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Industrial knowledge management using collaborative knowledge acquisition in a consultancy project

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Industrial management and organisation

ABSTRACT

Purpose: This paper proposes an industrial knowledge management approach that employs BSC and KPI to manage the consultancy project and uses collaborative tools to integrate the knowledge from the consultant teams and the industrial partner.

Design/methodology/approach: Project composes of five consultant teams that are in charge of five different modules: production, quality, technology, finance and marketing. These five consultant teams have to collaborate and share their experiences and knowledge in order to get synergies and to achieve the common goal. For the future consultancy projects, industrial knowledge base should be constituted.

Findings: The industrial knowledge management system reduces the iterations of gathering information due to the overlapped tasks of the consultant teams, and permits them to discuss on the problems, negotiate and compromise the contradictions toward the common goal.

Practical implications: The Thai government project – MDICP, supported by the ministry of industry, aims to develop and improve the competitiveness of Thai SMEs.

Originality/value: Many industrial companies were driving their business based on their empirical experiences and skills. However, to stay in today's competitive environment, only the empirical experiences and skills are not sufficient. As industrial knowledge is a part of observations, experiments and experiences from people in different functions, the companies have to integrate such inconsistency knowledge to acquire a sustainable development. Therefore, knowledge management becomes a necessity to drive the companies to achieve the common goal.

Keywords: Project management; Industrial knowledge management; Collaborative; Consultancy project; SMEs; BSC; Multi-discipline

1. Introduction

Industrial knowledge is a part of observations, experiments and experiences from various people in different functions. Most of Thai SMEs ignored to capture such inconsistency knowledge to develop sustainability for the organization. On the other hand, they continued driving their business based on empirical experiences and skills. Since the economic crisis and the floating of Thai currency in the last decade, many SMEs have been collapsed. Moreover, the impacts of FTAs (Free Trade Agreements) and the globalization (global market, global manufacturing) have made rapid changes to business environment. Thus, driving the business based on the empirical experiences and skills are not sufficient enough to stay in today's competitive environment.

There are more than 2.2 million of SMEs (Small and Medium Enterprises) in Thailand which represents around 99% of all enterprises [8]. These SMEs play an important role in Thai economy in term of labor employing, making value-added of raw materials/products, exporting, etc. The ministry of industry realized the importance of these SMEs then it has recently launched a project to support the Thai SMEs under the name, "Manufacturing Development to Improve Competitiveness Programme" (MDICP). This project aims to raise competitiveness of Thai SMEs to be able to compete in global market. Consultant teams are currently required for Thai SMEs in order to point the fundamental problems of the organization and then advise resolutions to solve the problems. In this project, there are five consultant teams who are in charge of five different modules as following:

1) Production – This module concerns mainly in production management and manufacturing process planning and control.
2) Quality – This module concerns in quality system and is based on the ISO standard.
3) Technology – This module concerns mainly about the information system of the company.
4) Finance – This module has to manage the financial and accounting system including purchasing control of the company.
5) Marketing – This module concerns mainly about customer' requirements, sales order quantity, as well as, strategy planning.

These five modules are concerned by various persons from different functions of the company. In addition, their tasks are overlapped with one another. Each module has different objective but the same goal. Thus, the consultant team of each module has to cooperate with one another as a multidisciplinary team. Yet, the industrial partner must provide the relevant information and constraints to the consultant teams. This study proposes a collaborative knowledge acquisition in a consultancy project. The objective is to integrate the industrial knowledge from the industrial partner and the knowledge from the consultant teams based on theoretical approach. At this time, management tools are needed in order to gather the participants to cooperate together to achieve the common goal. BSC (Balanced Scorecard) is used as a measurement tool of the project. It manages the company's strategy and helps support the teams to understand the strategy in the same notion. Constraints of the teams and problems of the industrial partner must be presented at the early of the project. Thus, a collaborative environment is needed to help support the team to share and exchange their information and knowledge, and also to state their constraints. The constraint sharing makes the teams to understand one another. The knowledge sharing and exchanging enhance the teams to find out the possible solutions in problem-solving process. As a result, the industrial knowledge base is constituted based on the concept of product model [3]. The empirical experiences of the industrial partner and the knowledge provided by the consultant teams will be captured in semantics and systematic form including component, link and relation. This product model permits the teams to associate their knowledge to the module and make relation to other relative modules.

2. Knowledge management context

The concept of Knowledge Management (KM) becomes more predominant in many organizations since they have recognized the importance of "to know what they know", which is their intellectual asset especially in the age of information. AIAI [1] defined the knowledge assets as the knowledge, regarding to markets, products, technologies and organizations, that a business owns or needs to own and which enable its business processes to generate profits, add value, etc. KM is not only about managing the knowledge assets but managing the processes that act upon the assets. These processes include: developing knowledge, preserving knowledge, using knowledge, and sharing knowledge. It involves the identification and analysis of available and required knowledge assets which are related to processes, and subsequent planning and control of actions to develop both the assets and the processes to fulfill organizational objectives.

Malhotra [7] defined the definition of KM as following:
"Knowledge management caters to the critical issues of organizational adaptation, survival and competence in face of increasingly discontinuous environmental change. Essentially, it embodies organizational processes that seek synergistic combination of data and information processing capacity of information technologies and the creative and innovative capacity of human beings".

2.1. Knowledge management framework

Malhotra [7] continued describe that KM focuses on 'doing the right thing' instead of 'doing things right'. It is a framework within which the organization views all its processes as knowledge process. In this view, all business processes involve creation, dissemination, renewal and application of knowledge toward organizational sustenance and survival. KM is considered as a business activity with two aspects: first - treating the knowledge component of business activities as an explicit concern of business reflected in strategy, policy and practice at all levels of the organization, the second one is to make a direct connection between an organization's intellectual assets – both explicit and tacit – and growth.

Based on the study of Van der Spek and de Hoog [17], the knowledge management framework can be described as following:

1) Identifying what knowledge assets a company possesses
   - Where is the knowledge asset?
   - What does it contain?
   - What is its use?
   - What form is it in?
   - How accessible is it?
2) Analyzing how the knowledge can add value
   - What are the opportunities for using the knowledge asset?
   - What would be the effect of its use?
   - What are the current obstacles to its use?

- What would be its increased value to the company?

3) Specifying what actions are necessary to achieve better usability and value-added
   - How to plan the actions to use the knowledge asset?
   - How to enact actions?
   - How to monitor actions?
4) Reviewing the use of the knowledge to ensure value-added
   - Did its use produce the desired added value?
   - How can the knowledge asset be maintained for this use?

The proposition of using KM is to achieve the objectives and the common goal of the organization. Thus, the executive managers must firstly set the company's direction and strategy plan. To transform the strategy plan to practicable approach, management tools are required.

3. Management tools

Once the company has defined its mission and goals, strategy management is one of the key success tools that assist the company to achieve the goal. We can divide a company's strategy into two levels: organization strategy and business strategy. The organization strategy guides the direction and the act approach of company (where to compete) while the business strategy shows the company's method (how to compete). In the consultancy project, the five consultant teams must perform their tasks following the company's business plan. BSC is a well-known tool for transforming the strategy plan into practicable approach.

3.1. Balanced scorecard

In this study, BSC is applied to manage the company's strategy and is used as a measurement tool of the project. BSC helps keep the company to focus on its strategy. BSC and KPI (Key Performance Indicators) aim to measure the performance of the company in four perspectives including financial perspective, customer perspective, internal process perspective and learning and growth perspective (originated by Robert Kaplan and David Norton and first introduced in Harvard Business Review article, in 1992). These tools are used to transform the company's strategy (both of organization strategy and business strategy) into the strategy map that the business plan must be consistent with. The strategy map presents the rational relation among different objectives of those four perspectives. It translates the company's strategy into operational terms which permit the members in the company and the consultant team to better understand the company's strategy. Figure 1 shows an example of a strategy map of an organization based on the concept of BSC. Once the strategy map has been created, the company must extend the strategy map into objectives, KPI, target and initiatives following the BSC concept as shown by example in Figure 2.

One of the key aspects of KM is the collaboration among various experts from different disciplines as well as the consultant teams, who are in charged of different functions of the company. Though, BSC enhances them to better understand the strategy, it does not support the collaboration during performing their tasks. Thus, a collaborative tool is required to model the industrial knowledge management system.

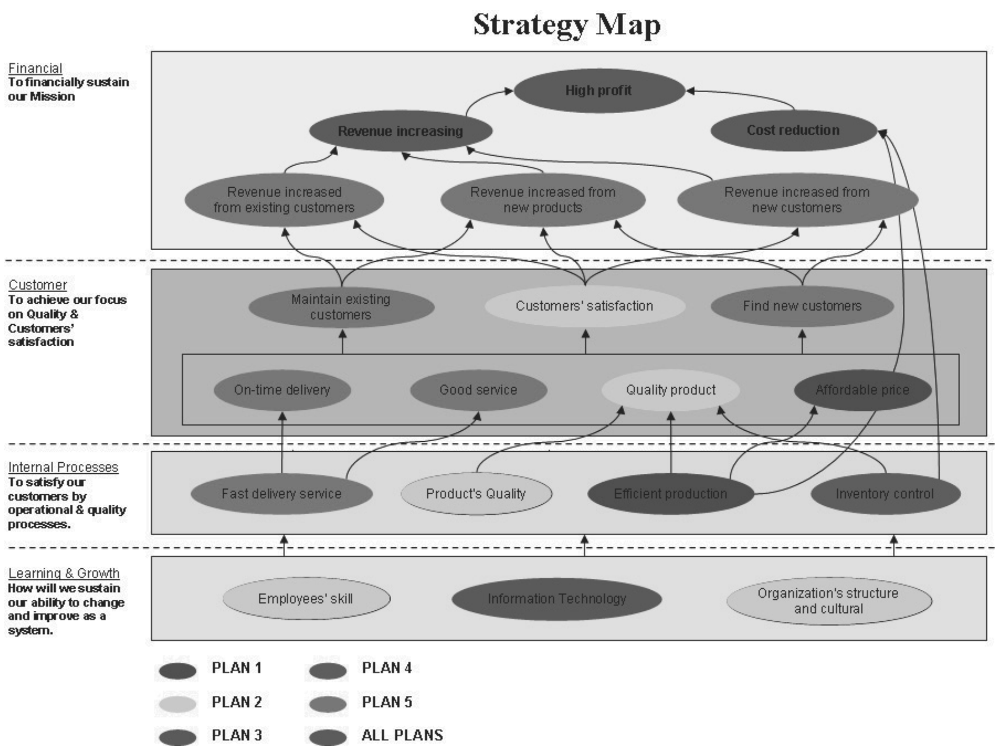


Fig. 1. Strategy map with the four perspectives (modified from Decharin, [4])

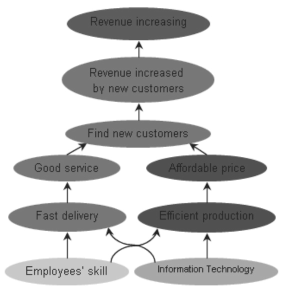
Strategy Map	Objectives	KPI	Baseline Data	Target	Initiatives
	Revenue increased from new customers	Revenue from new customers/ All revenues	10%	15%	
	Find new customers	Number of new customers	10	20	Launch campaingns
		Quantity order per customer	100	125	Propose various services
	Affordable price	Yield of materials	75%	> 80%	Cutting stock model
		Idle time (affects labor cost)	1 hr/man/day	20mins/man/day	Man-power management
	Efficient production	Percentage of defect	< 15%	< 8%	Implement QCC activity
		Capacity	70%	80%	Implement PM technic
	Develop employees' skill	Days of training	7 days	10 days	Continuous training plan
		Turnover rate	< 15%	< 10%	Activities for employees

Fig. 2. Translation of strategy map into kpi, target and initiatives (modified from Decharin, [4])

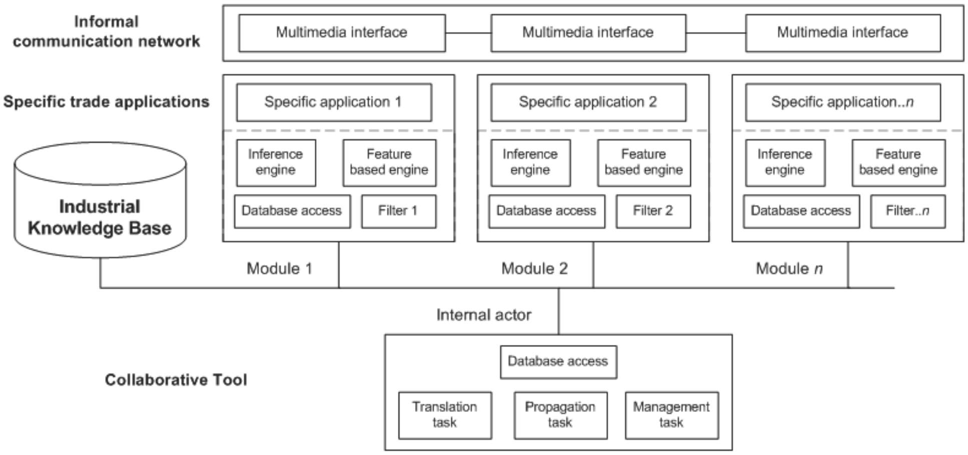


Fig. 3. Concept of industrial knowledge management system [12]

3.2. Collaborative tool

In this study, we use Cooperative Design Modeler (CoDeMo) as the collaborative tool in knowledge acquisition. Based on the concept of CAID [13], CoDeMo is developed to support the collaborative design (both of synchronous and asynchronous mode). CoDeMo is a client-server system that gives an access to multiple actors (the consultant teams and the industrial partner) who work on the same project [14]. According to the consultancy project, each participant uses a client process to manipulate data (and as well information and knowledge) through a GUI (Graphic User Interface). Based on the multi-view and multi-representation concept, the client process permits the participants to access to the shared knowledge base. The server process stores data and information in the common database, and also distributes relative information to concerned participants. In addition, the internal actor [15] manages three tasks in CoDeMo i.e. keeping the coherence of the information among the five modules and industrial partner (propagation task); translating the relative information to the concerned participants (translation task); and finally, managing the conflicts of information between the modules (management task).

The collaborative environment created by CoDeMo permits the participants to create new data and also to edit, modify or update information into the shared database. Figure 3 presents the concept of industrial knowledge management system that is composed of three parts i.e. the collaborative tool (CoDeMo itself including the industrial knowledge base), specific applications (can be considered as external tools) that help support the teams in evaluation and problem-solving process, and the third one, informal communication network that provides communication channels to the teams such as audio and video conferences, file sharing, web-based service tools, etc.

3.3. Product model concept

KM approach maintains the experiences and knowledge gained by the organization and the consultant teams. It tends to model expert knowledge and create problem-solving solutions. The experiences and knowledge will be translated in forms of rules, facts, cases, procedures of reasoning. The heterogeneous data and information from various sources and formats should be manipulated by using semantics and attributes and integrated into the common database [16]. According to the study of Chapa Kasusky [3], product model is a model of informatics that is comprised of knowledge model and data model. It is constituted by associating knowledge model into data model, as shown in Figure 4 (c).

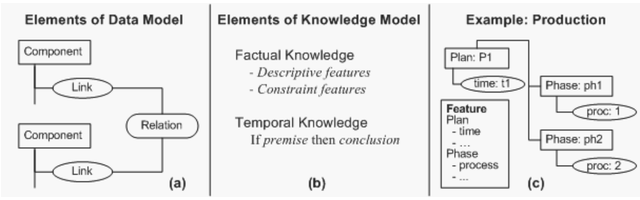


Fig. 4. Product model associated of data and knowledge model

Data Model

The data model is considered as a skeleton that stores coherent descriptions of product. It is composed of three types of object i.e. component, link, and relation as shown in Figure 4 (a).

- A component represents the description of a product. It may describe physically a part, a set of parts, or a portion of part. It can also be a set of materials, a temporary element before manufactured, depending on the actor in a specific trade view. A component is an instance of a feature and its characteristics.
- A link is associated with a characteristic of a component or an association of characteristics which it addresses. As name defined, it is used as a connecting node between components.
- A relation represents a connection between two links or more, and is associated with a constraint feature. The relation which connects the links from the same component will be 'behavior'.

Knowledge Model

Knowledge model allows the teams to associate their knowledge or describe relative information to the product with their own comprehension, vocabulary, and manner. It can be characterized into two categories: factual knowledge and temporal knowledge as shown in Figure 4 (b). According to the study of Gaucheron [5], knowledge can be classified into three significations as following:

- Vernacular knowledge – represents the knowledge relative to specific participant(s) and is always available to the specific participant(s) who created it.
- Vehicular knowledge – can be recognized and used by several participant(s) of different teams, who are interested in the same information. This knowledge is considered as communication object which can be exchanged between two or more participants. It must support the coordination between the participants where negotiation and compromise are needed.
- Universal knowledge – can be recognized and used by everyone. This kind of knowledge is usually stored in the shared knowledge base. This knowledge facilitates the notion of collaborative working and allows the participants to negotiate to have the same notion.

4. Collaborative environment framework

In the research field of Computer Supported Cooperative Work (CSCW), researchers try to deal with the problem of how collaborative activities can be supported by means of computer systems; how to model collaborative work; which computer based facilities should be provided? [2]. Mechekour (2006) classified computer supported collaborative work into two typologies: space-time typology and functional typology. The space-time typology depends on whether the workgroups are working in the same place or different place, and at the same time (synchronous) or different time (asynchronous). The functional typology is based on the functional aspect that is decomposed into three spaces for collaboration: Communication space, Co-operation space, and Coordination space.

Johansen [6], Chapa Kasusky [3], Gaucheron [5], Roucoules and Tichkiewitch [12], and Pimapunsri [9], a shared workspace should be created to support the experiences and knowledge acquisition between the industrial partner and the teams. Figure 5 shows the collaborative environment of the industrial knowledge base that supports the knowledge integration. The information and knowledge using in this environment is classified into three types as described in the previous section. The consultant teams have their own knowledge that exists in their mind. This layer of individual knowledge is called vernacular. However, some information and knowledge have to be shared to the concerned participants to help support in the problem-solving process. This layer of knowledge is considered as vehicular knowledge. The third one allows the participants to work with the same notion, and must be shared to all participants. It is known as universal knowledge. The collaborative environment permits the participants to access to the shared knowledge base and also be able to add, edit, or update information regarding to their authority.

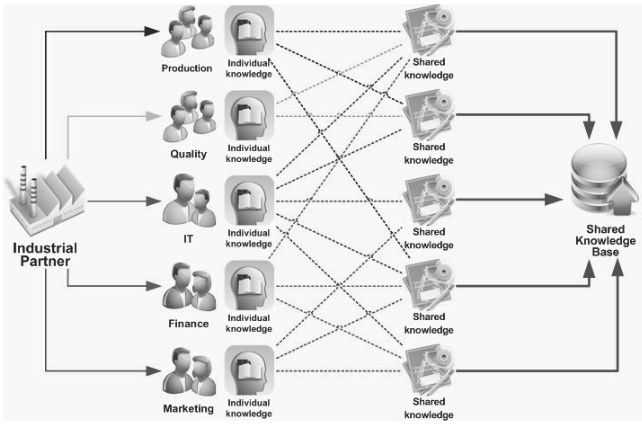


Fig. 5. Collaborative environment of industrial knowledge management

4.1. Collaborative knowledge acquisition model

The participants must be presented, at the beginning of the project, to work together in the collaborative environment. The industrial partner must firstly provide the information relevant to the problems or selected topics to the teams. Then, the consultant teams have to discuss and negotiate on the problems to find possible solutions regarding to the constraints. Figure 6 shows the cycle of knowledge integration. The industrial partner and the consultant teams are linked together by the collaborative tool and act as a multidisciplinary team. The consultant teams would employ these following tools to constitute the industrial knowledge base:

- Production – PPC (Production and Planning Control), BOM (Bill of Materials), MPS (Master Production Scheduling), MRP (Material Requirement Planning), CRP (Capacity Requirements Planning), SFC (Shop-Floor Control) and may also include PM (Preventive Maintenance).
- Quality – ISO standard, QMS (Quality Management System) that includes QC tools and sampling tools.
- IT – MIS (Management Information System) and DBMS (Database Management System).
- Finance – ABC (Activity Based Costing), BEP (Break Even Point Analysis), PM (Purchasing Management) and Inventory Control that is linked to the Production module.
- Marketing – CRM (Customers' Relationship Management), PERT/CPM (program Evaluation and Review Technique/ Critical Path Method), and SCM (Supply Chain Management) that concerns the involvements through the chain of suppliers and customers.

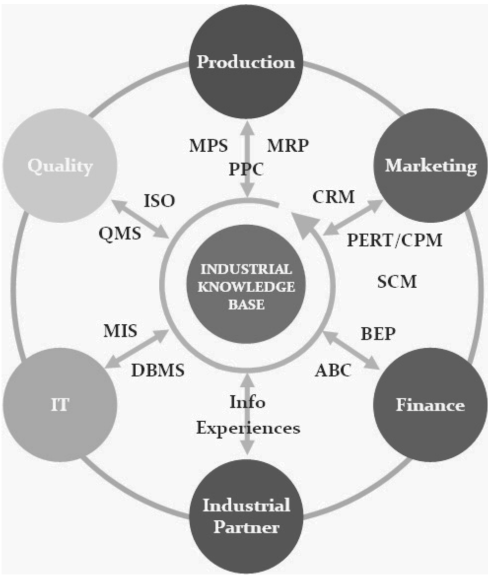


Fig. 6. Cycle of knowledge integration

According to the proposition of Malhotra [7], this concept embodies a transition from the concept of "information value chain" to a "knowledge value chain". The knowledge value chain treats human systems as key component that engage in continuous assessment of information archived in the technological system. In this view, the human actors do not implement best practices without active inquiry. Human actors engage in an active process of sense making to continuously assess the effectiveness of best practices.

4.2. Industrial knowledge management system

The industrial knowledge management system presented in Figure 7 is constituted of:

- The industrial partner that are, here, the companies who joined in the MDICP project, have to provide their empirical experiences, knowledge and necessary information to the system. This information will be transformed into systematic forms and semantic structures (data model and knowledge model) that are stored the industrial knowledge base.
- The consultant teams, who are in charge of solving-problem/ decision-making processes, have to provide their systematical knowledge that will be integrated with the information and the experiences from the industrial partner to the system.
- Information system means the collaborative system and management tools using in the system. It is used to capitalize the knowledge from the participants in the system. It permits the consultant teams to work together in a collaborative environment in order to discuss on the problems, negotiate and compromise the contradictions toward the common goal.
- Industrial knowledge base is in fact a part of the collaborative system (see Figure 3). It stores the data model, factual knowledge and temporal knowledge provided by the industrial partner and the consultant teams, which are used in the problem-solving/ decision-making processes of the teams.

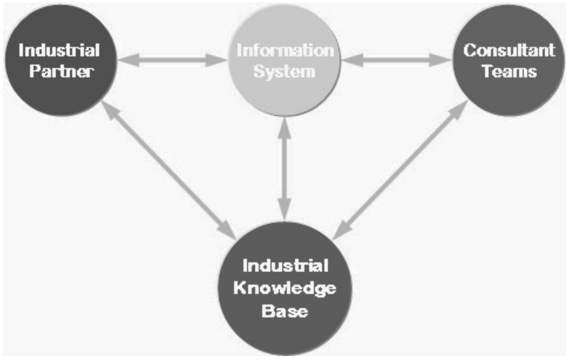


Fig. 7. Industrial knowledge management system

5. Implementation of industrial knowledge management system

According to the strategy map in the Figure 1, assume that the topic "Affordable price" from customer's view is chosen to be discussed to satisfy the customer's satisfaction. "Affordable price" means product price that the customer is capable to buy within his effort. To set the product price, the product unit cost must be analyzed. We can divide the sources of the production unit cost into three groups i.e. material cost, labor cost, and overhead cost. Table 1 shows the involvements of the five modules in production unit cost analysis. In fact, the overhead cost may consist of more than three sources as shown by example in the Table 1.

From the Table 1, the materials using in the production are definitely concerned by the following modules: production, quality, finance, and marketing. The members in the production module have to define the material's specifications that the finance (purchasing) module can procure with lower cost. Moreover, the chosen materials must be accorded with the standard's requirements of the quality module and also satisfy the customer's requirements in term of price and quality. In the aspect of labor cost, increasing the actual capacity by the mean of reducing idle time in the manufacturing processes also contributes the lower product unit cost. Based on the concept of multi-actor and multi-view [3, 11], the involvements and relations between the product unit cost and the concerned trade views (modules) can be transformed into the product model as represented in Figure 8.

Table 1.
Involvements of five modules in production unit cost analysis

Modules \ Cost			Overhead		
	Material	Labor	Consumables	Administration	Transportation
Production	√	√	√	√	
Quality	√		√	√	
IT				√	
Finance	√	√	√	√	√
Marketing	√			√	√

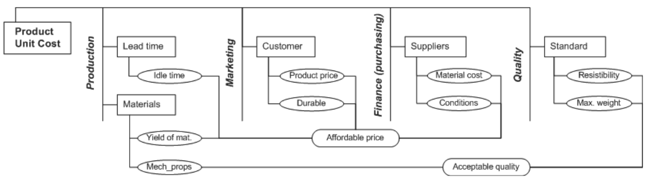


Fig. 8. Product unit cost analysis by multi-actor and multi-view

The participants can employ their specific application as external tools to evaluate their hypothesis or propositions as presented by example in Pimapunsri et al [10], a specific application for the manufacturer. This application provides results in evaluation of manufacturing process planning such as estimated manufacturing time and cost, direct material cost, etc. On the other hand, specific tools of any module would be integrated into the system to contribute information and knowledge to get synergies and achieve the common goal.

6. Conclusions

Based on the concept of KM, BSC, CWCS, and CAID cited in the references, this paper proposes the industrial knowledge management system for Thai SMEs in a consultancy project. The consultant teams and the industrial partner are brought into the virtual collaborative environment as a multidisciplinary team in order to find possible solutions to solve the company's problems. The knowledge value chain is created by the synergies of these participants. The information and knowledge that exists in the mind of the participants are pulled out and extracted to the shared workspace. The industrial knowledge management system reduces the iterations of gathering information due to the overlapped tasks of the consultant teams, and permits them to discuss on the problems, negotiate and compromise the contradictions toward the common goal.

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