Applying a Systematic Building Block to Project Knowledge Management

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Abstract
Current project management tools can record only project task performance, and not the knowledge context acquired from the project. This study proposes a prototype model that integrates knowledge context parameters into project management tools, such as PERT. This new model of project knowledge management tool uses building blocks to construct the entire project knowledge and flow management. To verify the feasibility of this model, a mapping model is used to demonstrate that this prototype may promote more effective project knowledge management, including evaluations of knowledge and of the knowledge executor, through integration of the knowledge context and PERT. We provide implications of our work for academics and practitioners, directions future research might take, as well as opportunities and prospects for commercialization of the proposed approach.

Keywords: Knowledge context, Project knowledge management, Building block

1. Introduction
Project management consists of a repetitive procedure that aims for a series of goals, each of which the members of a project team must strive to fulfill [1,2]. However, various uncertainties, primarily caused by changes in external information, exist in the process of project implementation and may become the obstacles to the success of a project. In fact, the lack of effective knowledge management approach often leads to project team members’ repetitive, needless collection of the same information or the lack of updating of old information with new information. Such a waste of human resources and the gathering obsolete information may contribute to a project’s failure [3].

There are plenty of project management applications available on the market, and each comes with its proprietary database, however, such a database does not have a system concept and is unable to record the knowledge context. In other words, such a project management tool cannot record project knowledge management process. To effectively manage the knowledge track for project management, the existing project management tools must be enhanced.

Section 2 presents the literature study of knowledge creation and knowledge management as a reference for the enhancement of the project management pattern. Section 3 describes the concept of a building block, sets the fundamental building block that enables input and output of information, data, and knowledge context, and elaborates on the features of a building block created with knowledge. Section 4 explains how this model records project flow and project knowledge context with three PERT nodes by integrating building blocks of knowledge context and PERT.

2. Background
Similar to knowledge management in enterprise, the KM for a project is a process that creates values from the intangible assets of team members [4-6]. Simply put, KM focuses on processing information and acquires useful information; its key elements lie in the decision-making process and include data, information, knowledge, and processes generated from individuals and organizations [7-9]. Knowledge is a capacity that allows application of knowledge, and context can be found in the creation of knowledge [10].

Machlup and Mansfield define data as an object for the analyzer, investigator, and problem solver; such an object may be number, word, sentence, record, assumption, etc. [11]. Tesky proposes that data is the result of a direct observation of an event [12]. Meadow defines data as a series of basic symbols [13]. Therefore, the concept of data can be summarized as: (1) data is an event recorded in simple symbols and is oftentimes reliable fact; (2) there is no relevance among bits of data, and there is no conceptual and meaningful level structure in a data cluster; and (3) data has no specific user or purpose of use. Thus data itself is a combination...
of text, numbers, and pictures, which are the original components of information.

Machlup defines information as a necessary medium that triggers and creates knowledge. It may enhance or reconstruct knowledge [14]. Charles T. Meadow and Weijing Yuan propose that information is a process that converts a received message, data, and signal into knowledge [15]. Therefore, the concept of information can be summarized as: (1) information is the presentation of processed data, and (2) information is a part of knowledge dissemination. Thus, information comes from the consolidation of data and represents a certain concept.

Purser and Pasmore define knowledge as an aggregation of fact, pattern, concept, opinion, and intuition that are used in decision-making [16]. Badaracco defines knowledge as truth, principle, and idea acquired from human activities [17]. Polani proposes that knowledge is a multi-element concept with inexplicit and explicit multiple meanings [18]. Davenport points out, based on the features of knowledge, that knowledge is a mixture of fluid matters that include structured experience, value, and information in the form of writing, that includes unique views of experts, and that provides a framework for the evaluation, integration, and information of new experience [19]. Therefore, the concept of knowledge can be summarized as: (1) a record of accumulated experience; (2) a systemized information organization, and (3) a behavior or state of reasoning. Thus, knowledge is an abstract that conveys concepts through a certain form, and knowledge only comes from information that has been deliberated by the human mind [16-19].

The creation of knowledge involves the process of inference [20], which is divided into induction and deduction. Nelson refers to induction as backward reasoning that obtains results and achieves goals by categorizing or defining with the rule that concerns a question, as illustrated in Figure 1. Deduction is, on the other hand, referred to as forward reasoning that generates more or newer knowledge through a certain set of rules or inspiration until a certain result has been achieved, as illustrated in Figure 3. The rule of the reasoning that can be explained with a certain method is explicit knowledge and that which cannot be explained is inexplicit knowledge. Usually the process of knowledge creation includes a mixed use of both. The solid circles in Figures 1 and 2 represent external data or information, and the blank circles represent the answer generated with the rules of the induction or deduction of knowledge; the circles end when the goal is reached.

The theory of type and creation of knowledge suggests that data and information are induced and deduced with the rules of reasoning by the human brain into useful knowledge to achieve a goal. Oftentimes the creation of knowledge involves both induction and deduction, but the basic principle concerns data input and knowledge output. Therefore, this study applies the concept of knowledge creation onto PERT, a project management tool currently being used to systematically record the knowledge track within a project.

Figure 1: Illustration of knowledge creation by induction

Figure 2: Illustration of knowledge creation by deduction
3. Mapping model

From the discussion in Section 2, it can be realized that there is a contextual relationship among data, information, and knowledge. The issue being dealt with is how to systematically manage the data, information, and knowledge context of a project. Some scholars have proposed structures and models that offer good references, including PM tools that integrate systematic concepts [21], as well as a building-block approach to improve an organization’s operational program model [22], and applying a knowledge strategy program within an organization [23]. Section 3.1 sets up a fundamental building block to connect the vertical project knowledge context and the horizontal project flow. Section 3.2 describes the features of the vertical project knowledge context.

3.1 Horizontal flow of project and vertical context of knowledge

The application of the building block in project knowledge and context project flow can be divided into two parts. The first part is the vertical part, which is the parameter flow of project data, information and knowledge. Such concepts derive from the unified modeling language, or UML, [24] used in computer-aided software engineering. UML is a graphic flow tool used in the analysis phase of software development and is applied in the analysis of database systems. The other part is the horizontal part, which is the project flow. Its concept derives from Program Evaluation and Review Technique, or PERT; a common project flow management technique.

The building block originates from the above-mentioned concepts of vertical and horizontal processes, and is the fundamental element for systematically processing project data, information, knowledge, and project flow, as illustrated in Figure 3. The vertical part is the input/output of knowledge creation process, where the building block functions as the rule of knowledge creation. The horizontal part is the in/out in the implementation of project procedure, and the function of the building block is the process for project flow. Because of the stackability feature of the building block, the executor must be recorded when the building block represents a node. According to Badaracco, knowledge is defined as the truth, principle, and idea acquired from human activities [25]; the use of the building block can also track the performance of an executor who is engaging with a project node.

3.2 Features of R&D project knowledge context

The concept of knowledge context in the vertical building block derives from the information analysis system by referencing and modifying the integrated system analysis and project management pattern proposed by Gelbarda [26]. The process of knowledge creation discussed in Section 2 reveals that the core of knowledge management concerns the contextual relationship among data, information, and knowledge. The process of project implementation may be subject to external data, which may include enterprise data or market data. Such data may change from time to time while a project is being implemented and may influence the procedure and result of such a project. Meanwhile, it is also the origin of the creation of project knowledge, and therefore its contextual relationship must be recorded for further review and improvement of the project.

The external data for the project as previously mentioned is the most primitive data parameter for the implementation of a project. Project members in turn transform such data through a certain set of rules or method into useful information for the project. Such information is transformed with experience and intelligence and then presented in the form of knowledge. Such rules, method, experience, and intelligence are the knowledge context with which the team members implement a phase of a project until the produced knowledge achieves the goal. Because the building block involves operating data and information with different types of parameters, such types of parameters are color coded for differentiation; this concept is illustrated in Figure 4. The external data, such as data1, data2, data3, and data4, generates info01 and info02 through BB1 and BB2. These pieces of information then generate know01 through BB3. Because the operation of parameters is an irreversible procedure, the input and output of parameters are represented with dotted arrows.
4. Mapping prototype

In mapping prototype, horizontal project flow connects the project knowledge context of the building block with three nodes. Project management flow is established on the base of Program Evaluation and Review Technique, or PERT. The concept of PERT regards project task as a node, and the dependency among tasks is used to plot the critical path. PERT is a network diagram that allows the project manager to control the progress and status of a project. Every node in a project that is based on PERT has its required task goal, and team members will consolidate the external data into information and then knowledge to achieve the operational goal. However, there is no effective method or model to manage the data, information, and knowledge within the project flow, and this is the feature of the model. The model proposed by this study achieves the knowledge management with vertical input and output of parameters. In other words, a procedure is given to the knowledge creation contextual relationship.

A project flow is the connecting of nodes with solid lines, or connecting building blocks as illustrated in Figure 5. The first level is the project level; the example has three nodes. The project level is the simplest form, identical to the traditional PERT form. The difference is that the input of the data parameter and the output of the data parameter and the knowledge parameter at node2 can be seen. Theoretically, the output of the data parameter should include the info01, but the info01 is hidden in the illustration. This means that team members may use discretion and decide whether or not the parameter output is revealed. In addition, there is a folded line to the bottom right of the node icon; it represents that this node can be expanded. The second level is the node level, which is node 2 in expanded form. It reveals that node02 includes two sub-nodes. Taking sub-node1 as an example, data01 through data04 are data input, hidden, as is info01 in project level. It can be seen that the output parameters are info02 and know01. The third level is sub-node level. The function of the sub-node is to wrap the building blocks with a vertical relationship in terms of information and knowledge, as illustrated in Figure 4. In sub-node2, for example, input of data05 and data06 at BB3 produce the output of info03, which is the input for BB4, where output of know02 is produced. The fourth level is building block level. At this level, multiple information building blocks are required when completing the operation of knowledge before sufficient information may be acquired. Therefore, BB1 in expanded form reveals BB11 and BB12, each of which produces outputs of info01 and info02, respectively.

The expansion and retraction of the building block may simplify the graph and sufficiently reveal the contextual relationship among content, data, information, and knowledge covered in a project node, offering further analysis information for appraisal of the project result and for project procedure improvement. In addition, the information and knowledge produced at different nodes serve as the input for successor nodes.

5. Discussion and conclusions

Current studies have contributed to the direct integration between project knowledge context and PERT. Furthering this integration, this particular study provides an integrated stackable, multi-level model structure in which PERT in/out and the knowledge parameter in/out of UML are combined on building blocks. Using such an integrated tool in project management may help to reduce the traditional ignorance about production of knowledge. Traditional project management is constrained to storing information and knowledge produced in the project process in a database for future retrieval; it is not concerned with how the knowledge is produced. This model, however, shall simultaneously provide supervision of the knowledge executor to remedy the fault in the decision-making and determine the person best suited to this decision-making.

Figure 4: Illustration of project knowledge context
Figure 5: Connected nodes and building blocks in project flow
Without such a bi-directional, integrated building block model, the evaluation of the reasonability of knowledge creation, knowledge value, the knowledge executor’s performance, and the effectiveness of such decisions with traditional project management methods such as PERT and CPM will be extremely difficult. There are three contributing reasons:

1. The evaluation of project knowledge must be based on quantitative data or the context with which the knowledge is created, and it relies on the result of the analysis provided by the team members after the project is completed. However, most of the team members in a project are not involved in the analysis phase of knowledge evaluation [27, 28].

2. The methods used for project knowledge value evaluation have difficulty in covering the creation of knowledge at partial nodes; even in the evaluation of the overall project knowledge, there is no contextual relationship available for diagnosis.

3. Basically the evaluation of project knowledge is conducted by an experienced but subjective project manager or supervisor at a higher level, or by comparing with previous similar projects, or by first segmenting the project into smaller parts, such as different phases, for separate reviews; all such evaluation methods lack objective criteria.

In addition to the above-mentioned three shortfalls resulting from not using the building block project management method, the mapping model proposed in this study offers the following advantages:

1. The mapping model allows effective and controllable evaluation of project knowledge through the contextual relationship of the systematic knowledge creation within the project because the direct input object and the direct output object of a building block can be compared with reasonable judgment.

2. The mapping model may extend the project knowledge performance and knowledge cost evaluation by calculating implementation time and personnel cost.

3. The development of the mapping model is based on the evaluation of the knowledge context, and the model can be applied to other project management methods and tools.

4. PERT may dynamically evaluate and control a project, report actual progress and provide comparison of actual project cost with a real-time update. On the other hand, it may also statically establish certain control methods in the project flow.

5. PERT allows drill-down analysis on some part of a project, especially the key processes that are critical to the success of the project, to lay down practical knowledge for achieving the goal. This part allows more functionality in the building block.

6. The potential drilling may offer earlier participation for the technical team or evaluation team and integration to the original team, allowing the entire project to be implemented faster with more reliable results.

The fact that conversion of a knowledge context to Pert/Gantt diagrams is actually a representation of a knowledge model as a semantic network opens opportunities for commercialization for practitioners. Gaines and Shaw [29] present a formal visual language that enables such a representation, and show how this language can represent a knowledge model in a document, either within a word processor or within a Web browser. Based on their work, the prospects are good for commercially expanding the proposed mapping model, in the future, to support virtual development teams on the Web.

In summary, this study has revealed a possible and effective project knowledge context to be introduced into PERT. The mapping model using pert node as a knowledge context element that covers the input and output of data, information, and knowledge parameters, can potentially improve estimation, planning, and control of the project knowledge context, including the controls of original time, human resources, and cost. Building block project knowledge management may prevent losing control due to lack of data and information and other project elements, and allow early analysis, evaluation, and monitoring in the project evaluation analysis phase.

6. References


