for users • Accessible IT/IS support to users • Dedicated IT/IS professionals on project
Lack of resource to implement PMIS	Limited resources or resources do not have skills for implementation	• Lost opportunities for re-engineering tasks • Poor utilisation of proposed PMIS • Resort to traditional document management procedures	• Heighten status of IT professional • Assigning responsibilities to strategic plan • Dedicated IT professionals on project • IT contract staff to fill gaps where necessary

Table 4 PMIS monitoring strategy

Performance indicator	Performance measure	Measurement tool	Implementation result
1. Reduced project overhead costs	• % reduction in project overhead costs	• Review and comparison of cost records	Marginally supported
2. More effective site supervision	• % reduction in unnecessary site visits required on project	• Review of site records/visits	Supported
3. PMIS training and support	• % of users satisfied with level of training and support	• Survey of PMIS users	Supported
4. Reliability of PMIS	• No. of user complaints with PMIS	• Review of records and documents	Supported

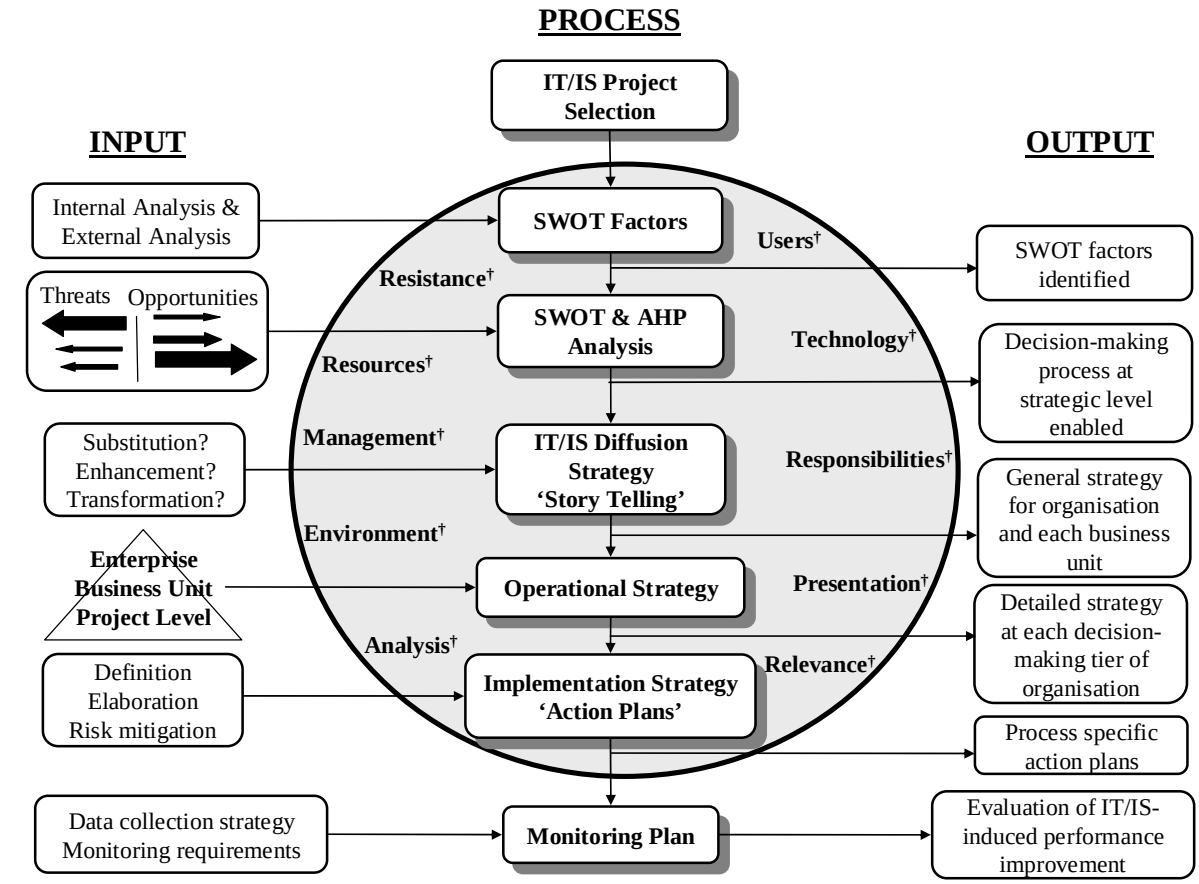

Fig. 1. Strategic IT/IS implementation framework

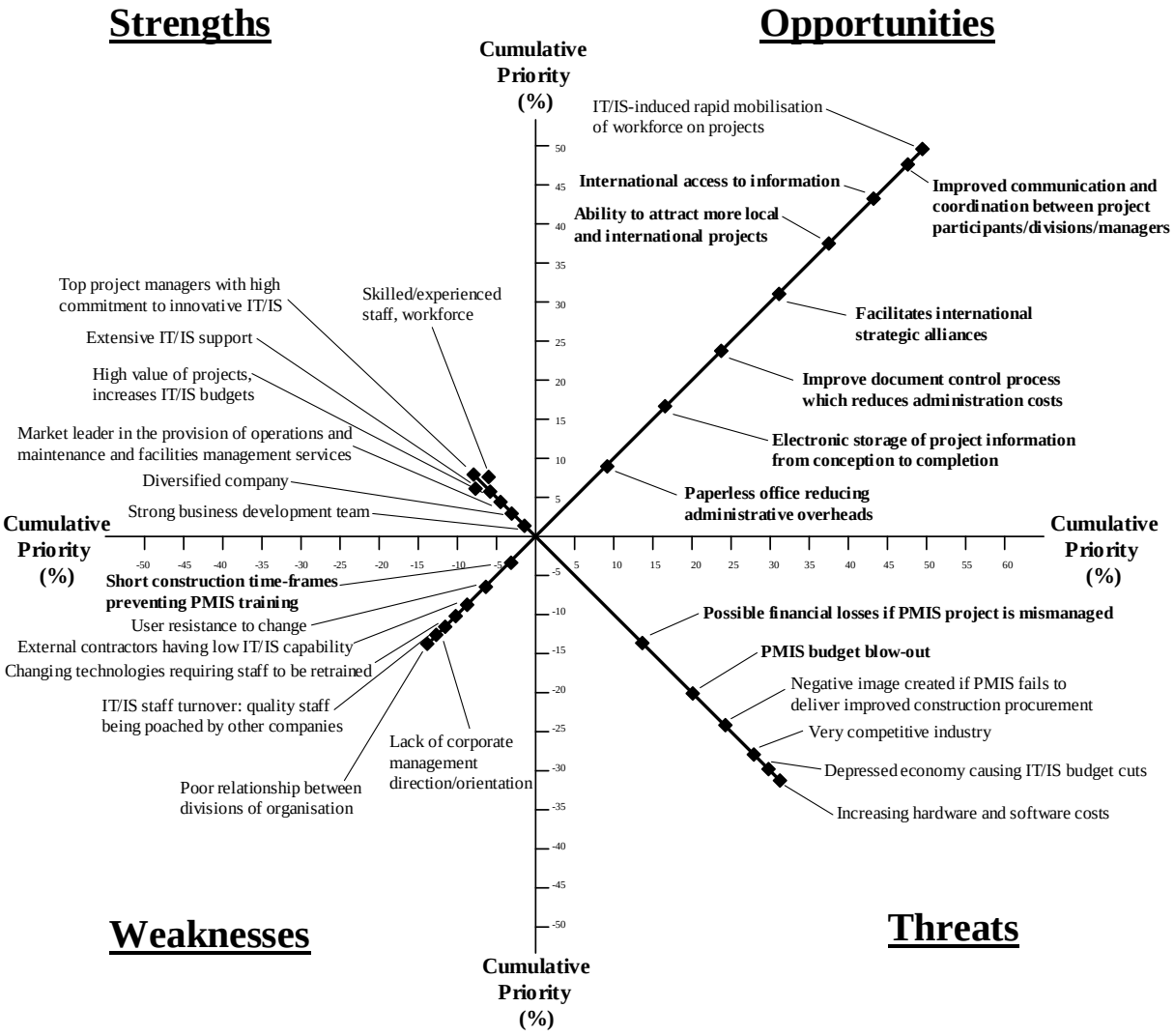

Fig. 2. Graphical representations of the results of pairwise comparisons of SWOT groups and factors

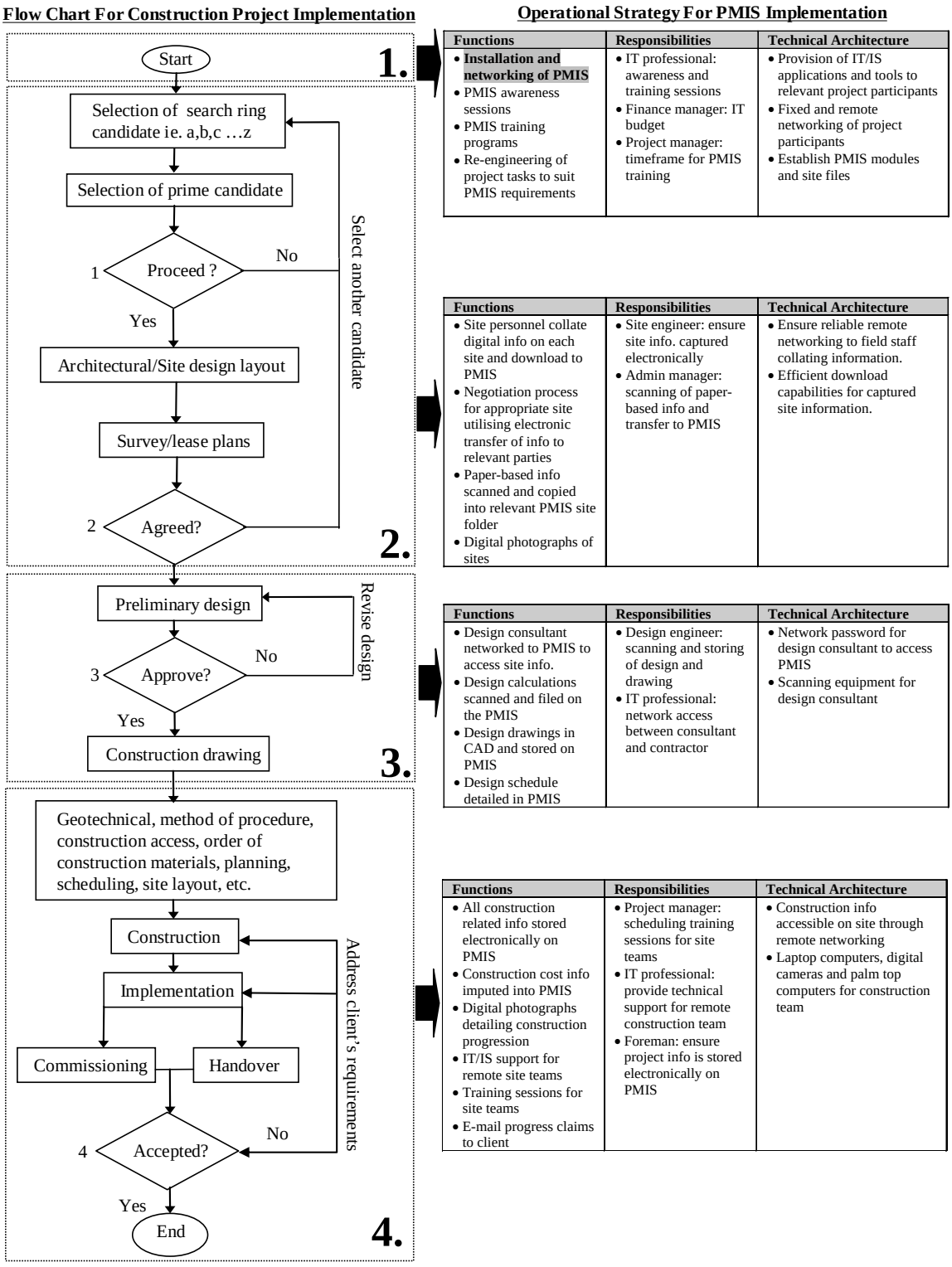

Fig. 3. Operational strategy for proposed PMIS