Knowledge Management & E-Learning
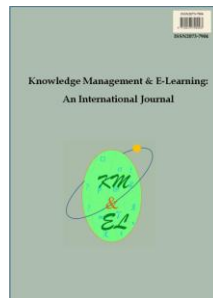
Measuring productivity of customer knowledge management in projects

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Abstract: Projects is one of the dominating modes of international business today. Companies interact with their customers in projects for a certain period. To explore the impact of customer knowledge management in such interactions, this paper promotes a measurement framework that can be used to measure the productivity of customer knowledge management. The measures are developed based on previous studies on customer knowledge management and project management. To verify the measures, this study conducted a survey involving 24 projects. The results of the study provide some insights into the impact of customer knowledge management in interactions between companies and their customers through projects.

Keywords: Customer knowledge management; Project management; Innovation; Customer satisfaction

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1. Introduction

The Oxford English Dictionary defines "project" as "an individual or collaborative enterprise that is carefully planned and designed to achieve particular aim. Holstius (1987) defined "project" as a transaction of a unitary function which is given to the buyer. Cova and Ghauri (1996) defined "project" as a complex transaction covering a discrete package consisting of products, services and other measures developed to establish the asset (capital) to the buyer at a certain time. Project operation is one of the modes that dominate international business today (Hadjikhani, 1996) because the product of industrial firms increasingly exhibits project-like features (Günter & Bonaccorsi, 1996). This is because the offerings from many international companies become more complex and systematic. This implies that industrial marketers should develop their capabilities to give more complex total solutions, including both tangible (product) and intangible (service) aspects (e.g., Grönroos, 1997). Project management study is extended to involve a customer-based approach, moving closer to the perspective adopted by project marketing (Gareis, 2002).

In marketing, a company that is focused on customers (Sheth, Sisodia, & Sharma, 2000) and driven by the market (Day, 1999) is considered a service company. Instead of just being customer-oriented, such a company also collaborates with and learns from customers and be adaptive to their distinctive and dynamic needs. This service centric logic implies that value is defined and co-created with the customer based on the value of usage, not based on determined output. One of service-centric models is learning and market-oriented organization (Vargo & Lusch, 2004). System sales and projects marketing have special characteristics, such as customized production, high value of unit order and the difference in terms of "know-how" between suppliers and customers (Backhaus, 1995; Günter & Bonaccorsi, 1996). These characteristics also emphasize the need to establish special knowledge about the project; the most valuable knowledge that is formed during the project, in the process to learn from the customer's problems (Meyers & Athaide, 1991). Companies collaborate with their customers to foster their performance in innovation and competitive advantage. Employing customer knowledge in the project increases the level of customer satisfaction and leads to the company's sustainability.

To build good relationships and collaboration with customers, each customer should be served well, thus employing customer knowledge management (CKM) is necessary (Davenport, Harris, & Kohli, 2001). CKM is the activity that manages the customer knowledge (Gibbert, Leibold, & Probst, 2002). CKM is an approach to make the customer knowledge a part of corporate knowledge (Garcia-Murillo & Annabi, 2002). CKM changes the role of customers from passive recipients of products or services to active knowledge partners. CKM strengthens, disseminates and expands customer knowledge for the sakes of both the customer and the company (Gibbert, Leibold, & Probst, 2002). Unlike the customer relationships management (CRM), which aims to learn the customer to make adjustments on every interaction, the CKM approach is purposed to learn from customers and to understand the required customer knowledge (Garcia-Murillo & Annabi, 2002).

Many companies find implementation of CKM to be very difficult, and only a few can run CKM well (Gibbert, Leibold, & Probst, 2002; Davenport, Harris, & Kohli, 2001). One of the reasons for this difficulty is the absence of an adequate framework for understanding CKM (Bose & Sugumaran, 2003). In addition, CKM is defined and implemented in diverse ways, so ease of implementation depends on how a company defines CKM (Rowley, 2005; Gebert, Geib, Kolbe, & Brenner, 2003). Many studies have discussed applying CKM for knowledge creation, innovation and competitive advantage for new value creation, e.g. Gebert, Geib, Kolbe, & Brenner, 2003, Gibbert, Leibold, and Probst (2002), Belbaly, Benbya, and Meissonier (2007), and Kohlbacher (2008).

There are studies on knowledge management implementation in project environments (Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003; Lehtimäki, Simula, & Salo, 2009; Kanapeckiene, Kaklauskas, Zavadskas, & Seniut, 2010; Reich, Gemino, & Sauer, 2012). Lehtimäki, Simula, and Salo (2009) conducted a qualitative study on project marketing and knowledge management in the relationship between buyers and sellers of a project. However, the study of customer knowledge management in projects is still limited. This paper is intended to fill this gap. A study on management of customer knowledge in buyer-seller relationships throughout a project could help seller firms to improve their activity in managing their relationships with their customers and increase the prospect of subsequent projects. To develop the measures to analyze the productivity of customer knowledge management (CKM) in projects, this paper utilizes theories of CKM and project management.

2.   Problem statement

There are many papers related to knowledge management, customer knowledge management and customer knowledge co-creation in terms of process, influencing factors and performance. However, research on the management of customer knowledge in projects as a unitary system and strategies to improve performance is limited. Based on this finding, the problem to be solved in this paper is how to measure the productivity of customer knowledge management in projects.

3.   Research purpose

The purpose of this paper is to develop a framework to measure the productivity of customer knowledge management in projects. This framework will be useful in further studies of how to improve the performance of the management of customer knowledge in the relationship between firms and customers. Based on the idea that knowledge

management could foster the value added, measuring the productivity of customer knowledge leads to good return on investment and organizational performance improvement.

4. Methodology

The methodology of this research consists of four stages: literature review, measurement framework development, testing and description. The literature review stage consists of analysis and synthesis of previous research studies related to the process, influencing factors and the outcome of customer knowledge management. The measurement framework for customer knowledge management is developed in the measurement framework development stage. The relationship between the knowledge enabler, knowledge creation, intermediate outcome and organizational performance of a knowledge management system is depicted in Fig. 1. This diagram is used to develop the measures of productivity of customer knowledge management in this study.
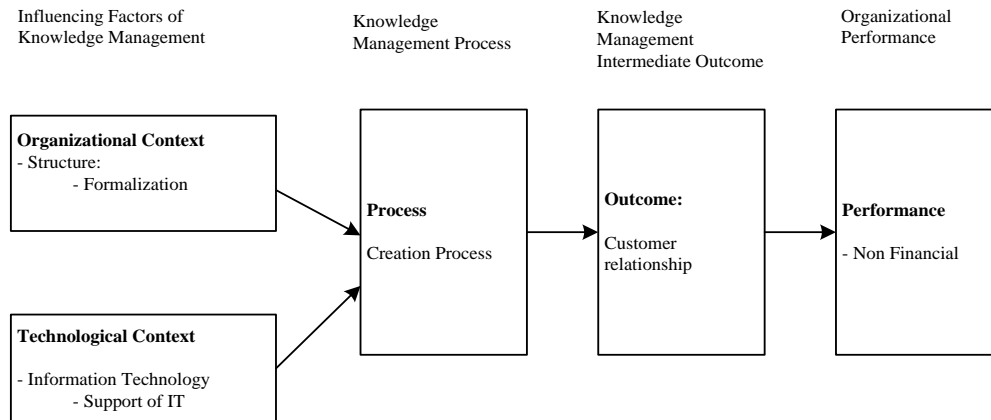
Influencing Factors of
Knowledge Management

Knowledge
Management Process

Knowledge
Management
Intermediate Outcome

Organizational
Performance

Organizational Context
- Structure:
     - Formalization

Process

Creation Process

Outcome:

Customer
relationship

Performance

- Non Financial

Technological Context

- Information Technology
    - Support of IT

Fig. 1. Relationship between influencing factors, process and organizational performance. Adapted from (Lee & Choi, 2003)

After developing the performance measure, a case study was conducted to verify the measures and to gain knowledge about customer knowledge management activities that are currently practiced. The model was evaluated in the testing stage through case studies of firms that collaborate with their customers. The case studies involve 24 projects conducted by firms and their customers in projects of service development. A descriptive statistical analysis was employed to reveal the characteristics of each variable. The content validation in this study was verified by interviewing academicians and practitioners that have knowledge related to marketing and customer knowledge management in projects. The results of the study will be discussed in the description section.

5. Theoretical perspectives

Knowledge is recognized as primary value generator in innovative companies, and customers are recognized as a knowledge source; this affirms the increasing importance

of studying customer knowledge management (Davenport & Jarvenpaa, 2003). Davenport and Klahr (1998) considered knowledge is power and customer knowledge is high-octane power. Leveraging knowledge held by customers offers significant benefits to customers and firms, e.g. personalized, unique experiences for the customer, higher profitability and growth to the next level of customer loyalty and knowledge for the firm (Yang & Chen, 2008). Firms should move from being autonomous knowledge creators, beyond firms that learn about customers and create value for them, to becoming co-creators of knowledge by learning and creating value together with customers (Sawhney & Prandelli, 2000).

Rowley (2005) defined customer knowledge as knowledge about customers, including knowledge about potential customers, customer segments and individual customers, as well as knowledge possessed by customers. There are three kinds of knowledge flows that play a vital role in the interaction between an organization and its customers. These are knowledge for, from and about the customer (Salomann, Dous, Kolbe, & Brenn, 2005). Gibbert, Leibold, and Probst (2002) argued that by managing the knowledge of their customers, corporations will be able to sense emerging market opportunities before their competitors, and thereby create more economic value for the corporation, its shareholders and its customers.

Customer knowledge management (CKM) is described as a process in which organizations seek to know what their customers know. CKM is the strategic process by which companies transform their customers from passive recipients of products and services into knowledge partners. CKM is about increasing, sharing, and expanding customers' knowledge, to the benefit of both customers and the corporation (Gibbert, Leibold, & Probst, 2002). It is important to understand what customers know, what experience they have with the company, their needs and how the company treats its customers, as well as the emotional and functional control of this relationship. Often, these aspects are lacking from organizational knowledge. To obtain good customer knowledge, activities should not be limited to marketing activities (Rowley, 2005)   .

Smith and McKeen (2005) found that organizations recognize four types of CKM, each type using knowledge in different ways. In the framework, CKM is described in four dimensions of knowledge: knowledge of the customer, knowledge from the customer, knowledge for the customer and knowledge co-creation with the customer. Knowledge of customer can be obtained from customer from data of customers and their transactions. Knowledge from customers can be obtained if a customer is an active informant and always provides feedback showing concern, criticism and positive experiences. This feedback helps companies to develop products and services continuously, determine the market segments more effectively, develop successful business strategies and create new products and innovative services (Rowley, 2005). Knowledge for the customer includes all knowledge that organization provides to its customers (Gebert, Geib, Kolbe, & Brenner, 2003). Knowledge co-creation is knowledge obtained from a two-way relationship (Smith & McKeen, 2005). Customer knowledge co-creation is creation of knowledge that is obtained from a two-directional relationship and intensive collaboration between company and its customer in CKM activity (Gibbert, Leibold, & Probst, 2002).

The dimension of measurement adapted from previous studies, i.e. Belbaly, Benbya, and Meissonier (2007), Feng and Tian (2005), Lehtimäki, Simula, and Salo (2009), described the relationship between the enablers and the process of CKM and the impact of CKM on new product development project, but the measurement framework and the quantification of the productivity of CKM are not described. Feng and Tian (2005)

promoted the enablers of a CKM which was adapted from enablers of customer relationship management (CRM). Lehtimäki, Simula, and Salo (2009) conducted a qualitative study on project marketing and KM at the level of relationship between buyers and sellers in projects. They revealed that to ensure customer retention and the development of trust and commitment, seller firms should consider managing customer knowledge as input and knowledge created throughout projects, and the exploitation of knowledge to customer.

The relationship between customer perceived value, expectation value, customer satisfaction and customer relationship at the outcome dimension of CKM are also described and they argue that good CKM brings benefits to companies in terms of customer loyalty, customer trust, customer satisfaction and quality and timing of customer relationships (Feng & Tian, 2005). Thus, this paper promotes a measurement framework that is compiled from existing measurement frameworks in previous studies, and validates this measurement framework through empirical study. This aims to fill the gap in studies about measurement of customer knowledge management in projects for productivity improvement.

6. Measurement framework of customer knowledge management in projects

The measurement framework of customer knowledge management in this paper was developed based on previous research that related to performance, process and influencing factors of knowledge management (Lee & Choi, 2003), knowledge in new product development (Lettice, Roth, & Forstenlechner, 2006), customer knowledge management (Smith & McKeen, 2005), customer knowledge creation in new product development (Belbaly, Benbya, & Meissonier, 2007) and the enabling factor of CKM (Feng & Tian, 2005). The dimension of measurement was adapted from Lee and Choi (2003) as depicted in Fig. 2. The content of each dimension was adapted from previous studies (see appendix) and the measurement framework was developed as listed in Table 1.
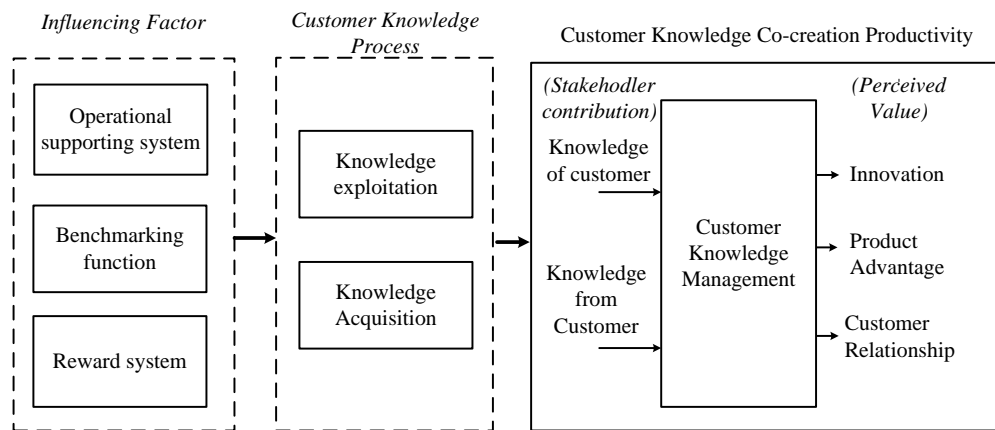

Fig. 2. Construction of customer knowledge management productivity in this study.
Adapted from (Lee & Choi, 2003)

Table 1
Framework of measurement

Authors	Implementation	Customer knowledge output and outcome	Input Dimension	Knowledge Process Dimension	Mechanism Dimension
Lee and Choi (2003)	Measuring the relationship of knowledge process, knowledge enabler and organizational performance	Organizational performance		Knowledge process	Knowledge enabler
Lettice, Roth, and Forstenlechner (2006)	Measuring knowledge in New Product Development	Performance indicator of new product development	Stakeholder contribution.	Adopted from Trott (1998): reuse of knowledge, innovation and knowledge exploitation	Operation context that consists of factors that enable the stakeholders to do knowledge sharing
Feng and Tian (2005)	CKM and condition analysis of successful CKM implementation	Customer satisfaction, trust, loyalty and quality and time of customer relationship			People, procedure, organization, culture, leadership, information and technology
Belbaly, Benbya, and Meissonier (2007)	Knowledge management system in NPD	NPD performance: time to market		Socialization Externalization Combination internalization Project complexity and project risk	Knowledge management system factors including centralization, formalization, collaboration, trust
Lehtimäki et al. (2009)	Measuring Knowledge Management in Project Marketing	Retain and develop trust and commitment knowledge as output	Knowledge as input	Customer visit, product demonstration, customer education, customer site visit, minutes of meeting	
This research	Measuring performance of knowledge co-created with customer in project of service development	Value perceived by the company: innovation, market performance and service advantage Value perceived by the customer influences the level of customer satisfaction	Stakeholder contribution: Knowledge of and from customer	Knowledge exploitation: customer visit, product demonstration, customer education knowledge acquisition: minutes of meeting	Environmental support and enabling factors, adopted from Feng and Tian (2005): formalization and information technology

6.1. Productivity of customer knowledge management

The productivity of customer knowledge management in this paper is defined as the ratio of output (added value perceived by the company, e.g. innovation, service advantage and customer relationship) to input (knowledge of customer and knowledge from customer).

6.1.1. Customer knowledge as input

In performance measurement of a process, Kennerley and Neely (2000) used a stakeholder–contribution or stakeholder-centric point of view. Ulrich and Eppinger (2004) used stakeholder contribution in measuring product development caused by the inter-disciplines insight in the process. In this paper the customer contribution is assigned to the input dimension. Customer contribution is defined as knowledge of the customer, i.e., customer data managed by the company, and knowledge from the customer, i.e., knowledge contributed actively by the customer).

CKM collects a large amount of data about customers and their transactions to help companies understand who their customers are. CRM advocates claim this system improves customer satisfaction and retention by providing better and more tailored customer service (McKeen & Smith, 2003). Knowledge about customers is the primary sense of CRM systems and data mining, not only consists of basic data about the costumer (i.e. name, contact information), but also consists of records of transactions with the customers, selected products and services and specific personal preferences (e.g. language, communication methods).

6.1.2. Outcome of customer knowledge management

From the perspective of collaborative network and relationship, the customer knowledge process should bring value to the customer and the firm. By understanding the customer, the company will have better information on the real needs and expectations of the customer. Listening to the customer will reveal knowledge that customers bring to the transaction (Garcia-Murillo & Annabi, 2002). Several studies depict direct evidence for the positive impact of KM practices on innovative performance.

CKM for customer knowledge creation has been widely studied to increase innovation and competitiveness (Kohlbacher, 2008; Gebert, Geib, Kolbe, & Riemp, 2002; Belbaly, Benbya, & Meissonier, 2007; Edvardsson et al., 2006). In these studies the output of customer knowledge management is to increase innovation, service advantage and customer relationship. Lettice, Roth, and Forstenlechner (2006) promote innovation as the effect of knowledge in new product development because innovation is the indicator of creativity. Li and Cavusgil (1999) promote product advantage and product market performance as the impact of market knowledge on new product development. Product advantage is the key success factor of NPD (Cooper, 2001). In these studies, the process of customer knowledge positively correlates with new product advantage (Li & Calantone, 1998). In this paper, this measure is adapted as service advantage. Feng and Tian (2005) promote the level of customer relationship as the outcome of CKM. This is the consequences of customer perceived value, customer loyalty and customer satisfaction. Customer relationship indicates the customer perceived value obtained from the customer knowledge process (Feng & Tian, 2005).

6.2. Process of customer knowledge management

KM is needed in the project environment because of the discontinuity and variety of flow of people, material and information in the organization (Bresnen et al., 2003; Disterer, 2002). The need for KM is great in project marketing, especially in innovative projects, where the customer requires technical support and consultation to evaluate the validity and quality of the projects offered (Lehtimäki, Simula, & Salo, 2009). The seller must issue (Nonaka, 1994) and communicate technical knowledge and tacit knowledge that attached to individual customers in the company in order to convince customers to take a risk on the early adoption of innovative technologies (Lehtimäki, Simula, & Salo, 2009). KM includes establishing, maintaining and transferring knowledge (Argote, McEvily, & Reagans, 2003; Kasvi, Vartiainen, & Hailikari, 2002). The ability to absorb knowledge is also important (Assudani, 2005; Kasvi, Vartiainen, & Hailikari, 2002), because the discontinuous nature of the project hampers the transfer of knowledge created in the project. Collecting new knowledge of the project requires systematic and sustained attention (Leseure & Brookes, 2004).

The company utilizes minutes of meeting to retain knowledge formed in formal direct interactions between the company staff and customers. Minutes of meeting enable the company to absorb customer knowledge in a project into organizational knowledge. This knowledge could foster the success of project and organization improvement. This study examines the quality of management and utilization of minutes of meeting to measure the performance of acquisition of customer knowledge in projects.

Knowledge exploitation in this paper denotes the knowledge process in CKM that provides knowledge for the customer. Knowledge exploitation is required since invention without knowledge exploitation will not produce innovation (Trott, 2005). This knowledge is more focused on information and specification of products and services developed by marketing or research and development departments.

6.3. Influencing factors of customer knowledge management

The measurement framework to measure the influencing factors in this research includes the operational supporting system, benchmarking function and reward system. The operational supporting system was adapted from previous studies, including the influencing factors of knowledge management (Lee & Choi, 2003), enabling factors of knowledge management in product development (Belbaly, Benbya, & Meissonier, 2007; Lettice, Roth, & Forstenlechner, 2006), enabling factors of CKM (Feng & Tian, 2005), and enabling environment and factors of collaborative network (Parung & Bititci, 2008). This paper promotes standard operation procedures and information systems and technology as the influencing factors of CKM.

Lettice, Roth, and Forstenlechner (2006) included the competitive context based on the idea that organizational performance is influenced by the competitive context in which the organization operates. Competitive context is a mechanism to capture the knowledge about competitor, thus in this research this is used as a benchmarking function. Rumizen (1998) promoted organizational alignment to support knowledge management. Organizational alignment is activities to run the organization as a team. This category includes the provision of rewards or incentives (Ho, 2009). In this paper, this measure is adapted as a reward system, which encourages the employee and the customer to work together in developing service. The construct of these measures is depicted in Fig. 3.
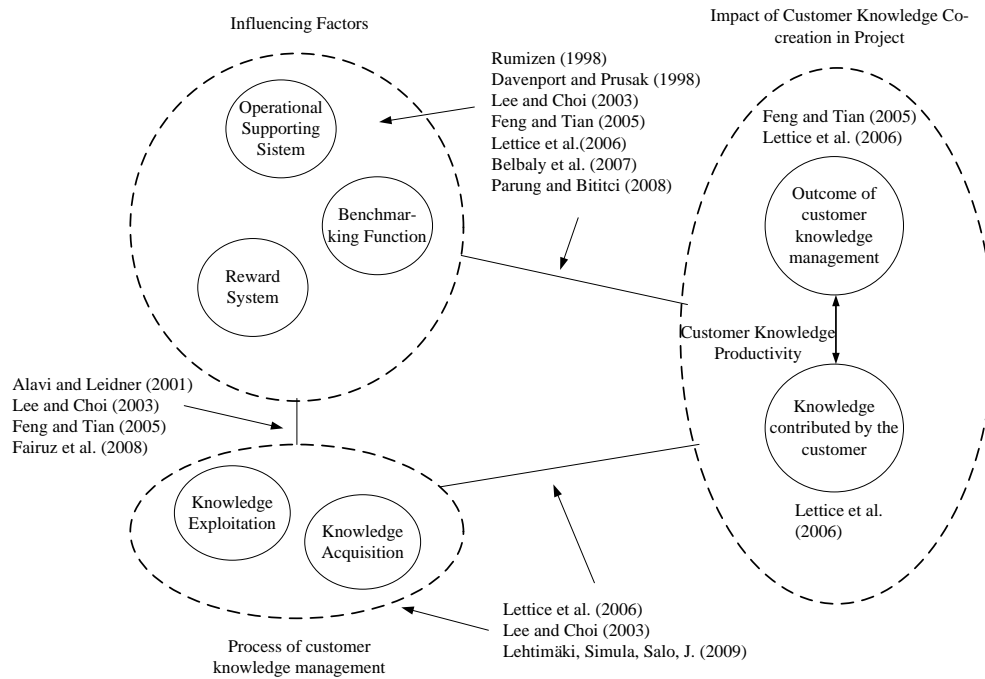
Influencing Factors

Impact of Customer Knowledge Co-creation in Project

Operational Supporting Sistem

Benchmarking Function

Reward System

Rumizen (1998)
Davenport and Prusak (1998)
Lee and Choi (2003)
Feng and Tian (2005)
Lettice et al.(2006)
Belbaly et al. (2007)
Parung and Bititci (2008)

Feng and Tian (2005)
Lettice et al. (2006)

Outcome of customer knowledge management

Customer Knowledge Productivity

Knowledge contributed by the customer

Lettice et al. (2006)

Alavi and Leidner (2001)
Lee and Choi (2003)
Feng and Tian (2005)
Fairuz et al. (2008)

Knowledge Exploitation

Knowledge Acquisition

Process of customer knowledge management

Lettice et al. (2006)
Lee and Choi (2003)
Lehtimäki, Simula, Salo, J. (2009)

Fig. 3. Construct of measures for process, influencing factors, and impact of customer knowledge management based on previous studies

7. Measure development

The measures construct were developed in three stages. The tentative measures were developed in the first stage from existing literature based on the defined constructs. To establish the validity of the content, at the second stage a list of defined constructs and measures was submitted to a panel of five project management, knowledge management and customer relationship management academicians who were recognized as authorities on the subject of customer knowledge management in projects. The panel members were requested to verify each measure assigned to the construct based on their expertise and understanding. To refine the list of measures, case study interviews were conducted in the third stage. In the interviews, executives from four selected companies were asked to comment on the clarity and relevance of the measures, and the items were refined accordingly. A pre-test was conducted among four firms.

8. Survey instruments

Regarding the quality of the measurement (as in the measurement obtained through customer surveys for this paper) there are a number of validity types that are typically addressed.

8.1. Content validity

According to Trochim (2002) content validity attempts to assess the degree to which the research accurately translates a construct into operationalization. Trochim (2002) groups content validity under the label "translation validity". Translation validity focuses on whether the operationalization is a good reflection of the construct. It assumes that the details of the construct are well defined and the operationalization against it can be checked.

In content validity, the operationalization against the relevant content domain for the construct is checked. This approach assumes that the content domain is detailed and well described, which is not always true. For instance, the approach used for content validity in this study is to check the validity of four dimensions of performance for customer knowledge management in projects using the extensive review of literatures in customer knowledge management productivity and the influencing factors of customer knowledge management.

That review spelled out lots of criteria for the content that were relevant for the four constructs. For instance, the dimensions in Choi and Lee (2000) that consist of performance, process, and influencing factor are relevant for measurement framework of customer knowledge management in projects. The performance in this research is defined by productivity, the ratio of outcome to input. The dimension of input includes knowledge contributed by customers based on the understanding of stakeholder contribution. The output dimension consists of the advantage of product being relevant to the customer knowledge outcome based on Li and Calantone (1998) and Li and Cavusgil (1999). The output dimension also consists of innovation based on Lettice, Roth, and Forstenlechner (2006) which included innovation as an outcome of knowledge management. The other measures on output dimension are customer relationship–based Feng and Tian (2005), which promoted the level of customer relationship as the outcome of customer knowledge management.

The knowledge process consists of knowledge exploitation based on Lettice, Roth, and Forstenlechner (2006) and knowledge acquisition based on Lehtimäki, Simula, and Salo (2009). Knowledge exploitation is required to enhance invention to become innovation (Lettice, Roth, & Forstenlechner, 2006). Knowledge acquisition is included in the process in order to maintain the knowledge created in single project to make it available in subsequent projects (Lehtimäki, Simula, & Salo, 2009). The influencing factors in this paper are adapted from Feng and Tian (2005), promoting the influencing factor of CKM by adapting the influencing factor of CRM.

8.2. Construct validity

Construct validity refers to the degree to which inferences can legitimately be made from the operationalization in the study and how those relate to the theoretical constructs on which those operationalization were based. Construct validity is the approximate conclusion that operationalization accurately reflects its construct. Trochim (2002) divided the issues associated with construct validity into two categories, called "land of theory" and "land of observation." The land of theory comprises all of the ideas, theories, hunches and hypotheses that research has about the world and the attempt to explain or articulate this to others. In the land of theory, one finds the constructs of the measure or concepts that one is trying to measure. The land of observation consists of what has been seen happening in the world and public manifestations of that world. In the land of observation the researcher finds his or her actual program, treatment, measurement or

observational procedures. Presumably, he or she constructed the land of observation based on theory (Trochim, 2002). According to Flynn and Pearcy (2001) there are two broad ways of looking at the idea of construct validity. One assures construct validity by defining the construct so precisely that the researcher can operationalize it in a straightforward manner. The objective of this approach is to assure if the construct can be operationalized correctly or not. The construct of performance in customer knowledge management in project has been discussed extensively in the literature and comprises customer knowledge management. In that, the operational model has been validated by theory. The construct of the process, influencing factors and productivity customer knowledge management is adapted from the previous studies related to knowledge management, customer knowledge management and knowledge management in projects, measuring the same construct with slightly different items.

The second perspective believes that there are no black and white constructs as concepts are more or less related to each other (Trochim, 2002). The meaning of terms or constructs differs relatively, not absolutely. In that respect, the measures of customer knowledge management productivity in projects might measure many of the constructs of customer knowledge management but may not capture all of them. Trochim (2002) recommends that in order to establish construct validity the researcher must focus on meeting the following conditions:

- The construct to be operationalized should be set within a semantic net

- Direct evidence that the operationalization was listed the way they must be theoretically developed should be provided.

- Evidence that data support the theoretical view of the relation among the constructs. For example, the relationship between the customer knowledge management and customer satisfaction.

The construct of measures in this paper based on previous researches is depicted in Fig. 3.

9. Survey results

The questionnaire for the survey was developed and a survey was conducted to evaluate this measurement framework by distributing the questionnaire and interviewing some respondents. Interviews and questionnaire distribution in the early stages to the respondents were intended determine if the questions were clear and if the data were available. The companies invited to participate in the survey are the selling firm that collaborate with the buying firms as the customer in service development. To test the questionnaire, this research involved 24 projects in four companies. The assessment was based on the judgement of the experienced manager that acts as the respondent during the survey, on a 1-5 Likert scale. The projects selected to be included in the case study represent knowledge management, service development and project marketing issues. The case project was challenging for the seller firms due to the innovative concept and the technically less knowledgeable but very demanding customer. The solution that consists of product and service provided by the seller firms is considered knowledge intensive in general. The experience of the case firm with this project provided valuable lessons on how to satisfy customers and increase the prospect of repeated contract with same customers for subsequent projects. All of these points highlight the importance of project marketing activities and provide reflection on knowledge management. Data obtained through the survey was analyzed by descriptive statistical analysis to reveal the

characteristics of each variable. The result of the computation and analysis are depicted in Table 2.

Table 2
Data descriptive statistics

Dimension	Category	Measures	Mean	Standard Deviation
Stakeholder Contribution	Knowledge from customer: customer contribution	Level of knowledge contribution from customer at pre-bidding stage	3.750	0.737
		Level of knowledge contribution from customer/client at development stage (after bidding)	3.292	1.268
	Knowledge of customer: customer data management	Level of management of customer data in database	3.958	0.624
		Level of management of transaction data in database	3.958	0.624
Perceived Value	Customer Relationship	Level of repeated purchase from same customer/client	3.792	0.721
		The length of relationship with the customer	3.958	0.806
	Innovation	Level of service inventions, "new to the world" service	2.625	1.056
		Level of new technology or design to support the innovation service to customer/client	2.833	1.204
	Service Advantage	Level of service creativity	3.792	0.415
		Level of service uniqueness	3.792	0.415
Knowledge Process	Knowledge Exploitation	Intensity of customer visit for promotion, based on customer invitation	3.920	0.722
		Intensity of factory visit by customer as part of service realisation (after bidding and dealing)	3.250	1.113
		Utilization of facility and technology for educating client/customer	3.708	1.160
	Knowledge Acquisition	Level of minutes of meeting produced from meetings	4.521	0.651
		Level of utilization of minutes of meeting in the same project	4.625	0.495
		Level of minutes of meeting distribution to related staff and customer	4.729	0.390
Influencing Factor	Operational Supporting System	Level of guideless utilization (i.e. SOP) in managing the communication and interaction with the customer/client	3.958	0.624
		Level of information system utilization and data management using computer technology to support staff and customer in service realization (i.e. CAD)	4.792	0.415
	Benchmarking Function	Level of benchmarking activities conducted by the company.	2.250	0.989
		Level of benchmarking activity that supported by professional institution (i.e. JDPower).	1.833	1.204
		Level of benchmarking activity that using established method or framework (i.e. BSC, Baldrige Criteria, etc)	2.250	1.189
	Reward System	Intensity of rewards and incentive from company, that is awarded based on staff performance on innovative works and knowledge utilization (includes financial and non-financial rewards)	2.667	1.007
		Intensity of rewards and incentive from company, that is awarded based on customer/client innovative and collaborative works (includes financial and non-financial rewards)	2.875	1.154

10. Discussion, practical implication and conclusion

Table 2 depicts the characteristics of the data. The highest average score is knowledge acquisition (higher than 4.500). It means that the knowledge acquisition is maintained well by the companies. The benchmarking function has the lowest average score, but at

the same time it has the highest standard deviation. This reflects that the intention of benchmarking the company performance with the competitor is still low in some companies, but some already make an appropriate effort for benchmarking purpose. The company that has the best score for the benchmarking function is the company that holds the certificate for standardized management process in the company. The other company that considers itself good in the benchmarking function is the company that has a specific department that functions as a market intelligent. They do market research continuously and the information they obtain from the research will be used by the marketing and engineering departments at the bidding stage. Other variables that also hold high standard deviation scores are the level of customer visits to attract more customers (average is more than 1). It shows that the activity in the company is varying. At the output dimension, innovation has the highest standard deviation score (1.056 and 1.204). From Table 2 and the findings, it can be concluded that the ability to benchmark the product and service of the company with those of competitors and the use of operational supporting system are essential. The most importance was placed on being able to reuse existing knowledge within the service development activities, yet the companies surveyed felt that this was an area in which they did not perform well.

By taking into account the results of the interviews for content validation, the benchmarking function can be conducted without having to employ the external institution and certain frameworks in the benchmarking process. As long as the company emphasizes the intensity and the quality of the benchmarking process, the company is still able to improve the performance at the output dimension. This finding requires further study to explore information system utilization, benchmarking function and innovation.

This paper does not describe the implementation and consideration of the measurement framework in the four companies in detail, but it is worth highlighting here some of the key findings from this part of the research as it informs the areas for further research. From the interview, the companies found that by introducing measures on customer data management, knowledge exploitation, knowledge acquisition, benchmarking function and reward system, they were able to start considering issues related to benchmark function and reward system and how to do management of customer data, knowledge exploitation and knowledge acquisition properly. For example, one company had just noticed that the customer data should be updated frequently because the contact person of the buyer firms can be replaced by another person. They used to maintain their relationship through formal and informal direct interaction, but as the company grows, the number of persons could be increasing, and they probably will not communicate to one person only. Another example is the knowledge exploitation process, i.e., customer visits, factory visits for customers and customer education programs.

Activities of knowledge exploitation for promotion purposes are usually high for all of the companies, but the activities at the stage of service realization that occurs when the contract is signed are considered to be essential and influencing the success of transferring the knowledge of the product and service to the buying firms. This activity also determines the satisfaction of the buying firms, especially after the hand-over stage. The acquisition of knowledge is the activity to adopt the knowledge from the buying firms during the project of service realization. The documentation is in "minutes of meeting" form as it is the way of the companies to capture the important information throughout the project so it can be retrieved easily for the purpose of project itself. The level of productivity and distribution are found to be high in the companies being observed, but the utility of the knowledge captured for the purpose of other projects and

for the company augmentation seems to be low. The respondents argue that they do not refer to the minutes of meeting directly, but they absorb the information in the minutes of meeting in their minds as their personal knowledge, and they use that knowledge for the purpose of other projects. This reveals that the intention to physically retrieve the minutes of meeting from the repository is still low and the staffs are confident to rely on their memories. There is a reliance on well-developed professional skills. These skills are required to help the staff make sense of difficult technical task in finishing project and to cope with the customer demand that are often not well defined and dynamically changing. Professional skills such as communication and interpersonal skills can be taught, but learning and development intervention to stimulate self-development and learning motivation in individuals are required (Romo, 2013). A shared set of beliefs in the goals of the project team and a shared set of benefits are needed to assure that processes of knowledge, including knowledge sharing and acquisition, successful. The member of project team should be convinced that empowering the team with knowledge for finishing the project will bring benefits to the respective member of the team (Koulikov, 2011). Thus, the concept of encouraging team member to enrich the team with knowledge should consider the intervention of the team leader and the benefits that can be shared to respective member, both for staffs from the company and the staffs from the customer side.

In turn, the interview led to a refinement of the measures being applied, as understanding increased. The companies were then able to tailor the measures and make them specific to their business in terms of customer relationship and project management. The companies felt it was an important step towards a more performance-oriented culture and would help them to begin to improve how they retain their potential customers and competent employees from a knowledge management point of view. However, it is felt that there would be unwillingness from employees to implement such improvements since their workload is high.

The review of the measures demonstrated that the dimensions were comprehensive and suitable for covering the most important aspects of service development projects. The measures provided a useful starting point for discussions, but needed to be carefully selected for each organization service development strategy and practice. Although limited implementation of the measures was conducted in 24 projects, the timescale of the research prevented a full-scale implementation of the proposed measurement framework. This research is still in progress; further research is therefore needed to more fully assess the results of implementing this measurement framework in different service development contexts. This should assess the comprehensiveness of the dimensions and the measures contained within each dimension; the issues surrounding the implementation and ongoing monitoring of the key measures in each dimensions, and the ability of the measures to improve the performance of service development and customer relationship and in particular the exploitation and acquisition of knowledge within the service development process. The further study is on how to quantify the productivity of customer knowledge management and to evaluate the correlation between the knowledge process and the influencing factors with the index of productivity.

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Appendix

Dimension: Stakeholder contribution

Category	Measures	References
Knowledge from customer: customer contribution	Level of knowledge contribution from customer/client at pre-development stage of the project	Veldhuizen et al. (2006)
	Level of knowledge contribution from customer/client at development stage	
Knowledge of customer: customer data management	Level of management of customer data in database	Reinartz et al. (2004)
	Level of management of transaction data in database	

Perceived value

Category	Measures	References
Customer Relationship	Level of repeated purchase from same customer/client	Parung and Bititci (2008); Feng and Tian (2005)
	The length of relationship with the customer	Kohlbacher (2008); Feng and Tian (2005)
Innovation	Level of service inventions, "new to the world" service	Lettice et al. (2006); Rogers (1998)
	Level of new technology or design to support the innovation service to customer/client	
Service Advantage	Level of service creativity	Moorman et al. (1993)
	Level of service uniqueness	Li and Calantone (1998)

Knowledge process

Category	Measures	References
Knowledge Exploitation	Intensity of customer visit for promotion, based on customer invitation	Kohlbacher (2008); Lettice et al. (2006)
	Intensity of factory visit by customer as part of service realisation (after bidding and dealing)	
	Utilization of facility and technology for educating client/customer	Lettice et al. (2006)
Knowledge Acquisition	Level of minutes of meeting produced from meetings	Lehtimäki et al. (2009)
	Level of utilization of minutes of meeting in the same project	
	Level of minutes of meeting distribution to related staff and customer	

Dimension: Influencing factor

Category	Measures	References
Operational Supporting System	Level of guideless utilization (i.e. SOP) in managing the communication and interaction with the customer/client	Belbaly et al. (2007); Lee and Choi (2003); Feng and Tian (2005); Massey and Kyriazis (2007)
	Level of information system utilization and data management using computer technology to support staff and customer in service realization (i.e. CAD)	Belbaly et al. (2007); Lee and Choi (2003); Feng and Tian (2005); Lettice et al. (2006)
Benchmarking Function	Level of benchmarking activities conducted by the company.	Lee and Choi, (2003); Lettice et al. (2006)
	Level of benchmarking activities that supported by professional institution (ie JDPower).	
	Level of benchmarking activity that using established method or framework (i.e. BSC, Baldrige Criteria, etc)	
eward System	Intensity of rewards and incentive from company, that is awarded based on staff performance on innovative works and knowledge utilization (includes financial and non-financial rewards)	Lee and Choi (2003); Lettice et al. (2006); Rumizen (1998)
	Intensity of rewards and incentive from company, that is awarded based on customer/client innovative and collaborative works (includes financial and non-financial rewards)	