Measuring the Success of ICT-Based Knowledge Transfer: A Preliminary Study

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ABSTRACT

Knowledge transfer has received increasing attention in recent years. This is evident from many knowledge transfer initiatives and projects reported in the literature. However, how to measure the success of knowledge transfer projects still remains as a challenge because knowledge transfer is a very complex process. This paper focuses on knowledge transfer facilitated by Information and Communication Technologies (ICT). It attempts to develop a conceptual model for identifying the causal factors affecting the success of ICT based knowledge transfer. Drawing from relevant literature it also proposes a set of associated measures for each dimension in the model. The success model of ICT-KT is based on a modification of a Delong & Mclean information system success model. Six dimensions in the model are developed, including Knowledge quality, System quality, Service quality (with sub-dimensions of E-service quality and Extension quality), Use, User satisfaction and Net benefits. Preliminary measures associated with each dimension are discussed and directions for future research identified.

Keywords: ICT based knowledge transfer (ICT-KT); success model; success measures

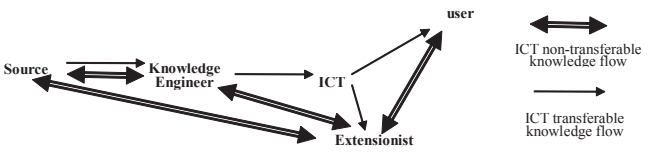
1. INTRODUCTION

In knowledge transfer, "human interaction and the resulting creation of objective knowledge is the key to progress" (Nonaka and Peltokorpi, 2006). In practice, knowledge is transferred not only in the form of one-to-one but also adopting one-to-many approaches. When developing countries need to cope with transferring knowledge to a large number of recipients scattered across remote rural regions, ICT based knowledge transfer (ICT-KT) is an effective solution. Transferring knowledge from a source to a knowledge disadvantaged recipient is defined by Lin et al. (2005) as a sender-advantage asymmetric structure.

Following a sender-advantage asymmetric structure, Feng et al. (2006) investigated a range of ICT-KT projects in China, which were launched for promoting the knowledge transfer from the national key universities to rural farmers. It was found that large amounts of ICT transferable knowledge were codified into expert systems available for non-expert users. As to the remaining ICT non-transferable knowledge a face-to-face approach was adopted. The knowledge extensionist, a role of a broker between expert, knowledge engineer and user, undertakes tasks of transferring ICT-non-transferable knowledge to bridge the communication gap and technical gap between the source and user and ensuring the success of knowledge transfer. The ICT-KT framework is shown in figure 1.

In practice, knowledge can be transformed in many ways to make it transferable. In the context of ICT-KT, face-to-face contact for the enhancement of effective non ICT transferable knowledge transfer has been noted by researchers. In a knowledge transfer process defined by Szulanski (2000) he argues the necessity of an external assistance to the knowledge user. Such close local support is important for a satisfactory level of user's absorption of new knowledge. Hainse and Goodhue (2003) describe a knowledge transfer triangle in transferring knowledge of ERP. The triangle consists of local implementer, ERP knowledge vendor, and the knowledge consultants, who "provide additional skills, knowledge, or simply manpower that is not available at the implementer or the vendor, or is too expensive if procured from the vendor".

Figure 1. The ICT-based knowledge transfer framework



The ICT-KT framework can be conceptually supported by knowledge repository theory (Argote and Ingram, 2000). The theory points out that knowledge transfer takes place in a network, which consists of three basic knowledge repositories (people, tools, and tasks). The ICT-KT framework is a typical knowledge transfer network consisting of the three knowledge repositories.

Regarding the role of an extension service in multi-path knowledge transfer process, Ray and Bhawuk (2002) demonstrate the importance of an extension service in transferring both conceptual and experimental knowledge from the source to recipients in their knowledge transfer scheme. The role of knowledge extensionist in ICT-KT is to enhance the completeness of knowledge transfer when the application of ICT-KT with vast field learners is expected to achieve a high standard of efficiency at the same time.

2. CONCEPTUAL BASIS OF ICT-KT SUCCESS MODEL

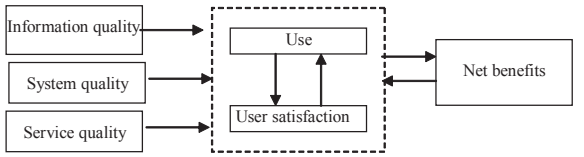
Cummings and Teng (2003) summarise four definitions of knowledge transfer success. The first looks at the engagement of knowledge transfers within a period of time. Based on communication theory, the second defines knowledge transfer as producing satisfactory results to recipients in time and on budget. Underpinned by technology transfer and innovation theory, the third is the re-creation of the source knowledge in the recipient side. The forth approach, drawing from institutional theory, regards knowledge transfer as a recipient acquiring "the ownership of, commitment to, and satisfaction with" the knowledge.

Ko et al. (2000) find that majority of knowledge transfer literature has adopted the source-recipient generic model. They define the knowledge transfer as "the communication of knowledge from a source so that it is learned and applied by a recipient". In management information systems study, communication theory is one of the most important grounds to support the conceptual development. In ICT-KT framework, ICT-transferable knowledge is transferred with its repository, an information system. To measure this part of ICT-KT success, the definition of knowledge transfer success based on communication theory is adopted.

2.1 D&M information Systems Success Model

DeLone and Mclean (1992, 2003) developed the D&M model to measure the success of information systems based on communication theory. Their original model in 1992 has been used by many researchers in the last decade. Communication theory was originally employed by Mason (1978) to measure the information system success. In Mason's study information is regarded as the product and the

Figure 2. The updated D&M model (DeLone and Mclean, 2003)



success of information system is divided into five levels to be measured: production, product, receipt, influence on recipient, and influence on system. Shown in figure 2, D&M further developed and updated this model towards a six dimensions of information system success: information quality, system quality, service quality, use, user satisfaction, net benefits.

2.2 Knowledge Transfer Process Model and the Quality Dimensions

Szulanski (2000) developed a process model to illustrate the process of knowledge transfer. The model consists of four stages of knowledge transfer: (1) initiation, work prior to the transfer; (2) implementation, between the decision to transfer and start of actual use of new knowledge; (3) ramp-up, actual use until satisfactory performance; and (4) integration, work after satisfactory performance being achieved. Four stages of the process model not only indicate a sequence of knowledge transfer process, but also a relationship of causality flows at the same time. This approach is also reflected in D&M model development (DeLone and Mclean, 2003). Underpinned by the same model development strategy, it is argued that a success model for ICT based knowledge transfer can be established based on D&M IS success model.

By combining Szulanski's process model with a causal relationship flow along the process, a holistic view of the knowledge transfer process and ICT-KT success can be drawn in figure 3. Following the process model, the causal relationship can be addressed in sequence of (1) Knowledge Quality and ICT System Quality; (2) Service Quality, with sub-dimensions of E-Service and Extension Service; (3) Use and User Satisfaction; and (4) Net Benefits.

2.3 SERVQUAL, E-S-QUAL and Service Quality

To measure the service quality, Parasuraman et al. (1985, 1988) developed SERVQUAL, which have five measuring dimensions. With the emergence of e-business, Pitt et al. (1995) argue that D&M model is designed to measure the effectiveness of IS system that focusing on products rather than service. With this view in mind they suggest that SERVQUAL is an appropriate instrument for measuring IS service quality. Therefore, Pitt et al. (1995) added SERVQUAL as an extra dimension in D&M model together with system quality and information quality.

The inclusion of SERVQUAL into D&M model provides a possibility to the further development of D&M model toward measuring the success of ICT-KT. With regard to its validity, we argue that the service quality Pitt et al. (1995) investigated is the e-service quality rather than the traditional people delivered service. Therefore, employing SERVQUAL to measuring the quality of information system service can be challenged (Kettinger and Lee, 2005). DeLone and Mclean (2003) realised the limitation of the original model and attempted to modify the model in 2003.

Also influenced by the emerging phenomena of e-business, SERVQUAL has been further adapted to E-S-QUAL, a multiple-item scale for measuring the web based service quality (Zeithaml et al. 2002; Parasuraman et al. 2005). E-service in E-S-QUAL is defined by Parasuraman et al. (2005) as the customer shopping online. Regarding the ICT based knowledge transfer, it is reasonable to adopt the E-S-QUAL to measure transfer service quality. For example, in e-learning system, many learning activities are supported by the ICT system and students pay for receiving education online. Another ICT KT project is online expert systems or web based knowledge repositories. In this case, knowledge recipient may have to pay for receiving knowledge/service from the system.

3. ICT-KT SUCCESS MODEL

The proposed ICT-KT success model is illustrated in figure 4. Based on the updated D&M model (DeLone and McLean, 2003), the model depicts the basic process and causal relationship of ICT based knowledge transfer. Service Quality and Information Quality have been modified to reflect the characteristics of knowledge transfer systems. The success of knowledge quality previously developed based on knowledge transfer process model by Szulanski (2000) is introduced into ICT-KT success model. Service Quality is subdivided into E-service Quality and Extension Quality. Information Quality is replaced by knowledge quality.

4. DISCUSSION ON ASSOCIATED MEASURES IN EACH DIMENSION

Having proposed the ICT KT success model, the following section attempts to discuss the possible measures which can be used in each dimension.

4.1 Knowledge Quality

One of the most difficult dimensions to be measured could be the knowledge quality. Kane et al. (2005) empirically tested the influence of knowledge quality to the effectiveness of knowledge transfer. In their definition, knowledge quality is the gap between the knowledge of a source's and a recipient's. With empirical evidence they argue that superior knowledge will be more likely to be transferred from a source to a user than inferior knowledge. To measure the knowledge quality in general, potential items can be drawn from a number of influential empirical studies on knowledge transfer success. The first group of possible measures are as following.

- *Superior knowledge:* knowledge to be transferred is advantaged than the existing knowledge of recipient (Kane et al. 2005)
- *Tacitness:* implicit and noncodifiable accumulation of skills that results from learning by doing (Simonin, 1999)
- *Specificity*: transaction-specific skills and assets that are utilized in production processes and provision of services for particular customers (Simonin, 1999)
- *Complexity:* the number of interdependent technologies, routines, individuals, and resources linked to a particular knowledge or assets (Simonin, 1999);
- *Unproven Knowledge:* Degree of conjecture on the utility of the transferred knowledge (Szulanski, 2000)
- *Embeddedness:* A recognized characteristic of knowledge that can be transferred with people, tools or routines (Cummings and Teng, 2003)
- *Articulability:* the extent to which knowledge can be verbalized, written, drawn or otherwise articulated (Cummings and Teng, 2003)
- *Knowledge distance*: the degree to which the source and recipient possess similar knowledge foundations (Cummings and Teng, 2003)

Secondly, some other literature focuses on the ICT transferable knowledge, or information, in their research context. Holsapple and Lee-post-2006-used quantita-

Figure 3. An holistic view of the knowledge transfer process and ICT-KT success

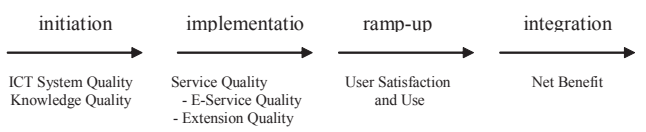
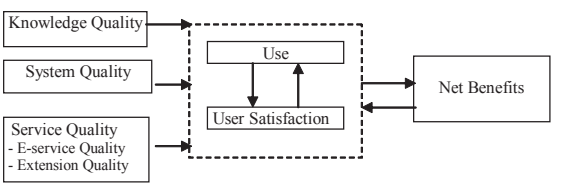


Figure 4. Proposed ICT-KT success model



tive method to develop matrix measures for e-learning. They empirically verified the causal relationship between knowledge quality and use and user satisfaction in e-learning programmes. Therefore, a group of measures on information quality suggested by DeLone and McLean (1992) can be introduced as the preliminary measures of knowledge quality in general. These measures include: *Importance, Relevance, Usefulness, Informativeness, Usableness, Understandability, Reliability, Currency, Timeliness, Uniqueness, freedom from bias.*

Thirdly, a group of measures suggested by DeLone and McLean (1992) can be introduced as the potential quality measures of knowledge in the format of ICT transferable knowledge. They are *Readability, Clarity, Format, Appearance, Content, Accuracy, Precision, Conciseness, Sufficiency, Completeness, comparability, Quantitativenss.*

4.2 System Quality

In a broad sense knowledge transfer systems are information systems. The quality measures of information systems are still applicable to ICT-KT. Thus, the original measures in D&M model can be employed. The full set of system quality measures can be found in DeLone and McLean (1992).

4.3 Service Quality

Service quality is defined as the gap between expected service and perceived service (Parasuraman et al. 1985). This is true in ICT-KT context. Measures on service quality can be drawn from the general concepts in knowledge management literatures. As discussed in the introduction, ICT based knowledge transfer is normally supported by knowledge extentionist as a complimentary service to enhance the transfer effectiveness and success. Therefore, the service quality should include both E-service quality and extension quality. Further, researchers have noticed that the social-cultural factors play an important role in knowledge transfer (e.g. Alavi et al. 2006). Both e-service and extension service should not be an exemption of their influence.

In marketing theory, user's satisfaction is achieved from entire service they received from different means. Potential measures of general service quality can be:

- *Knowledge friendly:* positive orientation to knowledge exploration, creation and sharing (Davenport, 1998)
- *Clarity:* the project terminology is designed toward most effective communication (Davenport, 1998)
- *Multiple channels:* knowledge transferred through multiple channels that reinforce each other (Davenport, 1998)
- *Protectiveness*: specialised technological, personnel, and price in access to proprietary knowledge (Simonin,1999);
- *Cultural distance*: differentials of values, beliefs, language proficiency and alignment between individuals (Simonin1999; Cummings and Teng, 2003);
- *Organisational distance*: degree of dissimilarity in business practices, institutional heritage, and organisational culture between organisations or communities (Simonin,1999; Cummings and Teng, 2003)
- *Source not Perceived as Reliable:* Degree to which the donor of the best practice is perceived as reliable (Szulanski, 2000)
- *Source lacks Motivation*: Motivation of the source unit to support the transfer (Szulanski, 2000, Davenport, 1998)
- *Barren organizational Context:* Degree to which the organizational context supports the development of transfers (Szulanski, 2000, Davenport, 1998)
- *Project priority:* different degrees of attention and/or resources can be received in knowledge transfer activities (Cummings and Teng, 2003)
- *Transfer activities*: establishment and management of administrative structure based on assessment of knowledge, and the mechanism to facilitating knowledge transfer (Cummings and Teng, 2003)

4.3.1 E-Service Quality

E-Service is provided in accordance with e-commerce and e-business. E-S-QUAL is a set of measures for the E-Service quality. Suggested by Parasuraman et al. (2005), E-S-QUAL has two different measuring scales, the first is a 22-item scale of four dimensions: efficiency, fulfilment, system availability, and privacy; the second is a subscale with 11 items in three dimensions: responsiveness, compensation, and contact. The subscale is developed to measure the quality of service recovery. It is apparent that E-S-QUAL was developed in the context of e-business, not knowledge transfer services specifically. Modifications need to be made to apply their measures in ICT KT.

4.3.2 Extension Quality

Knowledge extension is a sort of service delivered by field extenionist, a face-to-face delivered service. Firstly, empirical measures suggested by KM literature can be adopted as described below:

- *Experience*: the capability in possessing the relevant tacit know-how to fill in the gaps left by codified descriptions(Simonin,1999);
- *Arduous Relationship:* Ease of communication and intimacy of the relationship (Szulanski, 2000)
- *Physical distance*: the difficulty, time requirement, and expense of communicating and getting together face-to-face (Cummings and Teng, 2003)
- *Organisational infrastructure:* establishment of the roles and organisational groups whose members have the skills to serve as the resources for individual projects (Davenport, 1998)

Secondly, SERVQUAL can be adopted as the initial constructs toward the final measures. Parasuraman et al. (1988) define the five dimensions of SERVQUAL are: tangibles, reliability, responsiveness, assurance, empathy. Within the five dimensions, the tangible is a dimension that is not particularly relevant to knowledge extension. A list of 18-item instrument developed for SERVQUAL shown in table 1 in appendix can be adopted as the second group of preliminary scales for further development of Extension Quality of ICT-KT.

4.4 Use and User Satisfaction

Darr and Kurtzberg (2000) argue that successful knowledge transfer occurs when source knowledge is not only shared with but also used by a recipient. Firstly, empirical measures in the KM literature on use and user satisfaction can be adopted.

Use

- *Recipient Motivation*: Motivation of the recipient unit to support the transfer (Szulanski, 2000; Davenport, 1998)
- *Learning cultural:* The need for a culture of learning in an organization or an individual to facilitate learning in general, and knowledge transfer specifically (Cummings and Teng, 2003)

User satisfaction

- *Recipient's Absorptive Capacity:* Ability of the recipient unit to identify, value and apply new knowledge (Szulanski, 2000, Tsai and Tsai, 2005)
- *Recipient's Retentive Capacity:* Ability of the recipient unit to support the routine use of new knowledge (Szulanski, 2000)

Secondly, two dimensions and related measures specified by DeLone and McLean (1992) can be employed as the potential items for measuring the use and user satisfaction of ICT-KT. However, *Information satisfaction* and *Difference between information needed and received* should replace by *knowledge.*

4.5 Net Benefit

DeLone and McLean (1992) proposed a set of measures on the organisational impact in their original model and net benefit in their revised model. Most of those measures on the organizational impact are rather product/service marketing oriented and lack a general scope. Within those measures, *Contribution to achieving goals* is viewed as an appropriate measure for net benefit. DeLone and McLean (2003) suggested five measures for net benefits in the revised model, including *Cost savings, Expanded markets, Incremental additional sales, Reduced search costs, Time savings.* Davenport (1998) points out that the link to economic performance or industry value is a key factor leading to knowledge project success. Following this argument, three potential measures, *Cost savings, Time savings, Improvement of economic performance or industry value* can be adopted firstly.

Secondly, as ICT-KT is, in nature, designed to transfer knowledge in the one-to-many form, measures on impact on individuals should be considered. Argote and Ingram (2000) note that knowledge transfer can take place at both individual level and group level. It is argued that organizational impact can only be realised with successful individual impact. It is inevitable that knowledge transfer at the

organisational level must involve the transfer at the individual level (Tsai and Tsai, 2005). More importantly, ICT-KT at the individual level is crucial in its success. O'Hagan and Green (2004) conclude that the knowledge transfer is dependent on the quality and quantity of social interaction between individuals. When the knowledge is transferred with some tacit components numerous individual exchanges are called for (Nonaka, 1994). DeLone and McLean (1992) suggest a set of decision effectiveness to measure the Individual Impact of IS success. This set of measures can be adapted as the second group of measures on net benefit. The modified two new sets of measures are *Personal valuation of ICT-KT and Willingness to Pay for Knowledge.*

5. FUTURE RESEARCH AND CONCLUSION

Future research will be carried out to test and validate the ICT-KT success model. Although the model is adapted from the D&M model, which has been empirically validated a number of modifications are made in terms of the dimensions and associated measures in the context of ICT-KT. The validation of the model can be achieved using empirical evidence to be collected with the current ICT based knowledge transfer projects in China, such as web based expert systems and web based training and education systems for rural extension in agriculture and aquaculture. Churchill (1979) suggests a procedure for developing multi-item measures for marketing research. The procedure is followed by Parasuraman and his colleagues in developing SEVQUAL and E-S-QUAL. The similar procedure can be employed for developing and refining the measures within each dimension using interview and questionnaire surveys.

This research has conceptually adapted the D&M model for ICT based knowledge transfer success but must be considered a preliminary study in nature. The model facilitates the mechanisms for measuring that ICT-KT actually takes place in both objective and subjective dimensions. However, this model is limited to applications in a sender-receiver asymmetry structure of knowledge transfer, within which the sender is in a knowledge advantaged position.

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