MOTIVATION TO SHARE HOSPITAL BUILDING DESIGN KNOWLEDGE BY INFORMATION TECHNOLOGY IN HONG KONG

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Abstract

Hospital building design is important as it is the place where bacteria and microorganisms concentrate. Poor ventilation system and layout traps disease causing pathogens, threatens the lives of many frontline workers such as doctors, nurses, and health care assistants. While design knowledge sharing by IT ensures a rapid knowledge sharing among designers from all over the world, what are their motivations? Few or no paper has studied this issue. This paper studies this base on 4 traditional motivation theories: Theory X, Theory Y, Reinforcement theory, Two factor theory. Results show that positive reinforcement theory and motivation factors in two factor theory provide better explanation.

Keywords: *knowledge sharing, information technology, building design, motivation*

1. Introduction

In the olden days, knowledge sharing relies on face-to-face interactions, letter writing and phone call. Birth of information technology symbolizes a new era in knowledge management – the scene of someone who peeps from the window to see if the postman has brought us letters is less likely to be observed in our daily lives. Sitting in front of a notebook computer not only allows us to read tabloid magazine, but also enables us to know more about our world via email, websites etc. Reading books and professional magazines are no longer sufficient for building designers. To keep updating their knowledge, studying the latest design from other side of the globe has become a necessity. Whilst the outbreak of SARS in Hong Kong was a sad story, it has fastened the development of IT in knowledge sharing. Virtual classroom, websites etc had suddenly gained importance (as people avoided going outside at that time). The recent H1N1 incident has also touched the nerve of many hospital building designers again: is there any better way to prevent the spread of airborne pathogens in wards?

2. Knowledge and knowledge sharing

Knowledge is a broad and abstract notion that has brought epistemological debate in western philosophy since the classical Greek era (Alavi & Leidner, 2001). Current knowledge management literature has revealed that researchers define knowledge from different perspectives. For example, Baskerville & Dulipovici (2006) point out that knowledge can be regarded as valuable commodity for an organization in the context of knowledge economy and can be manipulated internally (e.g. create within organization) or externally (e.g. buy from outside). Knowledge, from this

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perspective, can be regarded as an object. Fong (2003) concedes that knowledge is a set of shared beliefs resulting from social interactions and embedded in the social context where it is created. This indicates that knowledge is contextual-dependent which contradicts the object view of knowledge. Alavi and Leidner (2001) summarize previous research and point out that knowledge can be regarded as a process, where people apply their experiences and gain continual knowing. Therefore, knowledge is closely related to human action. Similarly, Nonaka & Takeuchi's (1995) define knowledge as "*dynamic human process of justifying personal belief toward the truth"*. The relationship between knowledge and human action is also stressed. In this research, Nonaka & Takeuchi's (1995) definition will be adopted as building designers develop part of their knowledge by practical working experience.

Knowledge classification is another issue mentioned by researchers. The most well-known one is explicit-tacit classification. Explicit knowledge is defined as a concept which can be "*expressed in words and numbers, and easily communicated and shared in the form of data, scientific formulae, codified procedures, or universal principles*". On the contrary, tacit knowledge is "*highly personal and hard to formulize*". Tacit knowledge has its root in an individual's action, experience and ideals and it is quite context embedded. Hence, it is difficult to communicate or share tacit knowledge with others. Tacit knowledge can be further developed into technical dimension and cognitive dimension. Technical dimension is also known as "know-how" knowledge, which is "*informal and hard-to-pin-down skills or crafts*". Know-how knowledge is mainly acquired through long-term experience. That is the reason why senior workers are usually more skillful than junior workers in work place. Cognitive dimension concerns "*schemata, mental models, beliefs and perceptions*" which are integrated in our mind and we usually take them for granted (Nonaka & Takeuchi, 1995). Cognitive tacit knowledge shapes the way we perform and see the world. Only understanding the detachment of explicit and tacit knowledge is not enough, attention should also be paid on how to convert tacit knowledge to explicit knowledge. Highly personal knowledge has little value to the work team or companies until it can be converted into explicit knowledge and shared with the others. This research focuses on both explicit knowledge and tacit knowledge. Explicit knowledge may contain work procedures, documentations, etc. Tacit knowledge of designers mostly refer to the know-how knowledge which are gained through experience and understanding of the design work (Koskinen*, et. al.*, 2003).

Knowledge sharing is an activity by which individuals mutually exchange their knowledge or ideals and collaboratively generate new knowledge (Magnini, 2008). In working teams, knowledge sharing refers to the process where team members share task related ideas, information, and suggestions with each other (Srivastava*, et. al.*, 2006). De Vries, Van Den Hooff, & De Ridder (2006) conceptualize the process of knowledge sharing into two sub-processes: knowledge donating and knowledge collecting. Some researchers define knowledge from the perspective of single direction, for instance, Ding et al (2007) define knowledge sharing is the behavior by which '*individuals collectively increase other's understanding through the articulation and demonstration of personal knowledge*'. This definition is defined from the perspective of knowledge donator. This study looks at not only designers donating knowledge to others but also designers seeking knowledge from others. Thus knowledge sharing is a mutual process in this study.

According to Bakker et al (2006), knowledge sharing is mainly used in two ways in previous research: exploitation and exploration process. In exploitation process, exiting knowledge is captured, transferred, and used in other similar situations. Exploration is the process where old knowledge is shared, synthesized for generating new knowledge. Here, new knowledge refers to knowledge which is synthetically created and do not exist in collective before. It is also found out that knowledge sharing is more related to knowledge exploitation way in new product

development team (Bakker*, et al.*, 2006). This means that knowledge sharing usually happens in the form of discussion. Hospital building design can also be regarded as new product development since each building designed is unique. Thus, building design teams are also new product development teams. So knowledge sharing is regarded as part of exploitation process in this research.

3. Knowledge sharing by means of IT

The existing literature has shown that "IT" and "human" are the two major middleman in knowledge sharing. The IT-centric strategy emphasis the use of IT tools to "*facilitate the capture, access, and reuse of information and knowledge*" (Carrillo & Chinowsky, 2006). IT tools are especially good for facilitating storage or retrieving explicit knowledge which can be codified and documented, such as intranets, document management systems, etc. The human resource management (HRM) –centric strategy focuses on the means to "*motivate and facilitate knowledge workers to develop, enhance, and use their knowledge in order to achieve organizational goals*" (Carrillo & Chinowsky, 2006). This research focuses on the IT-centric strategy to motivate hospital building designers to share their knowledge. It examines how information technologies can facilitate and encourage designers to share hospital and health care buildings design knowledge.

Kankanhalli et al (2005) explain that there are two types of information technology in information system literature: the repository model and the network model. Repository model is more related to codification approach to knowledge management, where knowledge is codified and stored to facilitate knowledge reuse by providing access to codified knowledge. A key technology in this category is known as electronic knowledge repository (Kankanhalli et al, 2005). The network model is the personalized approach to knowledge management. This approach stresses the linkage among person for knowledge sharing. Knowledge directories are typical technological components of this approach (Kankanhalli et al, 2005). Knowledge directories mainly provide location of expertise, and electronic forum software which allow people to interact within communities of practice.

Information technology is a facilitator to support knowledge sharing processes and ease the knowledge sharing process (Riege, 2005). Information technologies provide people with quick access to large amount of information or knowledge at individual level (Riege, 2005; Hendriks, 1999). Hendriks (1999) suggests some of the examples of IT, e.g. electronic document management (EDM), document information systems (DIS) and document imaging systems. Those technology systems are mainly related to technologies of repository model, where documents are structured by means of categories and index. They even provide the search function for people to retrieve documents. These technological systems save time and effort significantly. Information technology can also reduce the barriers involved in knowledge sharing which are mainly resulted from physical distance, temporal distance and social distance (Hendriks, 1999). By eliminating physical distance barriers, information technologies can facilitate team work in and between business divisions and subsidiaries (Riege, 2005), e.g. virtual teams. Overcoming difficulties from temporal distance mainly means preserving knowledge over time, which is usually related to organizational memory (Hendriks, 1999). Maintaining organizational knowledge from past experiences is critical as it avoids reinvent-the-wheel and knowledge redundancy. Temporal distance also refers barriers in present such as difficulties in coordinating schedules (Hendriks, 1999). Under this circumstance, internet based discussion groups are helpful (Hendriks, 1999). Social barriers may concern with barrier come from differences in experiences levels, education levels, position levers, etc. Hendriks (1999) adds that different conceptual framework between

knowledge donator and collector is also considered as social barrier. Information technology can lower social barriers by tools of facilitating social translation, e.g., learning maps (Hendriks, 1999). Information technology also helps people to locate who knows the specific know-how or where can the knowledge be obtained in a quicker way, and thus improve the whole knowledge sharing process (Riege, 2005; hendriks, 1999). Some of the common examples of electronic tools in knowledge sharing and their corresponding pros and cons are noted in the table below.

E-tools	Pros and cons of the knowledge sharing method	Examples
Professional web-based communities	A1: Useful platforms in pooling individual's knowledge bit by bit together (Obonyo & Wu, 2008). D1: The success of information sharing relies on the members' activeness (Obonyo & Wu, 2008)	(Huband*, et. al.*, 2009)
Intranet	A1: Handy channel for information sharing within a short time (Ingirige & Sexton, 2007). D1: Users complain that intranet has failed to achieve what they expect (Ingirige & Sexton, 2007).	Intranet of Hospital Authority and various construction design team
Online games	A1: Online games can be interactive and interesting. D1: Information provided in each game is limited.	(Cheat Planet, 2009)
Blog	A1: Information can be posted by bloggers in a convenient way and received by readers without geographical limitation. A2: Blogs are archived in chronological order, new entries appended to the previous ones. (Shanyang Zhao, Internet and the lifeworld: updating Schutz's theory of mutual knowledge) D1: Validity of data depends heavily on bloggers.	(Perls, 2007)
Virtual classroom	A1**:** Upload any new information to the website at any time and in any place (Sun*, et. al.*, 2008).	(University of Salford, 2009)
Websites	A1: One advantage is to help quickly locate where the knowledge is and who knows the knowledge (Riege, 2005; hendriks, 1999). D1: Validity of data depends heavily on website providers	(Carr, 2008)

Table 1 Pros and cons of E-tools and the corresponding examples (Note: A1 refers to the first advantage, A2 refers to second advantage, D1 refers to first disadvantage, D2 refers to second disadvantage etc)

4. Special requirement in Hospital Building Design

Ventilation, heating, air conditioning system provide specially conditioned air to hospital staff and patients. This is particularly important to those wards where patients are particularly vulnerable to infection from airborne pathogens which might put the health of people around, including doctors and nurse at risks. Proper building design requires knowledge in characteristics of airborne pathogens, microbes, virus and bacteria. Similarly, knowledge of latest technological

development on ventilation, tools and equipment for controlling the spread of pathogenic particles are of utmost important. The science of aerobiology since the age of Louis Pasteur in the middle of 19th century provides the first insight on the relations between pathogens and air movement. In designing ventilation for isolation rooms for patients, current hospital design team usually provides negative pressure to ventilate the room with exhaust fan which exceeds the supply by more than 10% difference or more than 125 cfm difference. For example, to prevent the spread of Aspergillus (one of the airborne pathogens), high-efficiency particular filters, provide negative air pressure, dedicated exhaust and physical isolation of the construction area from patient care areas (Mayhall, 2004).

There is also another pool of literature which illustrates the importance of hospital layout. For example, nurses have different reactions on radial, double corridor, and single corridor. Similarly, renovations can bring positive effect on the mood and morale of staff in ward. Some designers believe in the idea of moral treatment. They introduce rural settings in hospitals provide goodness to patients and plant trees and woodlands in wards and cancer treatment centre. There is also heated argument over physical environment and mortality rates in hospital. Good ventilation, kitchens accommodation for nursing staff and drainage coupled with low patient density can lower the mortality rates in wards (Gesler*, et al.*, 2004). In Hong Kong, Lam (2004) has pointed out that a good design in hospital consists of standard ward floor with service corridors. To accommodate all vertical runs to the horizontal services, it is common to design a service floor below all ward floors. Careful zoning is required to avoid the use of large plant with large distribution systems. Use of service corridor/spine with sufficient width (Lam, 2004).

On top of the basic requirement on hospital building design, professional knowledge in hospital building design also stresses a combination of landscape design, medical science and environmental psychology. 100 soldiers in World War suffered from effort syndrome in London because of environmental stress is one of the vivid examples which show the important of environment in building design. Designers of the Pioneer Health Centre and the Finsbury Health Centre concern both the hygienic design and social ideas. Whilst it is an undeniable fact that the practicality of hospital designs from professional doctors and nurses' objectives are important, laymen's idea on what makes a good hospital building are of equal importance. Thus, the final product of a hospital actually reflects the compromise, debate, power struggle and controversy among all these stakeholders (Gesler*, et al.*, 2004).

Modeling, simulation, and visualization tools in building design which facilitate hospital building design

Various e-tools were applied for designing hospital to meet the needs of various stakeholders aforementioned. For example, DesignBuilder utilizes OpenGL solid modeler to allow building models assemble by stretching, cutting and positioning 'blocks' in 3-D space. Results of simulation provide visual feedback on actual element thickness, volumes and room areas (DesignBuilder Software, 2009). Hourly Analysis Program (HAP) offers energy analysis on energy consumption and operating costs (Carrier, 2009). Smart Draw provides templates of floor plan, ready-made graphics to increase productivity of building team (Smart Draw, 2009). FloVENT software offers a menu system for the design and optimization of heating, ventilating and air-conditioning (HVAC) systems. Computational Fluid Dynamics visualizes the airflows in the intensive care room, identifies turbulence which may cause encroackment of the 'clean' zone around the patient (Mentor Graphics, 2009).

Requirement	**Example of Building simulation tools**	**Example in Hong Kong hospital building**
Energy saving	DesignBuilder, Hourly Analysis Program (HAP)	Tuen Mun Hospital The solar heating system was designed to serve the hydrotherapy pool in the hospital. The closed circuit system utilises 96 m^2 of solar collector panels and can raise water temperature in the therapy pool from 24 to 36 ^oC. The designed pool capacity is about 240,000 litres and the rate of water circulation is 2.5 m^3/s. The solar system acts as a supplement to the steam heating system and is most effective during the daytime when the level of sunshine is sufficient (Deparment of Mechanical Engineering (HKU), 2005)
Requirement	**Example of Building simulation tools**	**Example in Hong Kong hospital building**
Airborne pathogens spread prevention	Mentor Graphics	Princess Margaret Hospital The VARI-centric balancing system controls the airflow and differential pressure between adjacent rooms and closes fully as soon as the pressure differential drops below the required level. To maintain negative pressures, VARI-centric air-pressure stabilisers small single-blade units with duties of about 80 l/s at 5 Pa are installed to prevent any new SARS infections. This enables the airflow to be switched to pass through an open door, forcing back airborne contamination without the need to alter air supply or extract rates (Modern Building Services, 2004). Heaven of Hope Hospital Western façade of the hospital building is arranged towards the sloping hill side for introducing natural air (Annonymous, 2004).
Green environment for patients	N/A	Kowloon Hospital Architect retains the green characteristics of the site (Annonymous, 2004). Lai King Hospital A garden was built for patients (Annonymous, 2004).
Building layout	Smart Draw	Tseung Kwan O Hospital A triangular ward blocks on 3 sides of each nurse station was built to ensure the nurses to have optimum views of each bed (Annonymous, 2004).

Table 2 Hospital buildings' requirements in Hong Kong

5. Traditional motivation theories

Kamara et al (2002) comment that an integrated approach consists of organizational, human and technological issues is necessary in building up an effective strategy of knowledge management. Some sort of motivators such as encouragement, penalties and direction have become necessary for companies to achieve their goals and targets (Li, 2006). Blind adherence to standard hospital template, e.g. DHSS notes no longer provide good value (Lam, 2004). Although there are more than 140 definitions of motivation, it can be simply interpreted as what causes people behave as they do (Denhardt*, et al.*, 2009).

5.1 Theory X

Douglas McGregor is of the view that men are not self motivated, to reach targets of an organization, organization members have to be directed, forced and threatened with penalty (Li & Poon, 2007). Supporters of theory X opine that the major motivation in using IT for knowledge sharing comes from the punishment. Researchers such as Morden (1995) argues that minimal supervision is sufficient to motivate members of organization on what they should do. Others, however, concede that human can exercise discretion (Cooper & Phillips, 1997), punishment and fine are peripheral means to achieve goals set by organizations only (Stroh, 2005). Moreover, many authors disagree with McGregor, they think that punishment is not effective because of its mild nature or time lag (Peters, 1991).

5.2 Theory Y

While theory X supporters are pessimistic about humans' behaviour, theory Y theorists look human in a positive way. They have 4 basic assumptions:

1. people are active in nature, they are self control and directed (Denhardt*, et al.*, 2009).
2. Work is pleasurable and natural (Denhardt*, et al.*, 2009)
3. Employees do not resist to change and work towards the companies' target (Denhardt*, et al.*, 2009)

In light of this, they can work very well to reach the goals of companies, include the use of IT as an information sharing tool, so long as there is a good environment and they are treated as a valuable member in our societies (Kock, 2005). After all, theory X and Y represents two extreme cases rest on unrealistic assumption, an amalgamation of the two is more realistic (Li, 2006).

5.3 Reinforcement theory

Reinforcements, whether it is positive or negative, alter people's acts. There are two types of reinforcement: positive and negative. Positive reinforcement strengthens people's behaviour by offering pleasant consequences on specific actions. Negative reinforcement or avoidance learning works as people wants to avoid unpleasant results of their acts (Courtland*, et al.*, 1993). Increase in salary and cash allowance are examples which can motivate employees to achieve certain company objectives (Davidsom & Griffin, 2006). Positive reinforcement tactic can motivate building designers to share their knowledge by IT (Courtland*, et al.*, 1993). Nevertheless, there is no guarantee on the success of such expensive incentives – it often produces too few winners and fails to bring sustainable effect. Competition among organization members creates much greater problems. (Li 2006) Negative reinforcement can also fail sometimes: when the expected gain from their acts are so great which is sufficient to offset the negative reinforcement, employees of a firm tend to accept penalty (Schermerhoen*, et al.*, 2003).

5.4 Two factor theory

Herzberg's two-factor theory proposes that there are both motivation and hygiene factors (P. Hendriks, 1999). The set of factors which lead to dissatisfaction is called hygiene factors or

dissatisfies. It includes working conditions, company policies and pay. Motivation factors, also called satisfiers, are the set of factors which lead to satisfaction. It includes recognition, achievement and personal growth (Courtland*, et al.*, 1993). Motivation, not hygiene factors, provides useful insights on motivation for sharing knowledge. Salary penalties or Bonuses, for example, may increase people's use of knowledge sharing technologies. Nevertheless, hygiene factors, e.g. status can hardly be a motivator for sharing knowledge. They may frustrate knowledge sharing when they are absent, but they cannot boost people's motivation on knowledge sharing (P. Hendriks, 1999).

Theory	**Building team's motivation in using IT for knowledge sharing**
Theory X	Punishment
Theory Y	Good environment and they are treated as a valuable member in our societies
Reinforcement theory	Positive reinforcement strengthens people's behaviour by offering pleasant consequences on specific actions. Negative reinforcement or avoidance learning works as people wants to avoid unpleasant results of their acts
Two factor theory	Motivation factors, also called satisfiers, are the set of factors which lead to satisfaction. It includes recognition, achievement and personal growth

Table 3 Summary of 4 theories on motivation in using IT for building design knowledge sharing

6. Interview

In order to know more about the motivation behind knowledge sharing between building team and professionals in hospital, 3 facility team members who has worked for more than 5 years and had participated in building design process in Princess Margaret Hospital were interviewed. One of the major reasons for choosing this hospital is that she is one of the most well-known hospitals specializing in infectious diseases and had played an important role in SARS outbreak in 2003. It helps us understand more about the motivation to share the information and possible changes after the outbreak of SARS. They generally agree that there are the two major important requirements on hospital design: 1) energy saving, 2) prevention of pathogens, 3). The major e-tools in knowledge sharing are email and websites. They generally agree that one of the very good motivations for knowledge sharing was the monetary return from such acts. Building designers share their latest design on web with the aim is to attract more customers and clients. By posting some successful examples on web, they can also boost confidence of these customers. Besides, they can become better known by other companies, enhancing their reputation among companies of similar trade.

	Interviewee 1	Interviewee 2	Interviewee 3
Most important requirements in hospital design	Prevention on spread of pathogens	Prevention on spread of pathogens, energy saving	Use of energy efficient technology
IT tools application in hospital building design	Resource planning	Building design and modelling	Building design

IT tools for building design knowledge sharing	Websites of other building design companies, email	Software and network tools, e.g. supporting, program development, email	Online information
Motivations to share building design knowledge by means of IT	Designers hope that they will become more famous and conform to the objective of the firm: increase market share.	Increase designers' competitiveness among all of the other designers. Provide better building design for patients and hospital employees.	Designers show off their superb building design.

Table 4 Results of the interviews

Conclusions

It is never in doubt that information technology has brought convenience to our generation. Knowledge sharing is longer restricted in face-to-face interaction, letter writing and phone call. Theoretically speaking, 1) punishment (theory X), 2) good working environment is of importance (theory Y), 3) offering pleasant (positive reinforcement) or unpleasant results of their acts (negative reinforcement), 4) Motivation factors, such as includes recognition, achievement and personal growth are sources of motivation for building designers to share their knowledge by means of IT. The results of the interview show that designers want to become more famous by posting their design on web. This implies that positive reinforcement and motivation factors serve better for explanation on why design team members share their knowledge on building design.

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