Developing Cross-Project and Corporate Learning Capabilities via Knowledge Management Infrastructures: Case Study of a Major Construction Firm in Taiwan

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Introduction

Being concerned with managing projects on a regular and recurrent basis as their core business and amplified by the fact that projects are becoming more complex and constrained (in terms of increasingly tighter schedules, budgets and higher quality or specifications of their clients) (Williams, 2003), it is essential that construction organisations learn how to learn from their past project experiences and share the accumulated knowledge to enable themselves to improve future management actions (O'Keeffe & Harrington, 2001; Cooper, Lyneis, & Bryant, 2002). This is so that they may practice 'continual improvement' and conversely ensure that they do not get worse at what they do.

Contemporary perspectives of project management have been known to be being unique (Bennett 1983; Pinto, 1995; Archibald, 2003; Williams, 2003; Barber, 2004) and temporal (Pinto, 1995; Brusoni, 1998; Barber, 2004; Burke, 2004; Uher & Loosemore, 2004) in nature (i.e., 'lonely project' perspective (Kreiner, 1995)) (Figure 1). This may cause project teams to become isolated from each another, habitually neglecting what happens in the external realm of their project, and thereby end

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up 'rejecting ideas from outside and lose their ability to generate new ideas' (McDermott, 1999, p. 2).

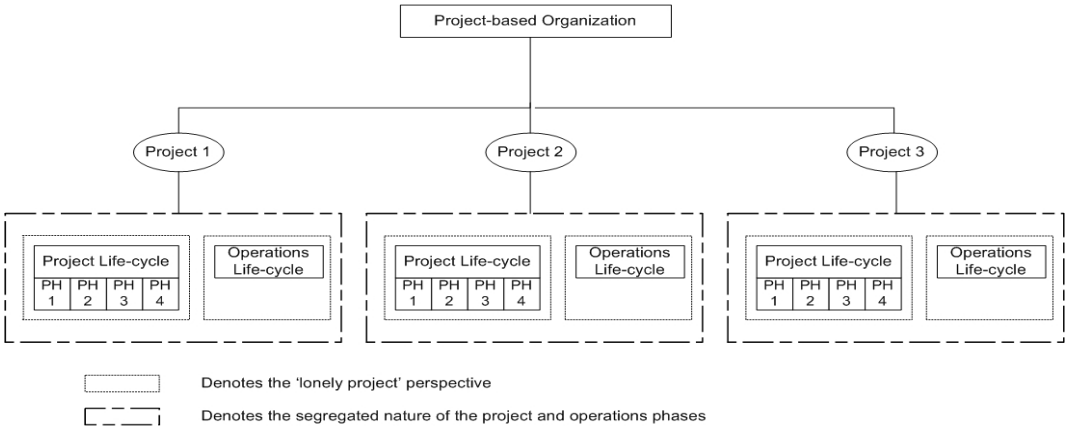

Figure 1. Contemporary perspectives of project management.

Ideally, projects should be viewed holistically as the 'life and soul' of a construction organisation. If projects are not managed properly, the organisation may cease to exist. To do so, the organisation needs to learn how to learn from the experiences accumulated from its past projects and apply them effectively to future ones via enabling organisations with the capability to learn across their projects (Figure 2).

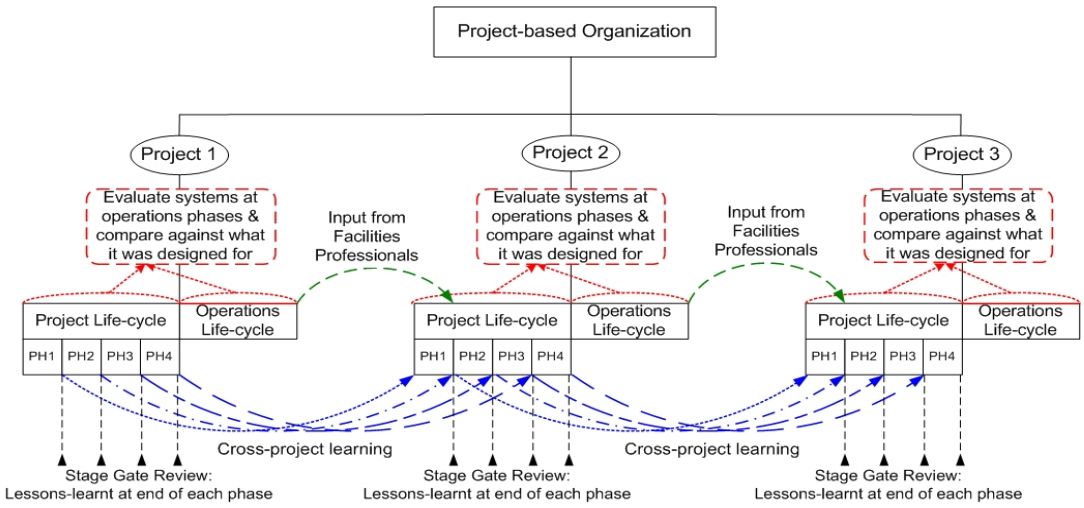

Figure 2. Enabling cross-project and cross-phase learning.

Some organisations have attempted to do so by setting up knowledge management infrastructures (some call it 'knowledge management (KM) systems'). But are such 'systems' really capable of enabling learning across projects?

The authors will attempt to answer the above question by analysing the findings of a case study conducted at a prominent construction organisation in Taiwan by examining the impacts of the KM initiatives at various levels of the organisation (individual, project, divisional/departmental, and corporate levels). Subsequently, outcomes and recommendations arising from the study are espoused.

Significance of Research

The research offers construction organisations the opportunity to examine themselves, understand and ascertain where they stand (i.e., their 'position') in terms of their capability to manage knowledge (particularly across projects), as well as provide them with the necessary 'know-how' and 'know-why' (not just the 'know-what') of knowledge management infrastructure development that is appropriate for their organisation (i.e., in the context of the organisation's structure, culture, operational style and geographic location etc.).

For construction organisations which may currently have KM practices, research findings would assist them in modifying their current KM practices, so that their cross-project learning capabilities may be enhanced.

For those which do not have KM practices, the findings would assist them in setting up appropriate KM practices in order to progressively build up their cross-project learning capabilities.

It is perceivable that firms which have better capabilities of tapping into their vast lessons-learnt resources (e.g., knowledge and experiences acquired from past projects) would not only be able to improve its future project performances but also subsequently achieve sustainable competitive advantage amongst its peers (improved organisational performance).

Research Design and Methodology

To ensure the reliability and validity of the data collected, a three-pronged case study approach comprising the following was conducted within the construction organisations involved in the case studies:

- Questionnaire surveys.
- One-on-one interviews.
- Analysis of organisational structure, documents, and knowledge management and organisational learning practices.

The Case Study

Background of Case Study

This case study conducted in Taiwan was one of four case studies conducted in major construction organisations in Singapore (two), Taiwan (one), and Australia (one). Substantial time (an average of 2 to 3 months) was spent embedded in each organisation. In the course of the literature review and prior to the commencement of the case studies, the author had taken the following into consideration.

The Need to Conduct 'Real-Life' Case Studies in Construction Organisations

In order to ensure that research outcomes were relevant and applicable to the practical 'real-life' needs of the industry, and not just the development of outcomes (e.g., development of frameworks and models) via academic readings and understandings, it was pertinent to conversely align and integrate industry needs and practices with academic research (and not just develop what we think is best for industry without their participation).

The Need to Conduct Case Studies in Various Countries

A key reason for conducting case studies in various countries (instead of several organisations in a particular country) was that organisations in Australia were found to be less forthcoming and willing to share what they were doing (and what they knew) with other organisations as compared to those in Singapore and Taiwan. If the authors had concentrated solely on a particular country, the research may not have progressed as far as it had.

Secondly, it would enable the researcher to benchmark and learn from what the 'better or best' construction firms were doing internationally (not just locally).

Thirdly, it would allow research findings to be 'richer' in context- in the sense that the different cultural attitudes of each country and its people (which may also depend on the origins of its people and its geographical location) as well as the different cultural attitudes of each organisation in each country may affect the way in which each organisation operates (i.e., the way it 'runs' its business) in that country, and subsequently the approach it had taken to manage its knowledge.

Organisational Background and Structure

The case study organisation is a small-medium sized Taiwanese-owned construction company (staff size of approximately 50) with an annual turnover of approximately NT50 billion. Approximately one-half of the company is comprised of project-related staff (e.g., construction project management, project documentation, estimation, procurement, and design), while the other half is comprised of administrative and business-related staff (e.g., office administration and management, business development, and finance and accounting).

Since its inception in 1994, it has built an extremely strong local repute and is progressively building its base internationally. In terms of turnover (earnings), it is currently within the 'Top 50 list' of construction organisations in Taiwan.

It also prides itself as being an extremely lean organisation with the flexibility of adapting to the fast changing economic conditions of the country, and the needs and market conditions of the construction industry. It has managed to keep the size of its organisation 'small and lean' and yet has the capability of managing projects and maintaining turnovers (in terms of revenues) similar to those usually only achievable by larger construction corporations.

Profile of Respondents

As the research focus was on the learning capabilities of construction organisations (which are fundamentally project-based), the majority of the respondents were those involved in the day-to-day running of construction projects. Several administrative and business oriented staff were also included because the authors believed that organisational learning

initiatives should involve all personnel within the construction organisation. Most would also have (in one way or other) participated in its development, management or used it at some point in time.

There were a total of 15 respondents for this case study which involved in-depth survey questionnaires, personal interviews, and analysis of the organisations' documents and knowledge management infrastructure/systems. At least one departmental head from each department/division (e.g., construction, estimation, documentation, procurement, business development, administration, Information Technology, and senior technical advisors) in the organisation were surveyed and interviewed. The head of the organisation, the President, and his Personal Assistant also took part in the survey and interview.

The average years of employment of the respondents in the construction industry was 13.62 years, and the average years of employment in this company was 4.84 years.

Impacts of Knowledge Management Initiatives

The following tables and histograms are compiled from the results of the questionnaires (see Appendix One for extract of questionnaire pertaining to this paper) and interviews carried out during the placement within the organisation.

The impacts of the KM initiatives were analysed and discussed in relation to the processes of managing 'knowledge' at the various 'levels' in the organisation (individual, project, division/ department, and corporate).

Impacts on 'Knowledge' Processes

Table 1

Impacts of KM Initiatives on 'Knowledge' Processes at Various Levels of the Organisation

	Capture and Retain*	Share	Apply	Create	*Average*
Individual		84.62%	69.23%	76.92%	***76.92%***
Project	76.92%	46.15%	61.54%	53.85%	***59.62%***
Division/Department	69.23%	69.23%	69.23%	61.54%	***67.31%***
Corporate	84.62%	92.31%	53.85%	53.85%	***71.16%***
Average	***76.92%***	***73.08%***	***63.46%***	***61.54%***	

*'capture and retain' (in the context of this study) refers to the explicit retention of knowledge via technological means within the organisation. The capability of individuals to retain tacit knowledge in their heads is an inert capability.

Discussion

Considering that the KM infrastructure was 'implemented' at the department and corporation level, and not specifically at projects (at time of case study, there were no site servers installed on sites due to logistical difficulties to do so), it was astonishing to find that the majority of respondents felt that the capability of the organisation to capture and retain knowledge and experiences was greater at the project-level instead of the divisional-level.

Capture and Retain: Analysis and Findings

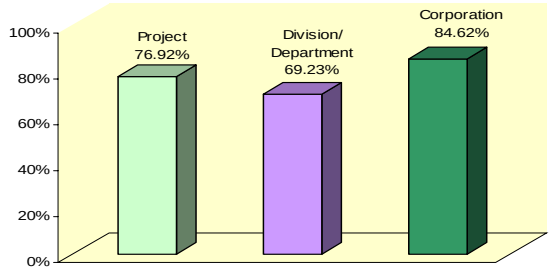

Figure 3. Improved capability of capturing and retaining knowledge and experiences from past projects.

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Share: Analysis and Findings

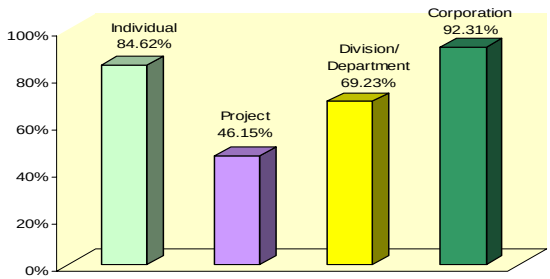

Figure 4. Improved capability of sharing knowledge and experiences from past projects.

Discussion

Since a construction organisation is essentially project-based in nature (i.e., made up of project teams), it was astonishing to discover that the ability of project team members to share their knowledge and experiences from their past projects was the weakest amongst the four 'levels' of the organisation.

Apply: Analysis and Findings

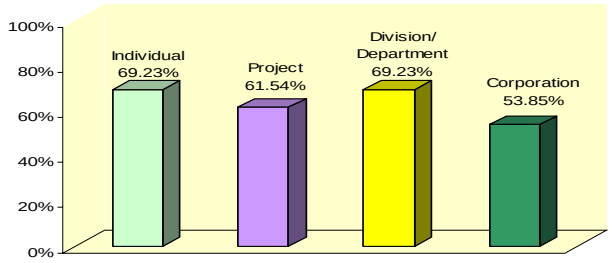

Figure 5. Improved ability to apply knowledge and experiences acquired from past projects to future projects.

Discussion

It may have been easier for individuals to apply knowledge and experiences from past projects ("current KM infrastructure had enabled staff to apply what they could find from the KM repository to their particular work area") to future projects because once these have been retrieved and embedded in their own heads, they have control over what they wish to reflect upon within their own time; unless the individuals personally do not wish to reflect upon and learn from what they had acquired in their heads.

Each department could also apply past experiences easily ("improved their ability to apply their past knowledge and experience within the department") as the knowledge gained

by individuals in each department may have been easily shared by individuals; unless individuals in each department are unwilling to share what they know with each other or do not wish to learn from others. Often, individuals within a department showed more collaborative attitudes towards each other as compared to individuals from different departments.

Again, it was astonishing to discover that the capability to apply past knowledge and experiences was lower at the project-level ("improved project team's ability to apply knowledge and experience from past projects to future projects") than the individual and departmental levels. This may be due to the poor capability of individuals to share what they know (i.e., how could an individual or a project team learn and apply if nothing was shared in the first place?).

At the corporate-level, however, departments within the corporation ("improved ability to apply knowledge and experiences between divisions/departments") may have difficulty learning from each other due to 'virtual walls' between the divisions (e.g., company politics, conflicting interests, protection of own interests). The organisational structure and its spatial layout may also affect the extent of sharing between departments.

Create: Analysis and Findings

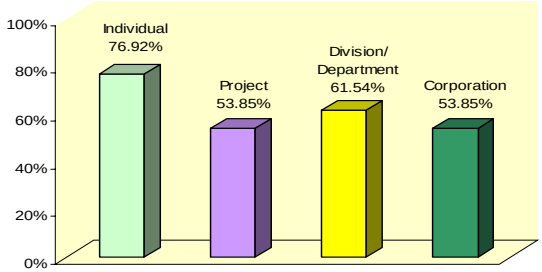

Figure 6. Improved ability to create knowledge and experiences.

Discussion

Individuals may have been most capable of creating knowledge due to the ability to develop new ideas in their own heads (tacit knowledge) in their own time (low reliance on others)- i.e., creativity is largely an individualistic activity.

It may have been harder to develop new ideas in groups (division, project and corporation) for several reasons. Firstly, it takes effort and time for individuals to get together and share what they know, discovered or developed with others within the division, project and corporation. This is even made less convenient by the intensity and dynamic nature of construction projects where staff proceed to subsequent projects almost immediately after they finish the current one. Secondly, such sharing activities are usually not included as part of staff's official working hours. Thirdly, individuals may not wish to reveal what they know (especially good ideas or solutions) in order to give themselves the (political and also 'egoistic') leverage against their peers. Fourthly, they may be apprehensive about sharing their past project experiences for fear that any mistakes made in the past may be revealed to others and subsequently lead to persecution (from superiors and clients) or embarrassment (amongst peers).

Impacts on Overall Capability of Managing Knowledge Processes: Analysis and Findings

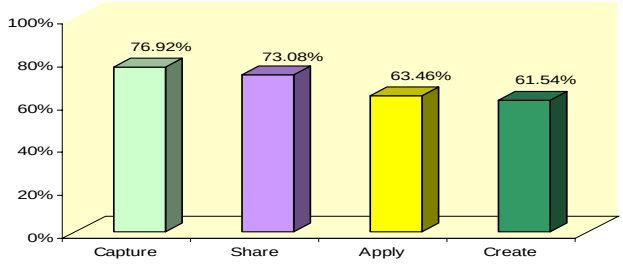

Figure 7. Overall impact on KM processes.

Discussion

The authors reckon that the organisation's current KM infrastructure may have adequate capturing and retention capabilities. However, it's much poorer capability to apply and create could be due to individuals' inability to share what they know with each other. For instance, if nothing or little is shared, individuals have nothing to reflect upon and learn from. In addition, should what is shared be of poor quality and relevance (i.e., only has quantity), it would not be of value to those who retrieve them.

Organisation Levels: Analysis and Findings

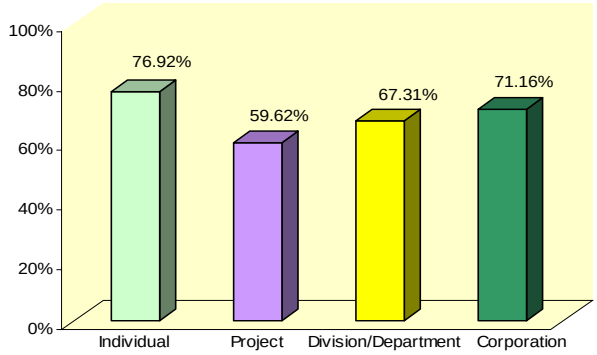

Figure 8. Overall impact on management of knowledge at various levels of the organisation.

Discussion

Again, it was astounding to find that although construction organisations are essentially project-based, the KM initiatives had the least impact on the management of knowledge at the project level.

This may be because individuals have their own inert ability (which may defer from one person to another) to manage the tacit knowledge stored in their heads. However, if individuals are unwilling to share what they know in their heads or if what

is shared is of little value, it obviously affects the learning and application capability within groups.

Impacts on Project, Program and Portfolio Delivery Capability

Analysis and Findings
(shown in figure 9)

Discussion

Although the capability of the project-team to manage knowledge is the lowest (59.62%) (Figure 8) amongst the four levels in the organisation, respondents felt that the KM initiatives had most improved the project-team's capability to deliver projects (76.92% of respondents) (Figure 9).

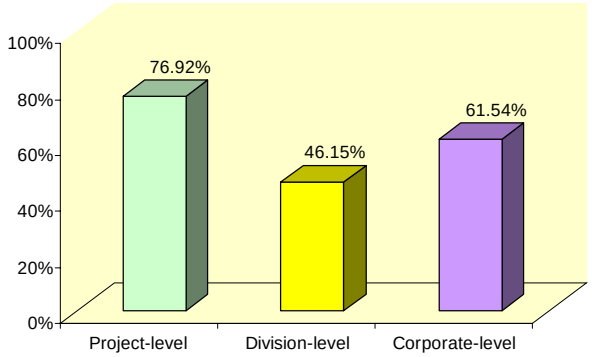

Figure 9. Impact on outputs (capability to deliver project/s).

On the other hand, despite having improved the capabilities of the division and corporation levels to managing knowledge quite significantly (67.31% and 71.16% respectively), respondents believed that the KM initiatives had significantly lesser improvements on their program and portfolio delivery capabilities respectively (46.15% and 61.54%).

Outcomes and Recommendations

Development of Data, Information and Knowledge Management Models

The authors have developed data, information, and knowledge management models (Figure 10) to assist construction organisations in identifying the components of a KM infrastructure appropriate for each organisation. The model is unique in that it not only espouses the contemporary processes of: organise and retain/store, share (transfer or retrieve), acquire, create or/and utilise but also the inclusion and emphasis on the need for individuals to analyse, reflect and understand the data and information shared, and then learn from what they've understood before knowledge is derived.

The authors propose two 'models' which construction organisations may take for the acquisition, creation, and application of knowledge (Model α and Model ß).

Model a: Model α assumes a more technological mode where the organisation's existing systems (e.g., information systems- IS or knowledge management systems- KMS) organises and retains explicit data and information (i.e., institutionalised) that had been converted from individuals' tacit knowledge initially residing in individuals' heads. Individuals then 'share' the data and information by retrieving them from the IS or KMS. Data and information may include details such as project size (area), cost, budget, variations, drawings, meeting minutes, and at best project reviews and written records of 'stories' of past project experiences (individuals' experiences that have been converted to written forms such as 'stories' are not knowledge because knowledge is unique to the individuals who had experienced the occurrences and resides only in their heads). However, it is important to note that the 'quality' of the data and information

retrieved by individuals depends on what goes into the system (i.e., garbage in, garbage out).

Individuals then use their existing knowledge and skills to analyse, reflect upon and understand the data and information tacitly in their heads, and learn from it (some do not learn at all). Once learning has occurred, the individual then acquire and embed the knowledge tacitly in their heads.

Individuals will subsequently either apply the knowledge they have acquired to the current or future projects they are doing by putting their thoughts into actions (e.g., developing a solution to a project problem); or share what they know with others in a group (e.g., project team or division) and apply what they have discovered from others; or attempt to create new knowledge (either in their heads (tacitly) or in written form (explicitly)), share what they individually know with others in a group, and subsequently apply their knowledge to the projects.

Model ß: With Model ß, individuals possess (tacit) data, information and knowledge in their own heads which are shared (transferred) verbally (e.g., stories, analogies and metaphors as well as project details such as cost, duration, specifications etc.) between individuals in a group (e.g., formal and informal meetings, and/or ad-hoc discussions) to become explicit data and information.

Individuals then use their existing knowledge and skills to analyse, reflect upon and understand the data and information residing (tacitly) in their heads and subsequently learn from it (some may not learn at all). Once learning has occurred, the individual then acquire and embed the acquired knowledge tacitly in their heads.

Having acquired the tacit knowledge, individuals may either apply the knowledge to their projects or decide to create new

knowledge. The creation of knowledge may occur tacitly in individuals' heads, or explicitly in the form of diagrams, drawings, and words (either individually or as a group), and subsequently applied to the projects.

Application of the Models to the Case Study Organisation

Model a: When applied to the case study organisation's structure and current KM infrastructure, this model is representative of the vertical 'flow' of data, information and knowledge within the organisation (Figure 11). The primary emphasis for this model is on enabling the organisation with the capability to reposit data and information centrally, and providing individuals with the ease of searching for and retrieving what they require. However, if an organisation were to solely adopt this model, individuals from different divisions/departments may only be able to search for and retrieve what they require (e.g., data and information reposited by other divisions) from the organisation's central repository.

Being project-based, this is time-consuming as most project individuals do not have the luxury of returning to their departments or main offices to retrieve (and spend time retrieving) what they require from the central repository; unless the KM systems are implemented at the project-level or if the project personnel could retrieve what they require from their main offices whilst still based on project sites (both were not implemented in the case study organisation). Also, most do not have the luxury to spend hours repositing explicitly what they have in their heads into the organisational system; unless the hours have been allocated or put aside as organisational 'sanctioned' knowledge repository hours. Evidently, if an organisation were to solely operating on model α, the organisational divisions/departments would largely be isolated from each other.

Model ß: When applied to the organisation's structure and current KM infrastructure, this model represents the horizontal 'flow' of data, information and knowledge within the organisation (Figure 11). The primary emphasis of this model is on enabling the organisation with the capability of sharing the data and information, that were initially residing within individuals (individual repositories), via verbal means (especially between individuals from different divisions/departments). This could be achieved via ad-hoc discussions, and purpose-formed groups such as communities-of-practice, focus groups, brainstorming sessions, lessons-learnt sessions, and project review meetings. Once individuals have shared what each of them may know (i.e., possess in their heads) within a purpose-formed group (horizontal 'flow' via verbal means), they could then either share what they have discovered with their colleagues in their own division/department or individually reposit them into the organisation's central repository (vertical 'flow' via organisation's technological KM system).

Gaps in the Case Study Organisation's KM Infrastructure

The organisation was (at time of study) largely focusing on model α (i.e., the use of technology to support vertical 'flow' of data, information and knowledge)- which explains its generally much higher 'capturing and retaining' capabilities versus its lower 'sharing', 'creation' and 'application' capabilities; particularly at the project-level.

Since a construction organisation's project team is most often made up of individuals from various divisions/departments in a construction organisation (unless it is a very small firm), it is recommended that the organisation takes an approach of integrating aspects from both model α and ß. In this case, apart from the technological provisions

already made by the organisation to enable vertical 'flow' of data, information and knowledge, it should incorporate tools/mechanisms that may enable increased sharing between individuals from different divisions via verbal means (horizontal 'flow'). Individuals can then take this further by explicitly repositing what they have discovered from individuals of other divisions/departments into the organisation's technological KM system (vertical 'flow').

Summary and Conclusion

It is insufficient for construction organisations to solely focus on the technological provisions of KM infrastructures (though it is necessary for organisations to have the capability to consistently organise and retain past project data and information in case its staff resign and/or retire), and a need to eliminate the misconception that knowledge can be retained in and retrieved from a KM 'system' (technological pun intended). 'Technological aspects' of KM cannot retain knowledge simply because knowledge only resides in individuals' heads. It can only organise and retain data and information. Furthermore, when individuals share what they know with each other (whether technologically or verbally), they only share data and information. Knowledge may only be acquired, shared and applied after individuals have analysed, reflected upon, understood the data and information that have been shared in the context of the project and its environment (e.g., project's geographical location, economic and political climate and culture of the country) from which the data and information originate.

Instead, to acquire, create and apply knowledge, project-based organisations should also make provisions for and encourage its individuals to share, analyse, reflect and learn

from each other via non-technological means (especially verbal means) such as discussion forums, meetings, project review sessions, lessons-learnt sessions, and communities-of-practice. In addition, individuals in the organisation have to be inculcated with a corporate culture to willingly share what they know with each other (i.e., not to hoard what they know).

Finally, it is hoped that the models may not just assist construction organisations in attaining a more realistic understanding of how individuals and groups could manage what they possess (whether it is data, information or knowledge) and learn from it, but also understand that an organisation's capability to manage data, information and knowledge is inextricably linked to its capability to learn from its past projects' experiences for application to future projects.

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Appendix One

Based on your experience, what impacts have the KM initiatives brought about?
You may select (✓) more than one

a. Improved ***individual staff*** work performance
   - o Improved individual staff work capability
     - ▪ Improved access to knowledge repositories has enabled staff to search for, adapt and apply the knowledge to their own work area. □
     - ▪ Improved sharing of information, experience, and knowledge amongst staff to resolve problems. □
     - ▪ Improved staff's ability to innovate (i.e., develop new ideas or creative solutions) to resolve problems when faced with similar projects or situations. □
     - ▪ Enabled staff to 'learn-on-demand' at their own pace and convenience. □
     - ▪ Others: please elaborate _____ □
   - o Improved individual staff work productivity
     - ▪ Reduced learning curve for new staff □
     - ▪ Learning from some-else's experience and knowledge has reduced/minimised repetition of common mistakes □
     - ▪ Resources found in knowledge repositories reduced time required to source from multiple sources when the need arises (i.e. reduced search time & faster access to information and knowledge) □
     - ▪ Reduced duplication of work and less waste (e.g., time and effort is not wasted in re-creating a contract document or work methodology which others have already well-applied and attested its reliability) □
     - ▪ Reduced dependence on a few particular key individuals. □
     - ▪ Increased employees' motivation □
     - ▪ Others: please elaborate _____ □
   - o Others: please elaborate _____ □

b. Improved ***project level (i.e., project team)*** performance
   - o Improved project team unity/collaboration (e.g., 'esprit de corp') □
   - o Improved project team's ability to create knowledge (e.g., develop new or refreshing ideas to resolve problems) □
   - o Improved project team's ability to capture and retain knowledge and experience for application in future projects □
   - o Improved sharing of project team members' knowledge and experience from their past projects □
   - o Improved project team's ability to apply knowledge and experience (obtained from past projects) to future projects. □
   - o Improved project delivery capability (i.e., increased ability to deliver a project more effectively and efficiently- e.g.,completing on time or earlier, reduced project cost, improved quality etc.) □
   - o Others: please elaborate _____ □

Appendix One

c. Improved ***divisional/departmental**** level performance *(*delete as appropriate)*
   - o Improved profits □
   - o Reduced staff turnover □
   - o Improved ability to create knowledge □
   - o Improved ability to capture and retain knowledge and experience within the division/department □
   - o Improved sharing of knowledge and experience within the division/department □
   - o Improved ability to disseminate knowledge and experience within the functional division/department □
   - o Improved ability to apply knowledge and experience within the functional division/department □
   - o Improved capability of the division/department to deliver its program/portfolio of projects more efficiently and effectively. □
   - o Others: please elaborate _____ □

d. Improved ***corporate*** level performance
   - o Improved profits (i.e., increased revenue and reduced cost) □
   - o Reduced staff turnover □
   - o Improved ability to create knowledge across the entire organization (i.e., between divisions/departments) □
   - o Improved ability to capture and retain knowledge and experience across the entire organization (i.e., between divisions/departments) □
   - o Improved ability to share knowledge and experience across the entire organization (i.e., inter-division/department collaboration and sharing of knowledge and experience) □
   - o Improved ability to apply knowledge & experience across the entire organization (i.e., between divisions/departments) □
   - o Improved capability of the corporation to deliver its program/portfolio of projects more efficiently and effectively □
   - o Others: please elaborate _____ □

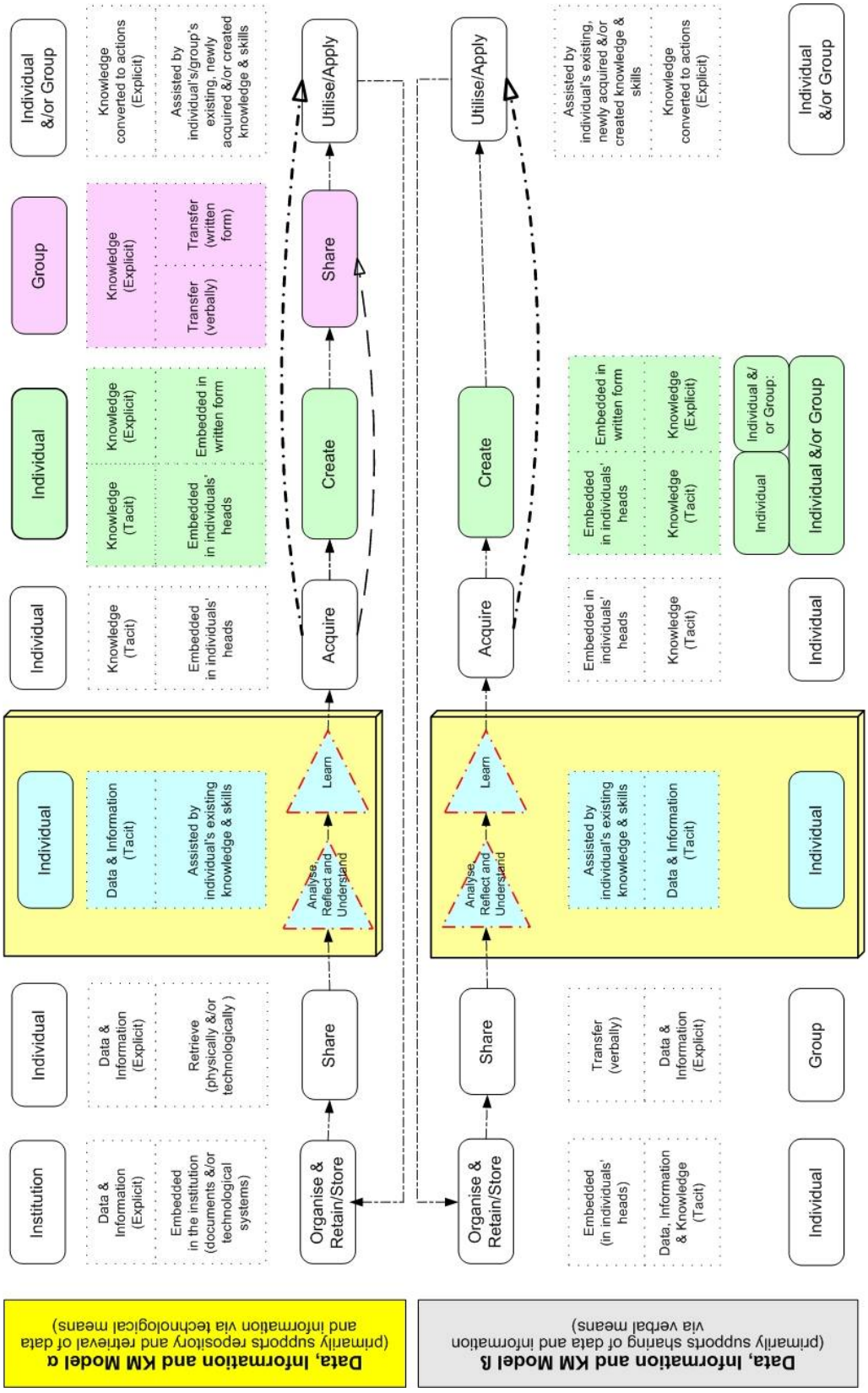

Figure 10. Data, information, and knowledge management models.

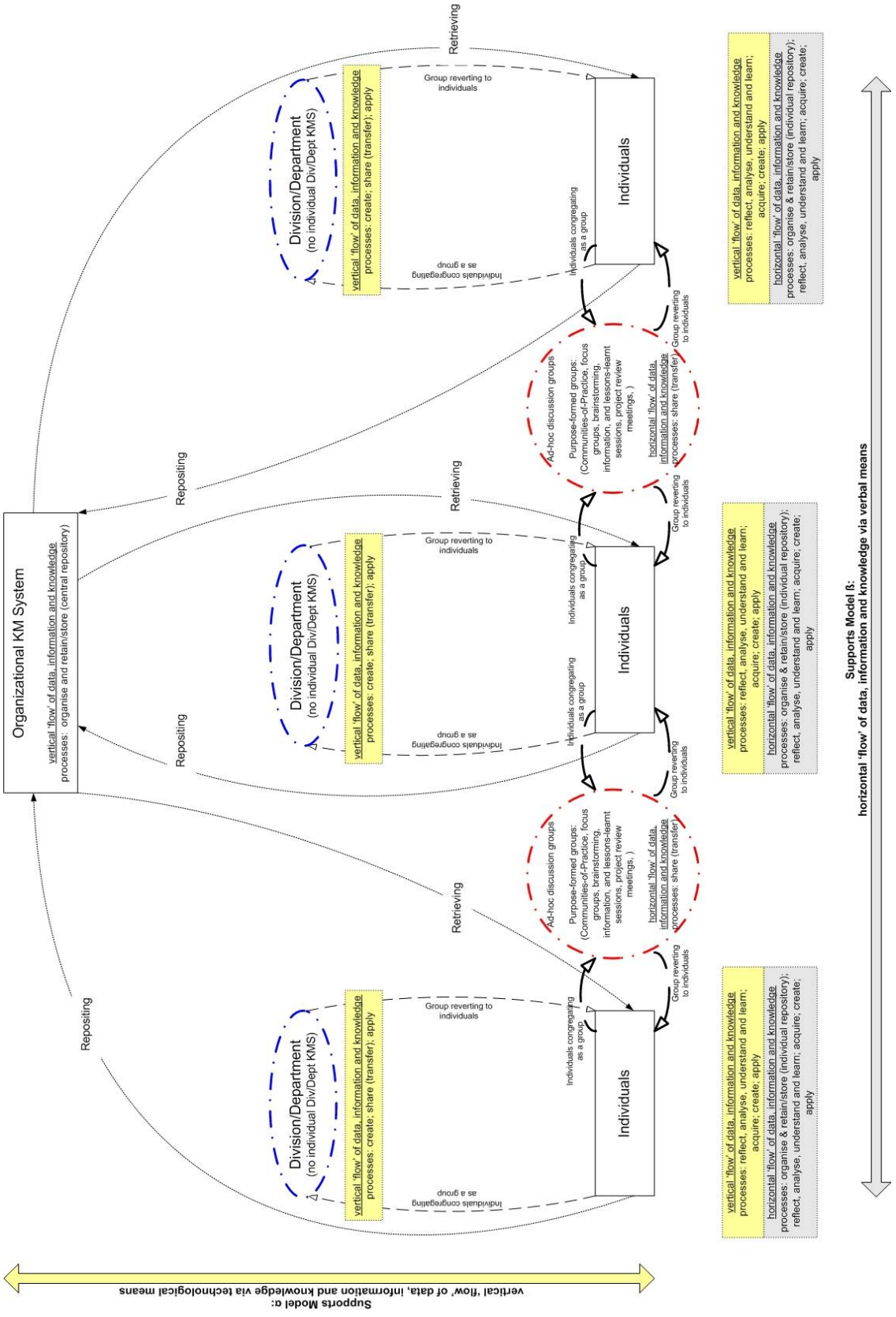

Figure 11. Application of data, information, and knowledge models to the case study organization.