Creative Construction Conference 2016

Knowledge Management (KM) in Concurrent Construction Projects

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Abstract

One critical factor in construction industry is how well firms manage concurrent projects effectively and obtain desired construction benefits. However, achieving this is not easy and challenging because several activities need tacit and explicit knowledge involved. The purpose of this research is to develop a generic KM algorithm using learning from and sharing to (LXS) matrix. We discussed the main concepts and strategies for rapid learning through KM in construction projects. . Some of the concepts discussed are (set-based thinking, agile PM and planning, iteration management, etc.). Moreover, the research carried out practical discussions in one of Norwegian construction project. The research looked at key literature in the field, identify the main issues in organizing KM in construction projects, and finally discuss the case of E39 ferry-free highway construction proposed by Norwegian public road authority (NPRA). The result from the KM matrix showed smaller projects are better to learn from all project phases than the large projects. The vice versa is true from sharing perspective. The research results instigate the roles of learning and sharing and urge to intervene systemic KM in concurrent construction projects.

Keywords: construction projects; knowledge management, learning, sharing, tacit and explicit knowledge.

1. Introduction

According to PM magazines recently published on PMI, managing multiple/concurrent projects bemoaned by project managers. This is mainly because managing multiple projects overload managers with more work, affect project performance, and in some cases create challenges to complete projects with a given resources (time and budget). On the other hand, competitiveness, resource scarcity, and the need for resource optimization push industries forward to manage multiple projects concurrently. General literature considers construction industries as a competitive, with a tight schedule, diversified processes and not standardized production. In addition, several stakeholders and actors temporarily assigned to complete the projects and this even make more challenging to manage the project. These typically create pressure on construction managers to hold challenging responsibilities and handle various projects with complex activities simultaneously.

In such challenging situation, construction managers need to have capability (knowledge) on how to prioritize, execute (handle) various activities, and ability to utilize appropriate methods (tools) effectively. According to [16], project managers are special type of professionals with special knowledge, skills and training. Recent literature discussed about the need and advantages of learning and knowledge management in construction [2]. To obtain the benefits from KM, construction firms put their endeavor to expose project managers for formal training to build the knowledge and develop the PM skills. According to [5, 18], construction projects have great knowledge and information flows during lifecycle of the project which is considered an asset for companies that should not be wasted.

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The goals of these efforts are to enhance the learning and sharing process. Learning and/or sharing could be within ongoing projects, completed projects, and experienced personnel involved in these projects. In this regard, [1] argue that reuse of existing organizational knowledge, which gained through experience, can greatly reduce the time spent on problem solving and increase the quality of work. Construction projects can learn from within the same company or outsiders, and from both small/large projects of shorter/longer project life spans. The type of knowledge acquired through the learning and sharing process could be tacit or explicit [12]. Fortunately, the relevance of both tacit and explicit knowledge, the distinction between them, critical success factors and the likes are well documented in KM literature. Nevertheless, only a relatively small proportion of construction organizations have implemented KM systems [5]. Indeed, some construction organizations embedded KM as a strategy. According to [20], 40% of the construction already have the strategy but it seems took longer time to invest on it.

One challenge is how to evaluate or measure KM. Typically, lack of systematic methods of learning and sharing processes that are feasibly difficult to evaluate in practice. In this connection, there is lack of real-time and readily exploitable (usable) methods (tools). According to the general literature, KM methodological developments and the capability to use these methods would help to create value on the construction investment.

According to [21], knowledge will not bring value unless it is actively used. To use knowledge effectively in construction projects, firms should consider KM as a part of firm's strategies. Literature notably identified KM as a framework for designing an organization's strategy that can help to learn, to create economic and social value [14]. In the same light, the strategic advantages of KM has been considered as a key driver for organizational performance and competitiveness. Regardless of several discussions on strategic advantages of KM in literature, our research would focus on methodological improvement as a part of KM implementation while managing concurrent projects. Typically, this research focuses on learning/sharing the knowledge and experiences in various sized multi construction projects. We approached the discussion using the following main research questions:

- How can we systematically identify projects to ''learn or share'' knowledge to other projects with various project size and life span?
- How projects can facilitate KM in the learning and sharing process? States of the art discussions.
- What could construction project get or benefited from these processes?

2. Methodology

The paper is conceptual but in light of practical discussion from Norwegian construction project. The need for this research emanates from lack of formal methodology for learning and sharing process in knowledge based construction organizations. Typically, in construction that run several concurrent projects with different size and project life span. The research uses KM and construction focused literature. In addition, it discovers some good practices and adaptable methods from production (product development) systems, such as iteration management, set-based thinking, and agile PM planning. The paper attempted to develop learning and sharing matrix to facilitate KM in construction.

3. Knowledge management in construction and conceptual matrix development

3.1. *Knowledge Management in construction projects*

Generally, KM assumed to be existed in any organizations. Literature showed the long history of KM in various organizations and several researchers developed models that suit these organizations [12, 19]. However, [5] showed a small proportion of construction organizations have implemented KM systems. The survey by [20] indicated about 40% construction organization already have a KM strategy. Indeed, there are limited attempts to apply advanced methods of KM in construction to [13]. Although the recent publications documented an increasing trend on the awareness of KM concepts, it takes some time for the construction industry to invest on it. Nevertheless, in the 21 century with increasing demands in construction due to population growth, immigration, the need for fast economic development and the likes push construction industries to develop KM strategy, which considered as an asset in an organization.

According to [18], organizational knowledge is a valuable, rare, inimitable and non-replaceable strategic asset. This asset can be organized in a way that it creates value and make usable by the organization [21]. In the process of value creation in connection with KM in large and complex projects, knowledge transfer (sharing and rapid learning), agile PM planning, set-based thinking, proper iteration management and system integration are crucial. However, these different knowledge enhancement processes discussed separately in different cases and fields of

studies in the general literature. Very limited research highlighted the system integration part. Especially the practical implications and looking a large/complex project as a system is rarely discussed.

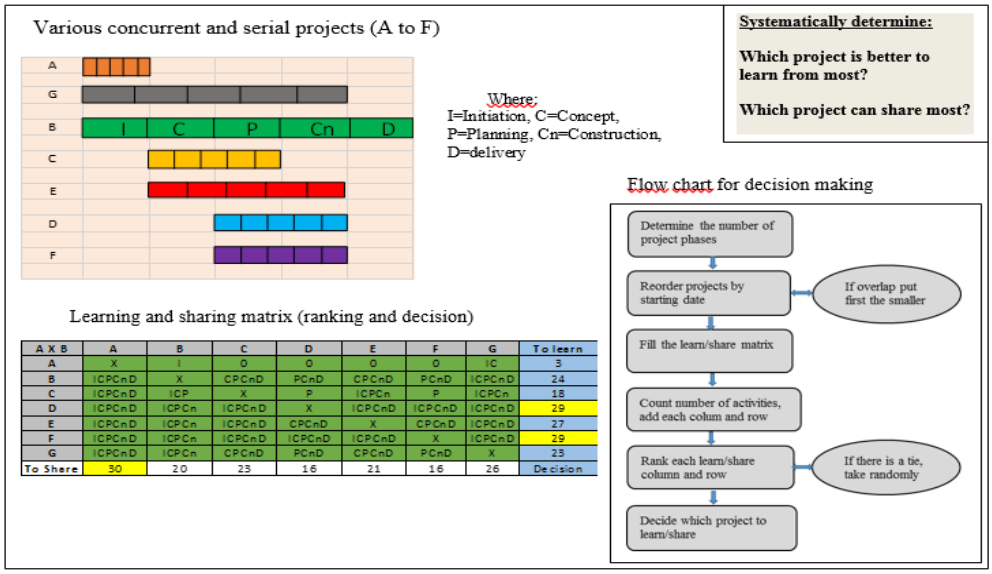
To gain competitive advantages of large or megaprojects, obtain the expected benefits & values, construction projects should have KM strategy (systemic framework) that facilitate the execution of a successful project. Typically, public construction projects aims to delight the public by exceeding their expectations and/or achieve the promised benefits in terms of various parameters (e.g. cost, time, quality, HSE).

As a contribution to achieve the aforementioned aims, we first discuss the various concepts of KM enhancing processes, such as agile PM planning, set-based thinking, iteration management, learning & sharing, and finally develop a system integration framework. In this connection, we approached by responding to the three research questions and link practical discussions to Norwegian E39 ferry-free coastal highway construction.

- ***Research Question 1*** How can we systematically identify projects to ‘‘learn from or share to’’ other projects with various project size and life span?

3.2. *Development of learning from and sharing to Matrix:*

Megaprojects lack similar previously completed projects for learning purposes. Most of megaprojects are new and need political decisions besides to the quality of the project proposal. Hence, the learning process dependent on the large and small size projects. The general KM literature showed how learning and sharing could benefit the organization performance by reducing cost, time and enhance quality. However, most these literature did not discuss about how construction managers can systematically select projects for learning and sharing. To fill this gap, we develop a hypothetical learning and sharing (LXS) matrix to select the right project with its flow-chart (see figure 1). For example, concurrent and serial projects (A to F) with five project stages (I, C, P, Cn, D) considered. Project D&F are better for learning and project A has potential to share most.



A X B	A	B	C	D	E	F	G	To learn
A	X	I	O	O	O	O	IC	3
B	ICPCnD	X	CPCnD	PCnD	CPCnD	PCnD	ICPCnD	24
C	ICPCnD	ICP	X	P	ICPCn	P	ICPCn	18
D	ICPCnD	ICPCn	ICPCnD	X	ICPCnD	ICPCnD	ICPCnD	29
E	ICPCnD	ICPCn	ICPCnD	CPCnD	X	CPCnD	ICPCnD	27
F	ICPCnD	ICPCn	ICPCnD	ICPCnD	ICPCnD	X	ICPCnD	29
G	ICPCnD	ICPCn	CPCnD	PCnD	CPCnD	PCnD	X	23
To Share	30	20	23	16	21	16	26	Decision

Fig.1 learning and sharing matrix.

Research Question 2 • How projects can facilitate the learning and sharing process? State of the art discussion

3.3. *Agile project management and planning.*

According to [3], most project managers need to follow a well-prepared plan and struggle to fight back on the plan when things go wrong. This typically force project managers to over utilize resources especially when the plan do not fulfill the rigid project requirements set at early stage. One characteristic of construction projects is scope change [16]. The more the project scope changes, the more agility required. In responding to the scope change challenges, agile project management (APM) introduced. The type of plan in APM should be realistic for the planners to respond in the short term to deliver early value, mitigate risk of the entire project [3].

Since the influence of the construction project is large at early planning phase, the cost of making changes increases with time [4] In this regard, construction firms resist (restrain) to the change from the original plan struggle to keep the original requirements as is in the beginning. However, change is proverbial as the construction project progresses because several expected and unexpected factors involved. Especially the unexpected ones force project managers to change the original plan.

In general, scope change could be due to value adding activities for expansion (modification) or because of uncontrollable (unexpected) phenomenon that require additional resources. Managing both type of changes need real-time decisions, flexibility, and optimization of resources. In this connection, literature recently showed some positive achievements of one planning framework adopted from lean production systems known as agile planning.

The emergence of agile planning is to fill the gap of the ordinary ‘‘waterfall’’ planning approach in which one cannot start the next step until the previous stage completed. In some civil engineering works which are monolithic in nature (e.g. skyscraper), iteration is rare and the waterfall approach could work pretty well. However, for non-monolithic projects, such as road constructions, iteration (agility) is inevitable. Agile planning (iteration management) is an active engagement of discussing the project goals, objectives, strategies and tasks that the project owner need to accomplish in the best way possible. Iteration is one of the distinct feature of agile planning. Typically, its relevance is feasible in large and megaprojects as these projects involve several stakeholders and factors.

3.4. *Set-based thinking (SBT) for rapid learning process.*

Although set-based thinking is one of the novel Toyota management system, it has recently been adopted to other industries. Construction is one of those industries attempting to apply SBT approach to facilitate design and project management [9]. According to [16] unlike point based (single alternative) approach, SBT is a design practice of reasoning, developing, communicating sets of solution in parallel but independently, understanding trade-offs, and finally narrowing respective sets of solutions based on additional information from other functions and customer. In line with [16], [11] claim adopting set-based practices encourages rapid learning, can eliminate rework at the root cause and the knowledge generated from SBT is often reusable for future projects.

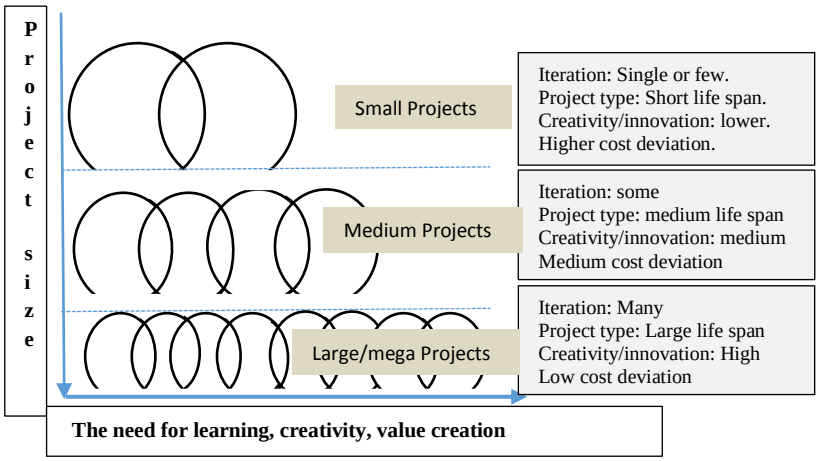
The peculiar characteristics of set based thinking is its fast learning process, event-driven solutions at different stages of the process. Set-based approach helps to converge different ideas (alternatives) into a single best solution. This process considered as a framework to enhance innovation and creativity. In this approach, the interaction between teams and different ideas are fast but the decision is late until the best idea comes out. SBT reduces the unnecessary prolonged iteration and support short cycle but fast iterations. Therefore, rapid learning plays a significant role to facilitate SBT. One important consideration in SBT is event- driven management that synchronize events as parts of a big project to solve special challenges (bottlenecks) throughout the stage gates. This literally means the process of breaking larger problems and challenges down into smaller but manageable parts that is in line with [10] proposal to handle complexity and diversification. By doing this and approaching SBT properly, it is possible to obtain four times more efficient than traditional stage-gate processes [6, 7, 8].

3.5. *Iteration management*

Development of KM strategy in construction require iterative activities as they evolve several complex activities (processes) and stakeholders. To withstand the challenges that are emanated from the complexity (diversification of activities) of the project, construction managers need good understanding on iteration management. According to [9] iteration can be seen from negative or positive perceptions. The first perception is the one that see iterations from its negative consequences. The type of iterations, which are unnecessary and do not generate value, are normally considered as a waste. On the other hand, the second perception claims the positive achievements of iterations on value creation, facilitating innovation and creativity.

Both the positive and negative effects of iteration has been discussed in construction literature but iteration management has been popular in product development. According to [10], managing several but diversified projects create complexity on management. The complexity may not because of the number of projects but also from the nature of the individual project complexities. Managing a single but complex and large project could be difficult than managing multi-projects that are small/medium sized with less complexity. Hence, the degree of requirement for iteration management and communication between teams of various discipline could vary accordingly. According to the general literature, long life span and complex projects could require iteration management more than the smaller life span with less complexity. Regardless on the levels of requirement in various sizes, complexities and life span of the project, systemic iteration management helps to acquire, analyze, store, disseminate information, and facilitate innovation and creativity in construction. Systematically managed iteration shortens the innovation cycle and can keep the construction industries competitive in the market.

Typically, having rapid, many iteration reduces risk, create opportunity for innovative (creative) ideas and finally lower the total cost of the project.



Research Question 3 What can construction projects benefited from these KM processes.

The ultimate aim of any construction of public infrastructures is to provide high standard and quality services to the public. This can achieved by fulfilling the goals of customer delight, which is exceeding the expectation of the public in this case. Therefore, it is important to make the public loyal to the construction, provide evidences that the public can be benefited (profitable) for the investment and create positive attitude about the construction.

To achieve these goals, it is important to show some explicitly measureable parameters together with intangible benefits of the construction build. Like projects in other disciplines, time, cost and quality has been used as a measure of performance in construction. However, constructing large public investment infrastructures requires and prioritize the overall satisfaction of the public. Because the investors (taxpayers) and one of the beneficiaries are the public, it important to make sure the construction project exceed the required expectation. To do this, all stakeholders should optimize resources and think beyond the specified project requirements in terms of time, cost and quality. Quality of service (i.e. technical, health, safety, environmental, etc.) should be the highest priority to satisfy the public. In this regard and for practical reasons, optimizing time, cost and quality needed for the feasibility of the project.

4. Practical discussions in light of Norwegian megaproject (E39 ferry-free coastal highway)

Norwegian public road authority (NPRA) have been responsible for several different sized construction projects. NPRA plans to construct one of the largest project (megaproject) known as E39 ferry-free coastal highway. It connects different cities and counties from Trondheim to Kristiansand. Although the expectations from E39 is huge as any megaprojects does, there are practical challenges that it should undergo, such as reducing the total travel time it took, crossing very deep fjords, topological challenges, use advanced and efficient technologies, etc. NPRA aims to reduce travel time by about half (from 21 to 12hrs.), facilitate and provide best transport services, safeguard the HSE issues.

Currently, the project is investigating various technologies and optimal solutions for the expected challenges, cost reduction strategies and implementation strategies, attempts to assess the wider impact and socio-economic benefits analysis etc. In the efforts to respond the challenges, lots of knowledge created from various stakeholders (NPRA, research institutes, etc.). There are various research groups (teams) working in different discipline with tacit and explicit knowledge. Advanced but diversified groups, teams, individuals, other internal and external stakeholders obtain this knowledge. Therefore, as the main questions discussed in section 3 and in connection with KM enhancement strategies, we will organize a systemic framework (next work) that could help E39 ferry-free fjord crossing coastal highway.

4.1. *The need for system thinking and system integration:*

Obviously, system thinking and system integration is important while planning to construct large public investment projects like E39. The issue is how project managers can wisely carry out system integration so that all the stakeholders obtain better knowledge about the project. In E39 project, several teams and stakeholders involved for the success of the project. So far, different teams, research groups and the management has carried out several research and activities. Although the current phase of the project is at fuzzy front end, where different alternative

ideas and technologies assessed, diversified ideas should converge to a single best solution. This can be achieved by implementing system thinking and integration. This provides fast feedback mechanisms for different teams working in different research institution, NPRA, and other stakeholders. The next work of this research would be develop a systemic framework for system integration through KM strategies.

5. Conclusion

Most construction projects are polylithic with several iteration, repeatedly changing processes and activities. To handle the unwanted changes, implementing a systematic KM strategy is eminent. As a part of this strategy, this paper introduces a conceptual learning and sharing matrix. It helps to determine systematically which project are better for learning and sharing. For example, smaller life span project found to be better for learning and the larger ones for sharing. The paper also discussed how to approach KM through the rapid learning strategies using set-based thinking, iteration management agile PM and planning. From the practical discussion of E39 ferry free coastal highway, the research highlighted the need for system thinking and integration. The future work will be synchronizing the aforementioned concepts in the systemic way and prepare a road map for KM implementation in megaprojects.

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