FROM MONITORING TO LEARNING: A CONCEPTUAL FRAMEWORK

Peter Shek Pui Wong[1], Sai On Cheung[1]

[1]*Construction Dispute Resolution Research Unit, Department of Building and Construction, City University of Hong Kong, 83, Tat Chee Avenue, Kowloon Tong, Hong Kong*

The demand of attaining sustainable improvements of the contractors' performance has engendered a vast amount of studies aiming at advancing the project monitoring systems and organizational learning (OL) process in construction. Nevertheless, the respective research outputs remain dispersed and disjointed. As such, there is a genuine need to have a systematic framework not only to evaluate the strengths and weaknesses of the previous studies, but also to explore the future research directions in project monitoring and OL in a holistic manner. The purpose of this study is to develop such framework. Reviewing previous studies, there is a lack of systematic approach to synchronize monitoring results to organizational learning. Further investigations on the ways to transpire learning opportunities from the project monitoring system shall be instrumental to fulfil the industry's demand on attaining sustainable improvements of the contractors' performance.

Keywords: Monitoring, Organizational Learning

INTRODUCTION

Contractors have been described as a front-line workforce that converts construction project design into practical reality (Palaneeswaran and Humphreys 2000, Xiao and Proverbs 2003). They were recognized as the hub of a construction supply chain as they not only link sub-contractors and suppliers, but also the client and the customers along the development process (Dainty et al. 2001). An unscrupulous contractor may deter project performance and lead to project failure (Wong 2004). Vice versa, an improved contractor's performance would increase client satisfaction as well as project value (Xiao and Proverbs 2003). Moreover, continuous improvement has been identified as a key to sustain the competitive advantages for all organizations linking in a construction supply chain of which the contracting organization is the central of the hub (Kululanga et al. 1999, Murray and Chapman 2003). Nevertheless, several industry reviews reported that contractors' performance has been declining (Latham 1994, Egan 1998, CIRC 2000, Mottahedin 2003). The declining performance is reflected by erosion of productivity, reduction in profitability and mounting inter-firm adversarial relationships within the supply chain (Tucker et al. 1996, Santos and Powell 2001, Love et al. 2004). Moreover, this problem has become more acute as the traditional contractors' practices are no longer sufficiently efficient and effective to respond to the higher and changing clients' demands under the increasingly competitive business environment (Nesan and Holt 1999, Holt et al. 2000, CIRC 2001, Santos and Powell 2001, Love et al. 2004). Love et al. (2000) described organizations in the construction supply chain as incapable to solve unprecedented problems, grasp unexpected opportunities, as well as adapt to dynamic business environment. Indeed, contractors have long been identified as being inflexible and

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unresponsive to the changes of customer needs in previous studies (Mann and Kehoe 1996, Clake and Clegg 1999, Holt et al. 2000). In order to rectify these situations, several literatures emphasized that contractors' practices should be reoriented to facilitate continuous improvement of their performance (Kumaraswarmy 1998, Kululanga et al. 1999, Holt et al. 2000, Love et al. 2000, Jashapara 2003).

RESEARCH OBJECTIVES

In construction, performance is often gauged by the levels of compliance with predetermined criteria on time, cost and quality (Proverbs and Holt 2000, Soetanto et al. 2001, Baloi and Price 2003). Improvement can be regarded as a change of action that minimizes the deviations between actual and predetermined performance (Al-JiBouri 2003). To this end, Al-JiBouri (2003) emphasized the importance of establishing a control system on contractors' performance. The system should consist of three components: [1] measuring performance; [2] judging the performance against standards, and [3] taking any necessary corrective action to improve the performance. Al-JiBouri (2003) further identified components 1 and 2 as 'Monitoring'. Moreover, contractors must accomplish component 3 to achieve improvement which could hardly be enabled by a Monitoring System alone without contractors' taking appropriate corrective action. Generally, contractors' corrective action is based on a process from transforming the received information to his knowledge for improvements. Previous literatures have described this process as a form of organizational learning (OL) (Kululanga et al. 1999, 2002, Love et al. 2004). OL could be defined as a process that an organization imbibes knowledge from his internal and external environment and transforms it to solutions to ensure continuous improvements (Kululanga et al. 1999). As such, both Monitoring and OL are major components of performance improvement. This may help to explain why there was a vast numbers of literature on advancing the Project Monitoring System and OL process in the construction supply chain for either capturing market share or survival purposes (Xiao and Proverbs 2003, Chen and Pauljaj 2004). Despite the growing importance and research interests in sustaining the contractors' continuous improvements, previous studies in Monitoring and OL in construction remain disjointed and scattered, and there is a genuine need of a systematic framework to fulfill the industry's needs (Kululanga et al. 1999, 2002, Xiao and Proverbs 2003, Chen and Pauljaj 2004). This paper describes such a conceptual framework linking project monitoring with organizational learning for continuous improvement purposes. The framework was developed from a systematic review on both theoretical and empirical findings in Project Monitoring and OL. Through identifying the strengths and weaknesses of these findings and integrating them in a holistic manner, the conceptual framework shall enhance the appreciation of the needs to transpire learning opportunities from project monitoring. This conceptual framework can also be extended to participants within a construction supply chain (Chen and Paulraj 2004).

PROJECT MONITORING

Reviews of the previous literatures suggested that research efforts on the advancements of the monitoring system were typically built around three themes aiming to ensure contractors' performances meeting clients' expectations (Jaafari and Manivong 1998, Kululanga et al. 1999, 2002, Holt et al. 2000, Ramo 2002, Al-JiBouri 2003, Crawford and Bryne 2003):

[1] Defining and standardizing contractors' performance metrics

These studies mainly sought to establish standards against which evaluation can be made. As such, contractors' performances are gauged against predetermined criteria. Typically, these criteria are transpired to relate to project goals in terms of time, cost and quality.

[2] Advancing visual aids functions

The theme of this line of studies is to design the use of visual aids automated by software such as spreadsheets to enhance readability and ease of apprehension of relevant information by users.

[3] Reducing time gap between data input and information output

The emergence of information technology allows the design and implementation of automation systems to simplify and accelerate the process of retrieving necessary information from the monitoring system.

Monitoring systems designed in 90's focused on either one or more of the above themes as summarized in Table 1 (Shih and Tseng 1996, Zipf 1998, Jaafari and Manivong 1998, Tommelein and Li 1999). Undoubtedly, these systems improved the ways with which attention of contractors were drawn to performance, as well as the provision of relevant and sufficient information to simulate corrective actions for continuous improvements (Al-JiBouri 2003). Nevertheless, several studies argued that traditional Monitoring Systems in construction had put too much emphasis on gauging the contractors' performance in terms of efficiency (Ramo 2002, Crawford and Bryne 2003). Ramo (2002) pinpointed that traditional Monitoring Systems aim at entailing detection of actual performance against the predetermined set of standards. Nevertheless, the 'partisan focus on efficiency' focus may encourage organizations 'to stick with old assumptions'. This may restrain their innovation and awareness to changes in clients' needs and thus sacrificing effectiveness in return. Crawford and Bryne (2003) argued that Monitoring System should be developed to facilitate both monitoring and evaluation functions. Despite 'monitoring and evaluation are intimately linked', their purposes are different. Monitoring is an ongoing and management-driven process of data capture and analysis emphasizing on fallacy control, hence efficiency. Evaluation is a periodic and stakeholder-driven process of assessment emphasizing on project organizations' effectiveness (Crawford and Bryce 2003).

Indeed, classical management theory portrays that either failure of contractors' efficiency or effectiveness would hampers organizations' ability of performance improvement (Drucker 1974, Mintzberg 1983, 1989). Drucker (1974) described efficiency as 'doing things right' and effectiveness as 'doing the right things'. Mintzberg described efficiency as 'achieving the measurable benefit to the measurable cost' and effectiveness as 'the consistency between the situational factors and the design parameters'. In other words, contractors' performance should be gauged by both efficiency and effectiveness.

In this connection, a progressive development of Monitoring System in construction was found in the past decade (Table 1 refers). Applying World Wide Web and data-base technology, recent Monitoring Systems such as the Balanced Score Card Performance Evaluation System (Landin and Nilsson 2001, Rodney and Mohammed 2001), Web-based construction project management system (Chan and Leung 2004) and Project Performance Monitoring System (PPMS) (Cheung et al. 2004) provide the vital instantaneous feedback loops for the retrieval of relevant information that would draw contractors' attention to both real and potential problems. Advance in

information technology also enabled swift system adjustments in response to the changes in clients' needs.

Notwithstanding the comprehensiveness of previous researches in the advancement of the monitoring system, some researchers worried that these research efforts may eventually be wasted if the contractors are reluctant or incapable to embrace these systems and take appropriate corrective actions for improvements (Kululanga et al. 2002, Al-JiBouri 2003, Love et al. 2004). It has been supported that an effective recognition, and subsequently, response to the information provided by these systems requires the ability to exercise organizational learning (OL).

Table 1: Development of the monitoring systems in construction

Development	Control System	Descriptions	Aims
Focus on efficiency	Workflow Technology-based monitoring and control system (Shih and Tseng 1996)	It is a system applying network-based technology and information system to track the flow of work, the flow of information and the use and commitment of resources along the project period.	Proactively automate the tracking of actual project performance and to verify their compliance with the project standards.
	Task Cards System (Zipf 1998)	It outlines the entire construction process in spreadsheet format and provides a graphic representation of the time and budget limit to complete each task of work.	Measure, track and compare every aspect of performance metrics within a single system. Help the project team to focus on tasks with potential to be completed beyond time and budget limit.
	Life Cycle Project Management System (Jaafari and Manivong 1998)	It is a system that evaluate the organization's achievement of the pre-agreed project objective functions	Link the reward and penalty by the achievement of pre-agreed standard to prevent time-consuming process on tracking and allocating the responsibility of errors
	Just-in-time management system (Tommelein and Li 1999, Lau and Choong 2001)	It is a system recording and reporting the efficiency of materials flow. The efficiency is usually evaluated against the preset quantity and time target.	To ensure the raw materials are not stockpiled and delivered in right quantities at the right time for production
Focus on both efficiency and effectiveness	Balanced Score Card Performance Evaluation System (Landin and Nilsson 2001, Rodney and Mohammed 2001)	It is a system that evaluates the organization's performance by four performance indicators namely financial, process, customer and learning perspectives. Organization's effectiveness to attain pre-agreed cost, time and quality standard is assessed by the Financial and Process indicators. His ability to fulfill the customer requirements and propose innovative ideas in the project are assessed by the Customer and Learning indicators respectively.	Evaluate organization's performance by not only his past performance but also by their adaptability to changes as that may affect the future performances.
	Web-based construction project management system (Chan and Leung 2004)	The system enables the collaborative organizations to allocate their responsibilities and provide an automatic workflow management on responding to their tasks and changes. Under a web-based environment. Furthermore, a bulletin board in this system enables on-line conferencing and e-mailing among organizations. Previous discussions and decision makings are recorded and traceable by them.	Facilitate speedy workflow management by an integrated web-page. Enable interactive communication Enable efficient assess and update of change of working requirements and orders
	Project Performance Monitoring System (PPMS) (Cheung et al. 2004)	The system evaluates the contractors' performance by 8 major aspects namely, People, Cost, Time, Quality, Safety & Health, Environment, Client Satisfaction and Communication. The monitoring process is automated through the use of the World Wide Web and data-base technology. The automated monitoring process of PPMS affords ease of set up and further adjustments of performance indicators to adapt to the change of the clients'	Enable efficient retrieval of information and measurement of contractors' performance Allow flexibility of the use of performance indicators adaptive to the change of clients' demands.

Indeed, a vast amount of literatures had emphasized the importance of OL for construction organizations to attain continuous improvements (Pedler et al. 1991, Pedler 1997, Kululanga et al. 1999). Holt et al. (2000) suggested that OL is demanded for sustaining the continuous improvements and competitive advantages. Murray and Chapman (2003) pinpointed that inadequate OL had negative impact on the contractors' performance outcomes. Love et al. (2004) advocated that contractors should integrate OL as part of daily routines as this would guide them to operate efficiently and effectively in response to the ever changing business environment. Nevertheless, it can be said that few construction contractors have viewed project monitoring from a learning perspective and implement procedures that systematically acquire, capture, convert and connect monitoring result for a learning outcome. Instead, it is assumed that OL is an independent response to the environmental challenges and occurs randomly or appear unintentionally (Jashapara 2003, Love et al. 2003, 2004, Sense and Antoni 2003). This may help to explain why it is described as difficult for construction organizations to incorporate OL as part of the organizational norm (Love et al. 2000).

Despite OL studies have emerged as an essential area of research and a great deal of progress has also been made toward OL researches in construction, several researchers also reminded that the understandings of OL in construction is under explored (Love et al. 2000, Spekman et al. 2002, Sense and Antoni 2003, Franco et al. 2004, Love et al. 2004). Furthermore, Huemer and Ostergren (2000) pinpointed the lack of more systematic empirical studies on OL is a major gap in previous OL studies in construction.

ORGANIZATIONAL LEARNING

OL is a developing and emerging research topic in construction (Kululanga et al. 1999, Love et al. 2000, Fu et al. 2002, Jashapara 2003, Murray and Chapman 2003). Argyris (1977) defined OL as a process of detection and correction of errors found from both internal and external environment. Fiol and Lyles (1985) described OL as a process of knowledge and understanding for improving actions. These definitions were often adopted to describe OL in construction organizations. There are other definitions suggested and they are summarized in Table 2.

Table 2. Literatures contributing to define OL in construction organizations by adopting classical OL definitions in other research contexts

Classical OL definitions in other research contexts	Literatures contributing to define OL in construction organizations
OL is a process of detection and correction of errors found from both internal and external environment (Argyris 1977).	Kululanga et al. (1999, 2002), Love et al. (2000), Jashapara (2003), Murray and Chapman (2003), Schindler and Eppler (2003), Love et al. (2004)
OL is a development of knowledge that shortens the performance gaps between real and expected results (Duncan and Weiss 1979).	Huemer and Ostergren (2000), Love et al. (2000)
OL is a process of knowledge and understanding for past actions and future improvement actions (Fiol and Lyles 1985).	Love et al. (2000), Fu et al. (2002), Jashapara (2003), Love et al. (2004), Franco et al. (2004)
OL is a change of behaviour due to detections of relevant information (Huber 1991)	Love et al. (2000)

In general, studies on OL in construction can broadly be grouped in two main streams:

[1] Exploring the motivators and notions of OL

The first stream of studies considered various motivators and the theoretical underpinnings of OL in construction. The aims of this stream of studies are to explore what motivates researches in OL; how OL can be described; how organizations in construction learn and the ways and means that continuous improvements can be attained. Findings in this stream of studies were normally based on the literature reviews, case studies and interviews with the practitioners.

Motivators of OL: The push of OL studies in construction has several drivers. Firstly, the urgency of the 'fundamental cultural and technical change of the construction industry' and the 'solutions to rectify the declining contractors' performance' suggested in many construction industry reviews reports provided the driving force (Latham 1994, Egan 1998, CIRC, 2000, Love et al. 2000, Santos and Powell 2001). Secondly, the need to sustain the competitive advantages in an evolving built environment highlighted the importance of improvements (Jashapara 2003). Indeed, several studies emphasized that the business environment in construction is not static. OL studies are of prime importance for construction organizations to be innovative and adaptive to the changing customers' demands (Kale and Arditi 1998, Murray and Chapman 2003). The above motivators are consistent with the four drivers of learning as summarized by Love et al. (2000, 2004) in their conceptual model for a learning organization in construction. These include: 'improved competitiveness and performance', 'quality improvements', 'improved customer-supplier relations', and 'manage and adapt to changing environmental conditions'. Notwithstanding the above, it has also been raised that a systematic and holistic OL studies in construction is much needed (Kartam 1996, Kululanga et al. 1999, 2002, Holt et al. 2000). As such, in search of a holistic approach is a driver of OL researches in construction.

OL styles: The notions of OL in construction have also been expounded in the works of Josephson (1994), Hirota et al. (1999), Kululanga et al. (1999), Love and Josephson (2004) and Love et al. (2004). OL was conceptualized by its styles and defined as a characteristics that an organization 'exhibits in the way it addresses its needs for continuous improvements' (Kululanga et al. 1999). OL styles that have been distinguished by different construction researchers are shown in Table 3. Indeed, authors often adopted two or more OL styles indicated in Table 3 to describe OL in construction. Jashapara (2003) distinguished OL in construction by Behavioral and Cognitive Learning. In another framework, OL styles were distinguished by Single-loop and Double-loop learning (Josephson 1994, Hirota et al. 1999, Jashapara 2003, Love and Josephson 2004). Learning styles such as Action Learning, Adaptive Learning, Anticipatory Learning, Deuterolearning, Generative Learning have also been suggested (Fu et al. 2002, Murray and Chapman 2003, Love et al. 2000). In addition, research efforts also have been put on comparing the importance of different OL styles to construction organizations (Kululanga et al. 1999, Love et al. 2000, Jashapara 2003, Murray and Chapman 2003, Love et al. 2004).

OL dimensions: OL in construction has also been described by its dimensions and mechanisms. As such, OL dimension is defined as a strategy that an organization employs for learning purpose by Kululanga et al.(2002) who summarized 10 common OL dimensions for construction organizations. These are: Learning from the past experiences; Learning from other firms; Integrating work with learning; Internal sharing of knowledge; Adopting internal improvement schemes; Individual employees' learning for advancement of organizations' operational performance; Use of team-level mindsets to decide strategies for improvements; Continuous renewal of

business process; Continuous scanning for new developments; and Developing a capacity to identify and respond to the future business process.

OL mechanisms: OL mechanism is defined as a management tool or approach that the organization would employ to sustain continuous improvement (Barnett 1994, Kululanga et al. 1999). With case studies and interviews with the practitioners, Kululanga et al. (1999) identified and classified OL mechanisms in construction into the five bases. Firstly, OL mechanisms could be based on collaborative arrangements among organizations. These can be joint venturing, partnering, consortia, license agreements and etc. Secondly, OL mechanisms could be based on non-collaborative arrangements among organizations like acquisitions and mergers. Thirdly, they could be based on networks like the professional institutions and information systems. Furthermore, OL mechanisms could also be based on 'Learning through individual employees' and 'In-house research-based improvement schemes, reviews, team learning, benchmarking, shows and exhibitions (Huemer and Ostergren 2000, Schindler and Eppler 2003, Maqsood et al. 2005).

Notwithstanding this stream of studies contributed to develop the notions of OL in construction, the findings were mainly anecdotal with limited quantitative supports for validation (Kululanga et al. 2002). Despite the research outputs from this stream of studies comprehended the theoretical underpinnings of OL in construction; these may not lead to the direct solutions to transpire the learning opportunities in the monitoring systems.

Table 3: OL styles in construction context

Organizational Learning (OL) Styles	**Authors**
Action Learning: It refers to a process from encountering to tackling problems by correct solutions (Marquadt 1996)	Fu et al. (2002)
Adaptive Learning: It refers to the organizations' ability to cope with changes (Hedberg 1981)	Fu et al. (2002), Murray and Chapman (2003)
Anticipatory Learning: It refers to the organizations' behaviour upon their expectations of the future event (Marquadt 1996)	Fu et al. (2002)
Behavioral Learning: It refers to 'detection and corrections of errors leading to the modification of rules within the established set of variables (Fiol and Lyles 1985)	Jashapara (2003)
Cognitive Learning: It refers to 'an organizational change that affects the interpretation of events and the development of understanding among organizational members'. (Fiol and Lyles 1985)	Jashapara (2003)
Deuterolearning: It refers to the organization's learning on how to learn effectively (Pedler 1997)	Love et al. (2000) Fu et al. (2002), Love and Josephson (2004)
Double-loop Learning: It refers to examination and attention to the changes in the underlying values for which adjustments are necessitated (Argyris 1977)	Josephson (1994), Hirota et al. (1999), Love et al. (2000), Fu et al. (2002), Jashapara (2003), Murray and Chapman (2003), Love and Josephson (2004)
Generative Learning: It refers to the repudiation of previous decision-making assumptions and understanding the rot of the problems (Honey and Mumford 1986).	Fu et al. (2002), Murray and Chapman (2003)
Single-loop Learning: It refers to the altering behaviors and actions to be taken when the 'mismatch between intentions and what actually happen' is discovered (Argyris 1977)	Josephson (1994), Hirota et al. (1999), Love et al. (2000), Fu et al. (2002), Jashapara (2003), Murray and Chapman (2003), Love and Josephson (2004)

[2] Collecting industry views about different aspects of OL

The second stream of studies collected the practitioners' perceptive views on OL in construction through case studies, interviews and questionnaire surveys. It aims not

only to address the strengths and weaknesses of the OL practices, but also to explore future research directions that would facilitate sustainable improvements of contractors. Research efforts contributing to this stream of studies are highlighted in Table 4. For example, Huemer and Ostergren (2000) and Jashapara (2003) reported that construction firms considered OL as not only an adaptive process of collecting all 'subunits that a simultaneously changing their own interpretation of the environment on the basis of their own experience', but also an evolutionary process built on an organizations identity in order to survive in international construction market. However, it has been reported that construction contractors display low capacity in integrating their management systems with learning outcomes (Katam 1996, Kululanga et al. 1999, 2002, Huemer and Ostergren 2000, Santos and Powells 2001, Love et al. 2003). Kululanga et al. (1999, 2002) contended that learning mechanisms and dimensions are rarely used because the scope for innovation is somewhat limited. As such, contractors were also found to have low learning capability to improve work quality (Love et al. 2003). The reason for such inadequacy may be due to the absence or ineffective use of feedback channels. In this connection, future studies of OL should be directed to develop a dynamic and interactive data-based system that could facilitate inter-firm OL and allow visualization of the improvement effects resulting from OL (Katam 1996). Similar findings were also highlighted by Huemer and Ostergren (2000) study who reported that the current OL practice lacks the 'systematic ways of institutionalizing and sharing experiences from different localities' and believed that 'modern IT tools will help improve the situation further'. Furthermore, similar studies conducted by Santos and Powells (2001) emphasized the necessity of clear guidance to contractors in order to translate their detection of errors and the changes of clients demands into knowledge for improvements.

Notwithstanding much effort have been put by the construction researchers, the scope of this stream of studies is still having rooms to be expanded as compared with the other research fields (Sense and Antoni 2004). In this respect, perceptive views on the central agitators and barriers that impairing the application of OL (Kotnour 1999), as well as the metrics to be used for gauging or measuring the OL effects in the projects (Lahteenmaki et al. 2001) should also be sought in future.

Table 4: Research efforts contributing to collect the practitioners' perceptive views on the OL practice in construction

Industry views	**Findings**
Relationships between OL and performance improvements	OL are positively related to the performance improvement and leading to competitive advantages (Jashapara 2003).
Functions of OL	Construction firms understand that OL 'is not only a process of adaptation to the environment but also an evolutionary process built on an organizations identity' in order to survive in the international construction market (Huemer and Ostergren 2000)
Usage of the OL mechanisms	Construction contractors rarely applied various forms of learning mechanisms to learn for new ways of working (Kululanga et al. 1999).
Usage and importance of different OL dimensions	Strong relationships were found between facilitating factors of learning and OL dimensions. Yet, the surveyed contractors were found unpopular to promote most of the facilitating factors of learning (Kululanga et al. 2002)
The capability of OL	The construction firms showed as low capability of OL to improve quality of work. In addition, the size of the contractor firms impacts the capability of OL too (Love *et al.* 2003).
Relationships between OL practices and performance	Weak linking was found between OL and the contractors' performance. The results indicated that 'the project performance goals appeared to be established in isolation of OL practices'. (Murray and Chapman 2003)

Relationships between OL practices and competitive advantages	'OL focused on efficiency and proficiency leads to competitive advantage in the UK construction industry' (Jashapara 2003)
The way to advance the OL practices in future	Practitioners believed that 'a corporate lessons-learned data-based' is a key to facilitate inter-firm OL. This 'allows a more direct representation and modeling' of the performance in the real-world construction projects (Katam 1996).
The way to advance the OL practices in future	'Although few systematic ways of institutionalizing and sharing experiences from different localities exist today…', the contractors believed that 'modern IT tools will help improve the situation further' (Huemer and Ostergren 2000)
The way to advance the OL practices in future	Contractors 'could not detect all their problems and knowledge needs' for improvement as they rarely applied 'pull learning' (i.e. learn to fulfill the client's need). It is necessary to have a clear guidance helping that contractors to translate their detection of faults, as well as the changes of clients needs into knowledge for improvements (Santos and Powells 2001)

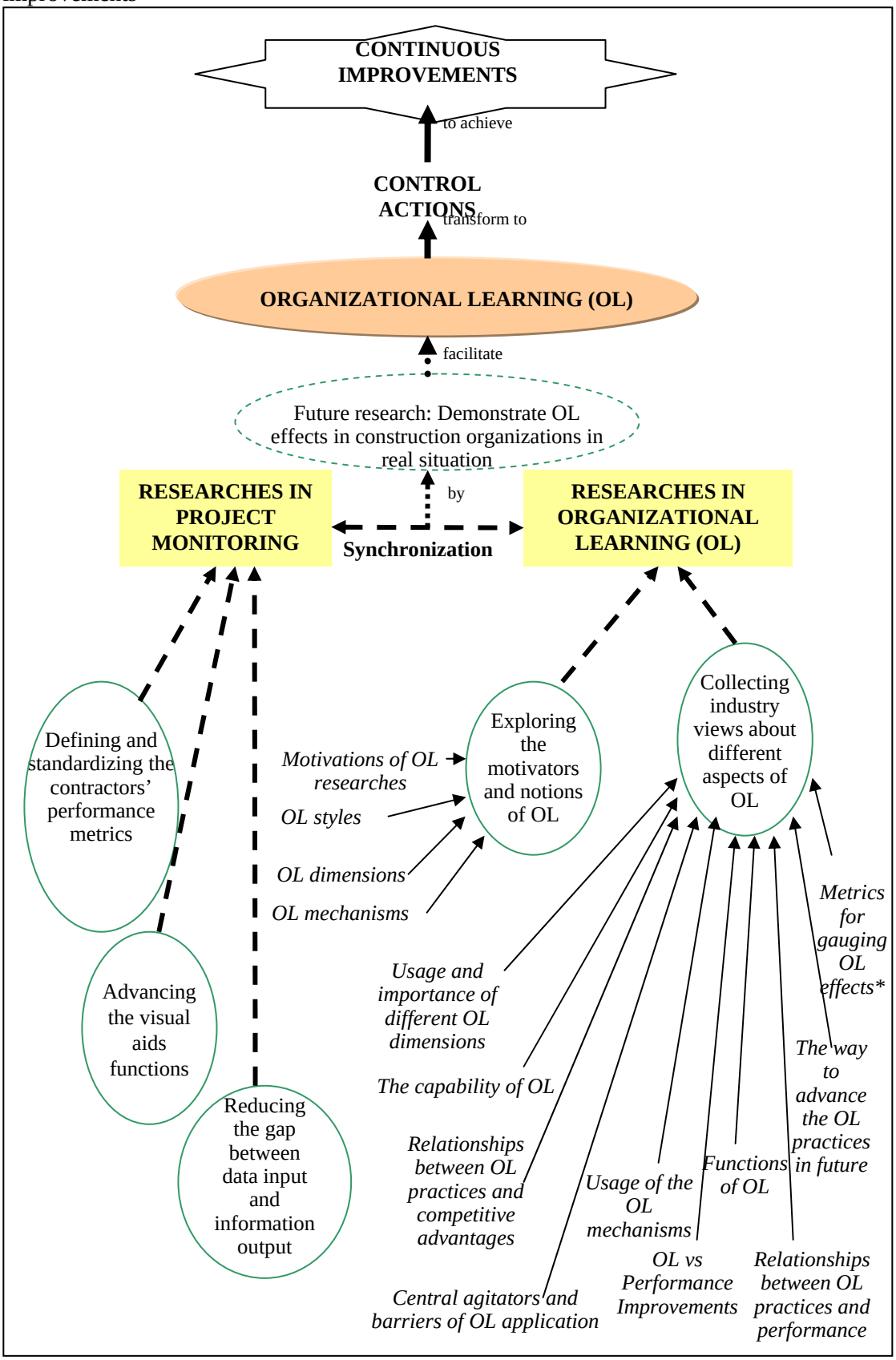
DEVELOPING A CONCEPTUAL FRAMEWORK FOR RESEARCH IN SUSTAINING THE CONTRACTORS' CONTINUOUS IMPROVEMENTS

In the previous sections, the strengths and weaknesses of the studies in project monitoring and OL are discussed. The general objective of project monitoring systems had been achieved by its ability in gauging contractors' performance. This facilitates recognition of performance standard by contractors. This has attracted comprehensive treatments. Moreover, a less attended related area is how contractors can capitalize on the learning opportunities made available from the monitoring regime (Kululanga et al. 2002, Al-JiBouri 2003, Love et al. 2004). Notwithstanding previous researches in OL had improved the practitioners understanding on the notions and practical experiences on implementing OL, there is cogent need for empirical support that demonstrate learning effect in construction (Jashapara 2003). Therefore, a systematic approach or method to measure and illustrate how the prescribed forms of learning would lead to increased performance in real situation shall prove instrumental (DeGeus 1988, Jashapara 2003). Future effort can therefore be directed to investigate how to synchronize project monitoring system and OL process. This shall build on transpiring monitoring results to learning opportunities, then investigating actions to attain sustainable improvements. In this connection, further studies should aim at devising monitoring system for learning outcomes (DeGeus 1988, Jashapara 2003).

Summarizing the previous research outputs and linking them with the proposed further studies, the conceptual framework of research in sustaining the contractors' continuous improvements is shown in Figure 1. As figure 1 depicts, an assortment of researches in project monitoring and organizational learning had been undertaken by the construction researchers. Literature in project monitoring has focused on defining and standardizing the contractors' performance metrics, advancing the visual aids functions and reducing the gap between data input and information output. Regarding the researches in organizational learning, previous contributions are found in the exploration of the motivators and the notions of OL and the collection of the industry views about different aspects of OL. Furthermore, future research on demonstrating the OL effects in construction organizations in real situation is required. This could help to transpire monitoring results to learning opportunities, then facilitating the contractor to rake appropriate correction actions for improvements. In this connection, empirical evidence of improvement would first be solicited. Research methodologies employed in measuring operational teams' OL capabilities through their performance records in engineering management field will also be explored (Uzumeri and

Nemhard 1998, Nembhard and Uzumeri 2000). This should form the next central part of this study.

Figure 1. Conceptual framework for research in sustaining the contractors' continuous improvements



CONCLUDING REMARKS

The importance of attaining sustainable improvements has engendered a vast mount of studies in project monitoring and organizational learning (OL) in construction. In this paper, a conceptual framework for research in sustaining the contractors' continuous improvements is developed by reviewing previous theoretical and empirical findings, as well as suggesting future directions of researches in project monitoring and OL. This conceptual framework is useful for evaluating the strengths and weaknesses of previous studies in a holistic manner. Furthermore, this helps the construction researchers to recognize the need to further investigate the possible ways to attain sustainable improvement. After the comprehensive review, it has become clear that there exists a devoid of systematic approach to synchronize monitoring results to organizational learning for appropriate corrective actions. Nevertheless, such approach is crucial for transpiring learning opportunities to the project monitoring systems.

Indeed, the findings in this study are also augmented by some previous articles in which they described the construction organizations as generally weak in seeking, managing and utilizing information pertaining to integrate learning in practice to attain sustainable improvements (Kululanga et al. 1999, 2002, Huemer and Ostergren 2000, Murray and Chapman 2003, Nesan 2004). In this connection, it becomes instrumental to demonstrate the learning effects in construction organizations in real situation. In this particular respect, the use of learning curve model has been affirmed by different research disciplines as the best method to demonstrate the OL effects in real situation (Zielinski and Allendoerfer 1997, Nembhard and Uzumeri 2000, Lee et al. 2003). It is suggested to further investigate the use of the contractors' performance data as collected from the monitoring system to demonstrate the OL effects for improvements in real situation.

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