Developing a Comprehensive Framework for Evaluating Key Project Tasks

Li-Ren Yang

Abstract—**Research has poorly explored critical project tasks in implementing effective knowledge management. The primary objective of this research was to develop a comprehensive framework for evaluating key project tasks that influence knowledge management implementation. The second objective was to identify and prioritize the important project tasks using the analytic hierarchy process. The results suggest that "acquire site data," "prepare milestone schedule," "conduct conceptual technical feasibility analysis," and "maintain daily job diary" have a higher priority in implementing knowledge management. The findings also indicate that "detailed design from conceptual design,""produce environmental impact study," and "generate floor plans" may contribute to effective knowledge management.**

Index Terms—**Knowledge management, project, task, analytic hierarchy process.**

I. Introduction

Knowledge management (KM) may be seen as a source of sustained competitive advantage for organizations. Thus, research in knowledge management has made considerable progression exploring the relationship between knowledge management practices and organizational performance. These practices include knowledge storage, knowledge integration, knowledge sharing, and knowledge application. Knowledge management is one of the key elements in organizational performance. Adopting knowledge management practices may improve firms' competitiveness and enhance their performance.

Although knowledge management appears to be related to desirable performance outcomes, research has poorly explored critical project tasks in implementing effective knowledge management. Most knowledge management studies have focused more on knowledge management practices rather than on project tasks. Additionally, conceptualizing knowledge management in the project context is still rudimentary. There is thus a need to identify important project tasks that influence knowledge management implementation.

To address these limitations and advance the understanding of knowledge management in the project context, the primary objective of this research was to develop a comprehensive framework for evaluating key project tasks that influence knowledge management implementation. The second objective was to identify and prioritize important project tasks using the analytic hierarchy process. This study reveals the importance of adopting knowledge management to enhance cross-functional cooperation in project teams. The results offer guides to improve project success.

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II. Literature Review

Knowledge management is based on the idea that an organization's most valuable resource is the knowledge of its employees. Knowledge management adoption is defined as the use of knowledge management practices, includes knowledge storage, knowledge integration, knowledge sharing, and knowledge application [1]-[3]. Previous research suggested that construction industry uses relatively little formal managerial procedures when managing knowledge [4]. Interoperability has become recognized as a problem in the architectural, engineering, and construction (AEC) sector due to the many heterogeneous applications and systems typically in use by the different players, together with the dynamics and adaptability needed to operate in this sector [5]. Thus, new knowledge tools and methods would increasingly appear critical to alleviate various detrimental power effects associated with bureaucratic knowledge practices within project-based industries [6]. Knowledge management was found to be associated with a critical determinant of performance outcomes [7-9]. For the purpose of this research, task-level knowledge management adoption is defined as the use of knowledge management practices in project tasks [10]. Based on previous studies [11,12], a project is composed of tasks covering five project phases. Increased levels of knowledge management adoption in project tasks may enhance project-level knowledge management, which subsequently improving project performance [13].

Prior studies have shown that managing relationships is critical to project success [14], [15]. While project management knowledge tools have become increasingly important in construction, factors that influence members' interpersonal trust and willingness to share their knowledge in project teams are important issues [3]. Six most important types of management skills and knowledge are leadership, communication, motivation of others, health and safety, decision making, and forecasting and planning [10]. Successful projects are characterized by the effective management of both tacit and explicit knowledge [16]. Thus, developing knowledge transfer framework that encourages construction organizations to transfer knowledge between projects is beneficial [1]. Generally, knowledge management has been shown to play an important role in the performance of organizations or projects. Effective through-life management of built facilities requires effective through-life knowledge management to support it [17].

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III. Research Design

This research was divided into two phases. Phase 1 included determining the applicability of the proposed project tasks. Phase 2 prioritized important project tasks using the analytic hierarchy process.

A. Phase 1 Research

A survey was developed to investigate the degree, if any, to which the proposed project tasks apply to knowledge management implementation. The listing of project tasks, which resulted from a literature search [11], contained 61 items from different project phases. For the purpose of this study, a project's life cycle is structured in five phases: Front-End, Design, Procurement, Construction Management, and Construction Execution. The 61 project tasks in the five phases are presented in Tables I to V.

TABLE I: Project Tasks in the Front-End Phase

Project phase	Project task
Front-End	Conduct need analysis
Front-End	Develop, evaluate scope of work
Front-End	Model user's process
Front-End	Develop budget estimate
Front-End	Prepare milestone schedule
Front-End	Acquire site data
Front-End	Conduct conceptual technical feasibility analysis
Front-End	Produce environmental impact study
Front-End	Obtain permits

TABLE II: Project Tasks in the Design Phase

Project phase	Project task
Design	Access supplier product information
Design	Field input on construction methods
Design	Analyze construction methods
Design	Detailed design from conceptual design
Design	Generate floor plans
Design	Design fluid systems
Design	Design structural systems
Design	Design electrical systems
Design	Design HVAC systems
Design	Document budget assumptions
Design	Detect physical interferences
Design	Prepare specifications
Design	Check design against owner requirements
Design	Track design progress

TABLE III: Project Tasks in the Procurement Phase

Project phase	Project task
Procurement	Determine procurement lead time
Procurement	Conduct a quantity survey of drawings
Procurement	Link between quantity survey and cost estimating
Procurement	Link between supplier cost quotes and cost estimating
Procurement	Refine preliminary budget estimate
Procurement	Develop milestone schedule
Procurement	Develop and transmit requests for proposal to suppliers and subs
Procurement	Prepare & submit shop drawings
Procurement	Acquire & review shop drawings; send response
Procurement	Compile quotes into proposal
Procurement	Monitor fabricator progress
Procurement	Plan transportation routes of large items

TABLE IV: Project Tasks in the Construction Management Phase

Project phase	Project task
Construction management	Develop detailed construction schedule
Construction management	Track field work progress & labor cost code charges
Construction management	Maintain daily job diary
Construction management	Update cost forecast
Construction management	Communicate construction progress
Construction management	Track on-site material inventory
Construction management	Link field material managers to suppliers
Construction management	Develop short-term work schedules
Construction management	Communicate Requests for Information & responses
Construction management	Builders provide feedback about the effects of design changes made by owner or A/E
Construction management	Communicate changes to field personnel
Construction management	Communicate status of change orders to field
Construction management	Update as-built drawings
Construction management	Contractors submit requests for payment
Construction	Owner payment to contractor

TABLE V: Project Tasks in the Construction Execution Phase

Project phase	Project task
Construction execution	Evaluate subsurface conditions
Construction execution	Carry out earthwork and grading
Construction execution	Construct rebar cages
Construction execution	Weld pipes
Construction execution	Select the appropriate crane for heavy lifts
Construction execution	Provide an elevated work platform
Construction execution	Fabricate roof trusses
Construction execution	Manipulate and hang sheet rock
Construction execution	Acquire & record laboratory test information
Construction execution	Finish concrete surfaces
Construction execution	Apply paint or coatings

Application of the project tasks was based on interviews with construction practitioners. The industry interviews encompassed ten executives from the Owner, Architect/Engineering (A/E), and General Contractor (GC) groups. Each of the professionals has over 20 years of senior management experience in the industry. For each proposed project task, the survey asked the participants to assess the extent to which individual project tasks apply to knowledge management implementation. This survey offered respondents three optional responses: applicable, not applicable, or need to be revised. The survey allowed the participants to offer additional comments on a potential revision. The refined assessment items were included in the Phase 2 expert survey questionnaire. Finally, the Phase 2 survey makes use of 18 important project tasks in assessing their relative importance.

B. Phase 2 Research

To address the issue regarding prioritization of project tasks, this research employed the analytic hierarchy process as a suitable multicriteria decision analysis tool. Analytic hierarchy process is one of the most commonly used multicriteria decision analysis tools. This approach requires a hierarchic structure where criteria are mutually independent. The analytic hierarchy process model includes all contributive factors (clusters and nodes) in the decision structure. The clusters and nodes used in the model are based on the project phase and items identified in Phase 1. The Phase 1 results show that items associated with the construction execution phase are not included. The structure used in this model is presented in Figure 1. In other words, Figure 1 lists the 18 key project tasks used in the analytic hierarchy process model. The relevant criteria are structured in the form of a hierarchy. The expert survey encompassed 15 executives from the Owner, Architect/Engineering, and General Contractor groups. Each of the professionals has over 20 years of senior management experience in the industry.

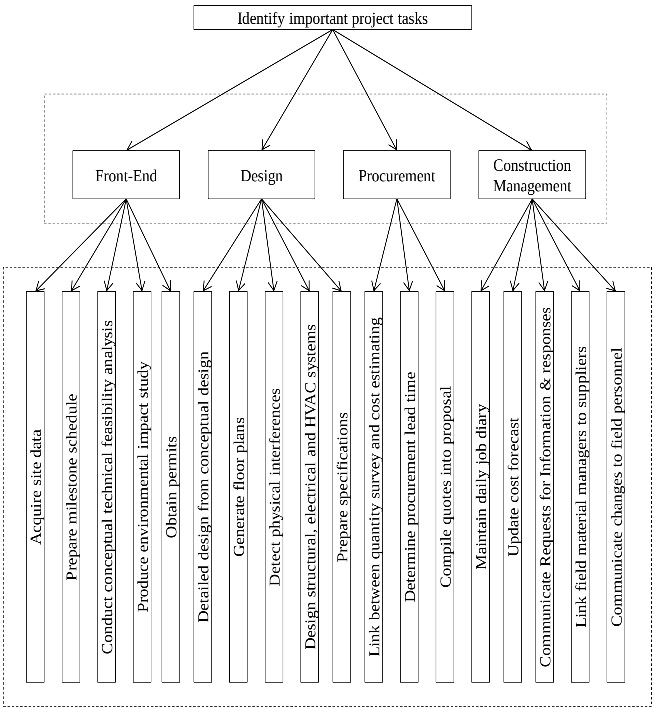

Fig. 1. Analytic hierarchy process structure.

In the analytic hierarchy process model, pairwise comparisons of the elements in each level are conducted with respect to their relative importance towards their control criterion [18]. As such, with respect to any criterion, pairwise comparisons are performed in two levels (i.e., the element level and the cluster level comparison). The intensity assigned to the comparison process between factors was made using Saaty's 9-point scale. Saaty [19] has suggested a scale of 1 to 9 when comparing two components, with a score of 1 representing indifference between the two components and 9 being overwhelming dominance of the component under consideration over the comparison component. After all pairwise comparisons were completed, the inconsistency of judgments was checked using the consistency ratio (CR). For acceptable inconsistency, CR must be less than 0.20 [20]. Group assessment was integrated using geometric mean [20]. Finally, the priority of the project tasks was identified.

IV. Results and Analysis

The Phase 1 results show that items in the construction execution phase are not included in the structure. The listing of project tasks, which resulted from applicability analysis in Phase 1, contained 18 items. Therefore, these project tasks for each of the four phases (i.e., Front-End, Design, Procurement, and Construction Management phases) were selected for further analytic hierarchy process analysis. The analytic hierarchy process model makes use of 18 project tasks in the Front-End, Design, Procurement, and Construction Management phases in assessing prioritization.

This model was used to prioritize the project tasks. The structure used in this model is presented in Table VI. The relevant criteria are structured in the form of a hierarchy. In this model, the first level below the goal is the project phases: Front-End, Design, Procurement, and Construction Management phases. The topmost elements (project phases) are decomposed into subcomponents (project tasks).

TABLE VI: Criteria in the Analytic Hierarchy Process Model

Category (Project phase)	Item (Project task)	Weight	Ranking
Front-End	Acquire site data	0.058	1
Front-End,	Prepare milestone schedule	0.057	2
Front-End,	Conduct conceptual technical feasibility analysis	0.057	3
Front-End,	Produce environmental impact study	0.033	6
Front-End,	Obtain permits	0.030	8
Design	Detailed design from conceptual design	0.039	5
Design	Generate floor plans	0.031	7
Design	Detect physical interferences	0.026	10
Design	Design structural, electrical and HVAC systems	0.025	11
Design	Prepare specifications	0.021	14
Procurement	Link between quantity survey and cost estimating	0.016	16
Procurement	Determine procurement lead time	0.015	17
Procurement	Compile quotes into proposal	0.011	18
Construction Management	Maintain daily job diary	0.041	4
Construction Management	Update cost forecast	0.028	9
Construction Management	Communicate Requests for Information & responses	0.023	12
Construction Management	Link field material managers to suppliers	0.022	13
Construction Management	Communicate changes to field personnel	0.020	15

In analyzing the prioritization by using the analytic hierarchy process approach, the priorities of the project tasks were determined. The priorities of the 18 project tasks are also presented in Table VI. For the item level, four project tasks (weights were over 0.04) stood out as being very important from the viewpoint of the Owner, Architect/Engineering, and General Contractor groups: “acquire site data,” “prepare milestone schedule,” “conduct conceptual technical feasibility analysis,” and “maintain daily job diary.” The findings also indicate that “detailed design from conceptual design,” “produce environmental impact study,” and “generate floor plans” may contribute to effective knowledge management. From the perspectives of the Owner, Architect/Engineering, and General Contractor groups, the three relatively least important project tasks (weights were below 0.02) are “link between quantity survey and cost estimating,” “determine procurement lead time,” and “compile quotes into proposal.”

V. Conclusions

While the diverse benefits of knowledge management have received substantial attention, the number of studies dealing with critical project tasks in implementing effective knowledge management is rather scarce. Thus, the primary objective of this research was to develop a comprehensive framework for evaluating key project tasks that influence knowledge management implementation. The second objective was to prioritize important project tasks using the analytic hierarchy process. The results suggest that the four most important project tasks were “acquire site data,” “prepare milestone schedule,” “conduct conceptual technical feasibility analysis,” and “maintain daily job diary.” The findings also indicate that “detailed design from conceptual design,” “produce environmental impact study,” and “generate floor plans” may contribute to effective knowledge management. This indicates that project managers need to be especially aware of the importance of these project tasks during the planning of a project. On the other hand, the findings also indicate that the relatively least important project tasks are “link between quantity survey and cost estimating,” “determine procurement lead time,” and “compile quotes into proposal.”

The paper provides value to practitioners by providing a general model for project task evaluation and to researchers by demonstrating a new application of analytic hierarchy process. This strategic decision making tool assisted the project managers in executing project tasks. Although the decision levels involved in any particular project may be different depending on the activities involved, the analytic hierarchy process model presented is a general model applicable to most capital facility projects. In addition, the basic framework in this model can be adapted to a particular situation. Project managers may select a set of criteria which are important for a particular project. In other words, a criterion that a project manager considers to be critical may be added to the general model. On the other hand, the model did not consider all possible criteria. As discussed previously, the listing of project tasks was too long to allow respondents to complete the analytic hierarchy process survey in a reasonable amount of time. Therefore, a systematic method for eliminating some of the less important project tasks was developed. Depending on the project environment, additional criteria could also be added. Additionally, the weighting given each criterion in the analytic hierarchy process model may be dependent on the particular situation of a project.

The research results offer guides to project planning process. Findings from this study are helpful to project managers in deciding what priority each project tasks has in the architectural, engineering, and construction sector. Project managers can use the research results to executing project tasks and modify their current project planning. While the model presented provides value, there are issues for future validation. Future research may also develop different models to validate and compare their efficacy. In addition, case studies may be conducted to validate the models and determine which project alternatives would best meet the company’s goals. Another objective for future study is to develop task evaluation models and investigate the prioritization of project tasks for the other industries (e.g., high-tech industry or traditional manufacturing industry). Finally, Delphi approach can be used to achieve consensus of opinion in the preference weightings.

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