ESTABLISHING THE KM-ORIENTED BPR MODEL FOR CONSTRUCTION FIRM - A CASE STUDY

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Abstract

This study proposed a KM-oriented BPR model to assist managers to implement the knowledge management in the construction firms. Two philosophies, namely the (1) Business Process Reengineering (BPR) and the (2) Knowledge Management (KM), were combined in the addressed KM-oriented BPR model to ensure the KM operations can be merged with the business processes. That is, by using the proposed model, the current processes can be reengineered to be a new KM-oriented process so that the KM operations can be implemented by the regular activities. To reengineer a KM-oriented process, both of the single-loop learning and double-loop learning utilized in the KM theory were applied for improving knowledge-intensive processes in construction firm. Based on the single and double loop learning mechanism, a knowledge gap analysis was addressed in this study to determine the weakness of processes for satisfying with the functional requirements of KM operations. Summarily, this study combined the knowledge management mechanism with the business process reengineering philosophy to assist managers in design a KM-oriented process, so that a foundation for KM implementation can be established finally.

KEYWORDS: Knowledge Management (KM), Business Process Reengineering (BPR), construction firm, Architecture of Integrated Information System (ARIS).

INTRODUCTION

Due to the huger scale, numerous kinds of participating professional personnel, long life cycle and complicated interface, quite gigantic and complicated relevant information was produced with construction projects. Hence the operation processes of construction firm possess high complexity and have high feedback demand for knowledge and experience (Carrillo et al., 2004). In recent years, the construction industry has already raised the agitation for paying attention to Knowledge Management (KM). However, the KM activities that the construction industry engaged are mostly in such categories as file management, knowledge community, etc., and the implementation of KM and business activity are unable to be integrated effectively.

Business Process Reengineering (BPR) (Hammer, 1990) is pioneered to be a revolutionary concept for business administration in recent years. Its opinion lies in the radical deliberation for business administration and completely renovates the operation processes, in order to obtain progressive improvement on the performance of business. Most businesses regard Information Technology (IT) as the essential role to involving in BPR. However, the special demand of construction firm is unable to be satisfied if the key knowledge that supporting the operation processes is not discussed. Therefore, how to incorporate KM in business operation process and turn it into a part of routine assignments becomes a subject to be urgently investigated.

This research integrates two major methods, i.e. BPR and KM, which assist business upgrade to establish the KM-oriented BPR model which could merge KM on the routine assignments and promote the innovative and competitive abilities of businesses.

A SUMMARY OF KM-ORIENTED BPR MODEL

Evolvement of the Role That KM Acted in the Business Operation Processes

In the traditional business output and feedback mechanism, the professional knowledge has already implied and operated in the business processes. However, the business doesn't pay much attention on it, and the relevant knowledge and experience usually retain on individuals only. When the personnel are fluctuated, the above-mentioned knowledge is also taken away thereupon, and the permanent losses of business are caused. Establishing the Organization Knowledge Base is to exteriorize the feedback mechanism of the business processes and utilize the assistance of IT to conserve the relevant knowledge and experience of the business processes effectively and reused by the demander. This is called the first generation KM (Cheng and Huang, 2008) which focuses on the collection and conservation of business knowledge. The traditional data centre and the file digitization treatment in recent years both belong to this type of KM.

Utilizing the knowledge conservation system, businesses conserve a large amount of knowledge produced constantly in process circulation. However, it is difficult to found the necessary materials in the huge knowledge database by the demander and the obstacle to reuse the knowledge is formed. Therefore, KM focuses on the integration of the content of the knowledge database in recent years and provides an interface that is easy to use, in order to improve the efficiency and quality of business operation processes. This is called the second generation KM.

The gradual progress of the times impels business competition model to change constantly. Business process objective needs to adjust flexibly with competitive environment changed fast, in order to meet the reformation. For this reason, business should have the mechanism to detect the problems of the processes. New knowledge is produced by Knowledge Production (KP) operation and categorized to organization knowledge base for business to refer. Therefore, the new problems of business processes could be solved. This is called the third generation KM.

Concept of Loop Learning for KM

Businesses utilize experience and knowledge of organization knowledge base to carry out business process, and then send the feedback and achievement to the knowledge base. Such processes belong to organizational or individual learning model among the field of KM. It could be divided into two types, i.e. single-loop learning and double-loop learning, in accordance with the implementing characteristics.

The single-loop and double-loop learning of KM model showed in Fig. 1 includes three major KM activities, i.e. 'Knowledge conservation', 'Knowledge integration' and 'Knowledge production'. The first two items have already had a lot of ripe theories, methods, information technology and platform to be provided for supporting. However, 'Knowledge production' that mainly purpose to solve the problems produced with business operation is still one of the researching focus for the KM fields at present. Besides the 'Knowledge creation' process, the 'Knowledge production' process should also include the 'Knowledge evaluation' process for verifying the effectiveness of the knowledge. Based on Fig. 1, this research utilizes the operation sequence of double-loop learning which was proposed by Argyris and Schön to assist and solve the problems that single-loop learning can't solve. The constructed concept of KM-oriented BPR model (Cheng and Huang, 2008) is shown as Fig. 1.

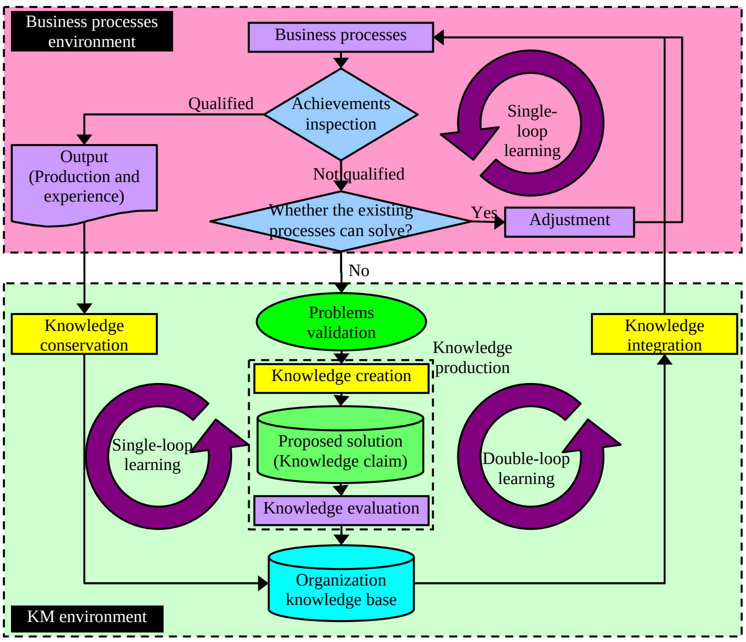

Figure 1: Conceptual sketch of KM-oriented BPR

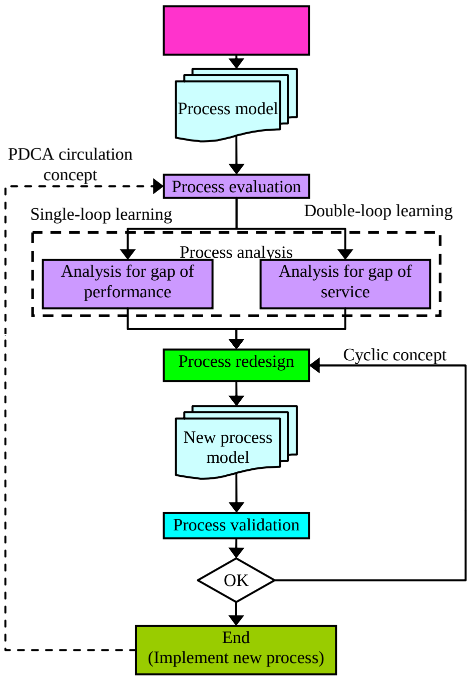

Figure 2: KM-oriented BPR model

Description of the Entire Scheme for KM-oriented BPR Model

Based on the BPR theory, this research develops the KM-oriented BPR model that fuses the concept and practice of KM and loop learning (McElroy, 2003) after deliberating the general BPR models on the literatures (Papavassiliou and Mentzas, 2003; Remus and Schub, 2003; Cheng and Tsai, 2003). Its basic scheme (Cheng and Huang, 2008) is shown as Fig. 2. There are five main processes in this model, including process representation, process evaluation, process analysis, process redesign, and process validation.

IMPLEMENTATION AND APPLICATION OF THE KM-ORIENTED BPR MODEL

Introduction of the Verification Case

This research selected construction firm A (establishing time for about 30 years, amount of capital for about 900 million NTD) as an example to verify the usability of the KM-oriented BPR model. It is expected to be able to promote the business process efficiency and quality, and also provided as the reference for the person who quotes this model.

Process Representation

'Process representation' is to express the process as the modelling type, in order to facilitate the follow-up assessment and analysis activities. This research established the relationship between process task and of knowledge utilizing 'knowledge/operation subject matrix'. The interface relations among the reengineering process and the other processes were deduced by the matrix, therefore the process model could be constructed by process model method. The steps of the process representation are illustrated as follows:

Identify for relevant knowledge and operation subjects in the processes

The business process is composed of a lot of business activities and knowledge subjects which are correlating with each other. This step aims to define the operation and knowledge subjects of the reengineering process clearly. Hence they could be provided for constructing the 'knowledge/operation subject matrix'. The construction firm offered relevant data, including the projects obtaining, constructing and management, etc. Therefore the inventory of relevant operation and knowledge subjects could be arranged from the business executing information, such as 'bidding forms', 'contract forms', 'purchase/subcontracting forms', 'quality forms', 'constructing forms', and 'financial forms', etc.

Develop of knowledge/operation subject matrix

The operation subjects obtained from the last step were listed in the first column of matrix one by one, while the knowledge subjects were listed at the top of the matrix. The corresponding relations between knowledge and operation subjects were then filled in to complete the matrix. In the matrix, C (Create) means produce knowledge, U (Use) represents read/revise/delete, and the blank means irrelevant with each other. Rearrange the operation subjects and adjust the order of knowledge subjects to allow the C to be represented from the top left to the bottom right. Then classify the operation subject with the close characteristics as the same process. According to the analysis of the operation category of the process of construction firm, the processes were rearranged into eight group, i.e. 'Business Management', 'Human Resource', 'Financial Accounting', 'Bidding/Contract', 'Cost Estimates/Construction Planning, 'Purchase/Subcontracting', 'Construction Management ', and 'Postsales Service'.

Process modeling

Knowledge view: This research incorporates 'analysis of process knowledge' of Eppler et al. (1999) into the 'knowledge/operation subject matrix', and defines categories of knowledge applying the U/C relations, and selected the Purchase/Subcontracting process to implement the reengineering. In the knowledge/operation subject matrix, the knowledge subjects with the symbol U and located on the left side of the Purchase/Subcontracting interval are 'Knowledge about the process', which was produced by the other process. The knowledge subjects with the symbol C or U and located inside the Purchase/Subcontracting interval are 'Knowledge within the process'. The knowledge subjects with the symbol U and located on the upper or lower side of the Purchase/Subcontracting interval are 'Knowledge derived from the process', which was produced by this procedure.

Role view: Expressing the participant in the process by 'Role view' accords with the execution model of the Purchase/Subcontracting process, which often serve customers by way of 'project'. This step focuses on the operation subjects that the process category contains. Scan one by one in accordance with the actual tasks, all roles that need to participate in the process execution could be therefore defined. According to the practical experience and above-mentioned processes interface, it is known that the roles participating in the Purchase/Subcontracting process includes three ones, i.e. 'cost controlling agent', 'purchasing agent' and 'constructing director'.

Function view: The operation subjects that the process category contained were executed the function decomposition one by one. It can be seen that the main operation subjects for the Purchase/Subcontracting process of construction engineering should contain six part, i.e. 'Purchase/Subcontracting budget planning', 'subcontracting task', 'change order', 'assessing subcontractor', 'Purchase/Subcontracting budget inspecting', and 'Purchase/Subcontracting performance inspecting'.

Control view: After finishing above-mentioned three process views, this research utilizes the extended Event-driven Process Chains (e-EPC) to connect various kinds of details of the process in series, and the process operation model could therefore be established.

Process Evaluation

'Process evaluation' must first draft target components with 'customer orientation'. Then measure the expectative and actual achievement degree of target component that process activities contribute, in order to confirm the necessity of process reengineering. Furthermore, it could be served as the reference basis for assessing the problems of the process.

Determination of target components

Adopting the idea of the 'quality function deployment method', this research transforms the demands of the customer correlated with the process into target components after investigating and arranging, and evaluates the relative importance of each target. The customer correlated with the process could be divided to two types. The first one is the internal customers which are the parties participating in the process, and also the process 'role' that the procedure model defined. The other is the external customers who are the consumers accepting the products of the process, and is generally the owner or cooperation enterprises. After validating the customers, their requirements could be comprehended via interview and questionnaire, etc.

Analysis of target component importance

The relative importance of target components is identified utilizing the relative importance weight matrix (Cheng and Tsai, 2003). In the matrix, customers' demands are listed vertically on the left-hand side, while target components are listed at the top. According to the relationship between the two, the corresponding number r_{ij} is determined. The higher r_{ij} value is, the more the target accomplishes customers' demand. Then, considering the emphasis that customers place on each demand, represent it as p_i and fill it in on the right-hand side of the matrix. The higher p_i value is, the more the demand elicits customers' attention. Finally, use Eq. (1) to calculate the score of the relative importance (w_j) of each target component.

$$w_j = \frac{\sum_{i=1}^{m} r_{ij} \times p_i}{\sum_{j=1}^{n} \sum_{i=1}^{m} r_{ij} \times p_i} \times 100 \tag{1}$$

where

w_j = relative importance weight for target component j

r_{ij} = corresponding rating between j^{th} target component and i^{th} customers' demand, r_{ij} = 0 ~ 5

p_i = emphasis degree of i^{th} customers' demand, p_i = 1 ~ 5

m = number of customers' demands

n = number of target components

Analysis of target component achievement

The target component achievement matrix is utilized to calculate the achievement of each target that the existing process complete. The operation subjects are placed on the left, and the target components and the scores of the relative importance (w_j) are listed at the top. The mutual relationship with each other were investigated, and the expected contribution degree value A_{ij} (A_{ij} = 0.0 ~ 1.0, $\sum_{i=1}^{m} A_{ij} \leq 1.0$) and actual value a_{ij} (a_{ij} = 0.0 ~ A_{ij}) of each operation subject were inserted into the corresponding position. Then calculate the values utilizing Eq. (2) ~ Eq. (10), and complete the table.

$$CE_i = \sum_{j=1}^{n} A_{ij} \times w_j \tag{2}$$

$$CR_i = \sum_{j=1}^{n} a_{ij} \times w_j \tag{3}$$

$$EA_j = w_j \times \sum_{i=1}^{m} A_{ij} \tag{4}$$

$$Ra_j = w_j \times \sum_{i=1}^{m} a_{ij} \tag{5}$$

$$G_i = \sum_{j=1}^{n} (A_{ij} - a_{ij}) \times w_j = CE_i - CR_i \tag{6}$$

$$TEA = \sum_{j=1}^{n} EA_j = \sum_{i=1}^{m} CE_i \tag{7}$$

$$TR_a = \sum_{j=1}^{n} Ra_j \tag{8}$$

$$G_{sv} = 100 - TEA \tag{9}$$

$$G_{pf} = TEA - TR_a \tag{10}$$

where

CE_i = *expected contribution degree value of i^{th} operation subject*
CR_i = *actual contribution degree value of i^{th} operation subject*
EA_j = *expected achievement value of j^{th} target component*
Ra_j = *actual achievement value of j^{th} target component*
w_j = *relative importance weight for target component j*
n = number of target components
m = number of operation subjects
G_i = *gap between expected and actual contribution degree value of i^{th} operation subject*
TEA = total expected achievement value of all target components, TEA = 0 ~ 100
TRa = total actual achievement value of all target components, TRa = 0 ~ TEA
G_{sv} = *gap of service*
G_{pf} = *gap of performance*

The calculated *TEA* value is 77.5, so that G_{sv} is 22.5. It indicated that the operation subjects the present process contains can only serve about 3/4 of the target components at most. This is defined as the gap of serve of the process in this research, and will be redesign utilizing double-loop learning. On the other hand, the *TRa* value is 58.5, hence the gap of serve of the process G_{pf} is 19. This part must be improved and strengthened by single-loop learning.

Process Analysis

Gap of performance of the process - single-loop learning

From the four major views of process modelling, it is known that the factors influencing process efficiency include 'knowledge subjects' of Knowledge view, 'organizational human resources' of Role view, 'operation functions' of Function view, and 'logical relationship' of control view. Among them, the knowledge subjects will course obvious influence to the process. Hence this research investigated the relationship and their degree between knowledge subjects and process efficiency in accordance with the knowledge orientation, and established a 'knowledge subject contribution degree accessing matrix', in order to verify the important knowledge of the process.

The target components, operation subjects and knowledge subjects possess extremely complicated relationship, so that it is difficult to obtain the contribution state of knowledge subject to the target component directly. Therefore, this research derives excepted contribution degree values of knowledge subjects for target components according to the above-mentioned structure, and then assesses the real contribution degree values. The knowledge subjects that caused lower target component achievement were therefore obtained, and they were just the part that should be strengthened while reengineering.

Gap of serve of the process - double-loop learning

Knowing from the process evaluation stage, some target components can not be achieved via existing process, and this gap is unable to obtain by analyze gap of serve of the process. Therefore, this research adopted double-loop learning model of KM to investigate this part. The operation and knowledge subjects that should be added or modified are analyzed and verified, in order to improve the total achievement of all target components.

Utilizing Knowledge-Life-Cycle constructing sheet analysis for the gap of serve in the Purchase/subcontracting process, there are 12 KM operation subjects involved in the existing process problems. Among them, 'quote the unit price analysis data' have possessed in the existing process, but has not connected with historical database. So that it should be revised. The other 11 items have not provided by the existing procedure, and should be classified as the newly-added subjects. On the other hand, there are 12 relevant knowledge subjects in all that are concerned with the existing process problems. The ' ratify the standard purchase/subcontracting budget and application form' item has already possessed in the existing model. The other 11 items should be classified as the newly-added subjects.

Process Redesign

Verifying the principles of process redesign

According to the comprehensive investigation to the target component achievement matrix in the process evaluation stage, detail analysis for gap of efficiency and service in the process analysis stage, and the practical experience, the principle of process redesign could be verified.

Establishing the new process model

This step established the new process model in accordance with the principle verified before. However, the modelling procedure should be revised as:

1. Control view: Based on the e-EPC chart before reengineering, fuse the above-mentioned principles of process redesign and establish the e-EPC chart for the new process.

2. Function view: Revise the existing operation subjects of the process based on the e-EPC chart of the new purchase/subcontracting process.

3. Role view: For making contribution to experience feedback mechanism, the new process accrue 'conservation of the purchases/subcontracting knowledge' item, in order to make process efficiency more complete.

4. Knowledge view: Through the analysis of the new process e-EPC chart, the revised knowledge subjects could be obtained. The new-added knowledge subjects are all for responding the new purchases/subcontracting process.

5. Knowledge/operation function matrix: Reviewing the knowledge, role, function, control views separately, the revised knowledge/operation function matrix could be obtained.

Process Validation

After reengineering procedures, the new process should be estimated in advance in accordance with the demand, in order to validate the result and performance of reengineering. This research adopts the efficiency and cost of the process to assess the process performance. Calculate the process value (*PV*), which is defined as the 'executing efficiency per unit cost', to serve as the basis for assessing the process performance. If the new process value is greater than existing process value, the result of the process reengineering is eligible.

$$PV = TEA/TC \qquad (11)$$

where

TEA = total expected achievement value of all target components, TEA = 0 ~ 100

TC = total cost of the process

Evaluating the achievement of new target components

While evaluating the operation efficiency of the new purchase/subcontracting process, the expected achievement degrees of every operation target were assessed one by one. It can be found that the expected contribution degree value of the operation subjects is up to 96.6, which is obviously higher than 77.5 that the existing process is. It indicated that the process after reengineering can fill the gap of service that the existing process can't cover.

Analyzing the cost structure of the process

A process is composed of a lot of activities that possess input/output relationship, and therefore the process cost can be obtained through cumulating the total cost of every single cost of the activities. In view of the above, this research adopted the concept of 'Activity Based Costing (ABC)' measurement to distinguish the cost structure of the process (Cheng and Tsai, 2003). Depending on the professional and technological construction management service of the construction firm, the executed business processes usually belong to knowledge-intensive process. 'Manpower' is the main consumed resources in the process, so that the occupation rate is much higher than the sum of the other resources. Hence this research proposes the analysis of the cost structure of the process to consider the human resources of every operation subjects only, in order to simplify the analysis burden substantially, and does not lose the significance that the analysis result represents.

Comparing the total cost of the new process to that of the existing process, it possesses a slight increasing trend of cost. It is because that the new process accrued a lot of operation subjects. The two operation subjects with the higher cost rate in the existing process, i.e. 'establishing the unitary analysis', and 'establishing the detail budget items of Purchase/subcontracting', are revised as 'adjusting the unitary analysis' in the new process, and the cost rate is obviously decreased. It indicated that the expected achievement of reengineering have already procured.

Evaluating the improvement of process reengineering

Via analyzing the operation efficiency and cost of the processes before and after reengineering respectively, it can be seen that the PV evaluation is $\frac{77.5}{347,500}(\text{before reengineering}) < \frac{96.6}{422,000}(\text{after reengineering})$. It indicated that the operation efficiency per unit cost of the new process is superior, namely the reengineering achievement can be accepted.

CONCLUSIONS

This research focused on the integration and application of the two management theories, i.e. BPR and KM. Regard a construction firm as the object, establish the KM-oriented BPR model, and take the purchase/subcontracting process as the example to verify it. The obtained research results are concluded as follows:

1. This research established a process model utilizing four major views, i.e. knowledge, role, function and control views, and cooperated with operation/knowledge subjects matrix. The relationship between the operation model of the business process and the organizational knowledge could be clearly expressed. It can be served as the KM-oriented BPR model.

2. This Research uses KM as the main instrumentality to establish the KM-oriented BPR model, and fuses the concept of the single-loop and double-loop learning to the process analysis. The KM could be implemented into the daily operation process, in order to strengthen business's competitiveness.

3. Regard knowledge production, knowledge evaluation and knowledge integration as the most important tasks in the forming and reusing processes of organizational knowledge, the service gap of existing process could therefore be completely comprehended.

4. Utilizing the KM-oriented BPR model this research addressed to execute the process reengineering for the purchase/subcontracting process of the construction firm, the performance and service efficiency of the process could be significantly improved.

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