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An exploratory model of knowledge flow barriers within healthcare organizations

Chinho Lin\textsuperscript{a,}\textsuperscript{*}, Bertram Tan\textsuperscript{b}, Shofang Chang\textsuperscript{c}

\textsuperscript{a}Department of Industrial Management Science & Institute of Information Management, National Cheng Kung University, Tainan, Taiwan, ROC
\textsuperscript{b}Institute of Business Administration, Kun Shan University of Technology, Tainan, Taiwan, ROC
\textsuperscript{c}Institute of Health Information & Management, Chia Nan University of Pharmacy & Science, Tainan, Taiwan, ROC

1. Introduction

Individuals interact and share knowledge but new organizational knowledge is obtained through knowledge flow [15]. However, barriers arise to the flow and tools are needed to improve it.

A theory of the complexity of human behaviors, cultural historical activity theory (CHAT) [30], provides a practical model of human activities, focusing on the relationship between the subject and object of the activity, and relationships mediated by tools and communities. Hasan and Gould [13] argued that CHAT was appropriate in dealing with unstructured and messy human activities such as senior management decision-making and knowledge management.

In all industries, knowledge management is essential for effective knowledge-intensive professional services, such as those in healthcare organizations. Medical expertise is based on physicians' well-developed, highly structured, and reshapeable knowledge networks. In recently, executives have been seeking new ways of capitalizing on their intellectual assets by making knowledge more accessible throughout their organization. For example, healthcare organizations in the UK were encouraged to develop structured knowledge-based systems that would assist physicians and improve the quality of medical decision-making [29].

Practitioners are aware of various barriers to efficient knowledge flow (e.g. [26]), but studies of medical knowledge management are somewhat limited. Therefore, we attempted to build a holistic model incorporating the influential factors of knowledge flow and the barriers to it in the healthcare context.

2. Literature review

2.1. Cultural historical activity theory

Traditional rationality and bounded rationality models have been criticized for paying too little attention to the way that context influences problem-solving behavior. In contrast, the CHAT approach, which described the complexity of human behaviors, emphasized the contextual factors of human activities. It has been widely used in education, IS and knowledge management. It states that human activity is mediated by cultural signs: words, tools, and communities. Thus, CHAT has four constituents (see Fig. 1): the subject, an active, cognizant individual or social group; the object, the target on which the subject's activity is directed; they are mediated by the use of tools and the community in which they exist.

Vygotsky's work was extended by Leontiev, who developed the theory of activity that has been widely used in cultural research, computer science, IS, and knowledge management [19]. Leontiev also suggested that CHAT was a framework for constructing IS.

\textsuperscript{*}Corresponding author. Tel.: +886 6 2757575x53137; fax: +886 6 2759451.
E-mail address: linn@mail.ncku.edu.tw (C. Lin).
including those that provide organizational knowledge management and sense-making activity of managers.

2.2. CHAT applied to knowledge flow

Knowledge flow is a process whereby knowledge is passed between people or knowledge processing mechanisms. In our research the subject was the “knowledge source”; the object was the “knowledge receiver”; community was the “context”, and tool was the “knowledge flow mechanism”. Fig. 2 shows these transformations.

2.3. Determinants of and barriers to knowledge flow

The actors and tools of knowledge flow may become barriers if they are not handled properly. Temporal limitations, lack of staff motivation, and lack of incentives occur. In addition, lack of cross-departmental cooperation, lack of absorptive capacity, hierarchical status, and physical distance are all obstacles to knowledge sharing [8]. We therefore classified knowledge flow barriers into the categories shown in Table 1:

1. Knowledge characteristics:
   Causal ambiguity and non-validated knowledge hinder knowledge flow. The first occurs when the reasons for success or failure in replicating a capability cannot be determined. Tacit knowledge involves human skills and is difficult to measure. In addition, knowledge without a record of past usefulness is likely to be questioned by the recipient.

2. Knowledge source barriers:
   Efficient sharing depends on people being willing to contribute material to the organization. However, they often have invested resources in building a competence feel it is theirs unless incentives are given. In healthcare organizations, specialists and sub-specialists are likely to share knowledge with referring physicians who are sources of business, but they may be reluctant to share knowledge with or train competitors.

3. Knowledge receiver barriers:
   A precondition for knowledge transfer is that the receiver has sufficient related knowledge to assess its value (absorptive capacity), and does not resist using material from outsiders (the not-invented-here [NIH] syndrome).

4. Contextual barriers:
   During problem-solving, people develop and modify their understanding, and the context emerges and transforms. Context influences people’s attitudes and choices, thus, context influences what problems are considered to be solvable or are solved.

   We therefore classified contextual barriers into three categories: (1) relationships between sources and receivers, (2) organizational, and (3) other.

5. Inadequate/lack of mechanisms:
   KPMG consulting [18] suggested that the greatest barrier to organizational knowledge usage is a blocked channel between knowledge providers and knowledge seekers. Gray and Meister [10] believed that employees’ use of different knowledge sourcing methods would result in different outcomes. Phelps [25] noted that almost no mechanisms existed to support the development of a novel and successful strategy in the treatment of patients. Detmer and Shortliffe [7] believed that barriers to medical knowledge diffusion included clinicians’ lack of access to up-to-date information resources, ignorance of the availability of relevant information, lack of time for inquiry, and poor organization of information.

   Knowledge flow mechanisms are either intangible, such as mentoring, formal meetings and informal occasions or tangible, such as journals and IT.

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Factors causing knowledge flow barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge characteristics</td>
<td>Causal ambiguity [28]</td>
</tr>
<tr>
<td></td>
<td>Non-validated knowledge [31]</td>
</tr>
<tr>
<td>Knowledge source barriers</td>
<td>Lack of motivation [27]; fear of losing ownership, position of privilege, superiority; not adequately rewarded; unwilling to devote time and resources</td>
</tr>
<tr>
<td></td>
<td>Unreliable knowledge source [8]</td>
</tr>
<tr>
<td>Knowledge receiver barriers</td>
<td>Lack of motivation, including NIH syndrome [17]</td>
</tr>
<tr>
<td></td>
<td>Lack of absorptive capacity [3,4]</td>
</tr>
<tr>
<td></td>
<td>Lack of retentive capacity [5]</td>
</tr>
<tr>
<td>Contextual barriers</td>
<td>Relationship between knowledge sources and receivers; arduous relationships [1]; unawareness on both ends of the knowledge flow [28]</td>
</tr>
<tr>
<td></td>
<td>Organizational context: cultural characteristics [24]; time constraints [21]; incentives [10,14] policies, protocols, how decisions are made; education systems [20]</td>
</tr>
<tr>
<td></td>
<td>Others: geographical dispersion; language [9]</td>
</tr>
<tr>
<td>Insufficient mechanisms</td>
<td>Tangible mechanisms: clinical guidelines; medical journals [23]; information technology [6]</td>
</tr>
<tr>
<td></td>
<td>Intangible mechanisms: mentoring; formal meetings and informal occasions [16]; journal reading clubs, evidence-based medicine; problem-based learning [12]</td>
</tr>
</tbody>
</table>
Barriers concerning medical knowledge flow are shown in Table 1.

3. Research model

We explored the influential factors affecting medical knowledge flow based upon a revised CHAT model that addressed knowledge sources, knowledge receivers, context, transferred knowledge and KM activity outcomes (see Fig. 3). The important assumption in CHAT was that all human and mental activities were mediated by the use of tools and the community in which they occur. Therefore, we assumed that each of the elements of knowledge flow affected the outcomes.

4. Research methodology

4.1. Research process

Our research was exploratory and qualitative in nature; the study consisted of three phases. In Phase I, a literature review and in-depth interviews were conducted to explore medical knowledge flow barriers and to develop the model. In Phase II, a questionnaire was constructed and a case study using a survey approach was employed to test the model. In Phase III, a Delphi study was employed to validate the model. The research process is shown in Fig. 4.

4.2. Validity of qualitative research

In our study, the concept of triangulation was used to verify the validity of the data. Three phases of distinct study methodologies were conducted for triangulation. Different data sources:

- In Phase I: 25 physicians from 7 different hospitals were involved.
- In Phase II: 129 physicians from a medical center were used.
- In Phase III: 20 experts or middle medical managers were interviewed.

We also used various data collection methods, including in-depth interviews, surveys, and the Delphi approach.

Two types of validity testing (internal and external) were used; these are typical of quantitative research. Internal validity in qualitative research refers to the degree to which a researcher is justified in concluding that an observed relationship identifies potential causes and effect relationships. There are several methods by which qualitative researchers can improve internal validity. In addition to data and method triangulation, our study assured internal validity through a Delphi approach, which allowed us to gain opinions from experts.

Qualitative research is usually considered weak in generalization but there are ways to improve its external validity by repeated studies with different sets of individuals and organizations. In our study, the findings were shown to the respondents in order to verify the credibility of our interpretation and then 20 experts from 14 different specialties and 12 hospitals were asked to confirm the results.

5. Phase I

5.1. Research method

We conducted in-depth interviews with physicians using semi-structured questionnaires between December 2003 and February 2004 in hospitals where the physicians served. All individual interviews were face-to-face and lasted from 1 h to 90 min. As a good sample should assure variety and a balance of critical attributes, our sample was selected on the basis of physicians' interest and availability. The 25 physicians included 10 visiting staff (medical specialists), 8 residents (doctors under specialty training programs), and 7 interns (senior medical students) from seven hospitals located in different parts of Taiwan. Two are located in Taipei, northern Taiwan, two in Taichung and Changhua, central Taiwan, and two in Tainan, and one in Kaohsiung, southern Taiwan.

Descriptive statistical analysis was conducted for the structured questions, and thematic analysis was employed for the transcripts of the open-ended data. Preparation and analysis of the interview data generally followed the guidelines outlined by Boyatzis [2] and Miles and Huberman [22]. Each interview was audiotaped and transcribed verbatim from this. Statements that appeared to contain relevant themes were sorted together; these themes involved the medical knowledge flow barriers. Statements containing the same theme were then grouped to form categories. An iterative process was used to further refine themes and categories until the coders agreed upon a satisfactory representation that adequately accounted for the variety of statements. By analyzing all the data in this way we assessed how frequently specific issues were mentioned, and how they were addressed.

5.2. Validity of the data

Several procedures were used to ensure the validity of our study. We first presented the findings to the respondents: our analysis and interpretation were mailed to them for revision and
confirmation. The majority of the respondents agreed with the analysis, except for some wording corrections. We avoided coding bias by having two people code the interviews. They thoroughly reviewed all transcripts and selected all statements pertaining to the themes. Any disputes were discussed until a consensus was reached. Also, the reliability of the statements was increased through the use of semi-structured interviews involving very specific prompts, which facilitated the abstraction of relevant statements.

5.3. Results from the Phase I study

From our content analysis, factors derived from the interview transcripts were classified into five medical knowledge flow barriers, which corresponded to the barriers found in the literature review. The relationships between these barriers were also determined.

5.3.1. Classification of medical knowledge barriers

The medical knowledge flow barriers were classified into five categories:

1. Source barriers, including fear of advantage lost.
2. Receiver barriers, including lack of trust of the source, lack of absorptive capacity, and lack of intention.
3. Transferred barriers, including characteristics of the knowledge and lack of evidence-based knowledge.
4. Contextual barriers, including poor relationships between the knowledge source and receiver, and lack of time, incentive systems, and rewards.
5. Lack of mechanisms for flow.

Results from the thematic analysis, including the themes and some important corresponding statements, are shown in Table 2.

In general, physicians in the three echelons (visiting staff, residents, and interns) expressed consistent perceptions toward most knowledge flow barriers, except for knowledge source barriers. Visiting staff had less agreement with physicians at other levels and did not regard the fear of losing competitive advantage as a knowledge flow barrier.

Based on these results, we hypothesized:

**Proposition 1.** Medical knowledge flow barriers can be classified into five categories: knowledge source barriers, knowledge receiver barriers, characteristics of the knowledge transferred barriers, contextual barriers, and insufficient mechanisms.

5.3.2. Associations between the medical knowledge flow barriers

We observed that different barriers affected and reinforced one another. For example, a physician reimbursement system may encourage senior physicians to monopolize critical surgeries in order to increase their income, resulting in a non-sharing knowledge culture. Thus, organizational context can affect knowledge sources, and knowledge source barriers can lead to poor relationships between knowledge sources and receivers. Table 3 presents the themes and some representative statements about relations between knowledge flow barriers; the following abbreviations are used:

- \( KS \) = knowledge source.
- \( KR \) = knowledge receiver, \( KT \) = knowledge transferred. Con = contextual factor.
- Orcon = organizational context, Mec = mechanism.

We therefore hypothesized:

**Proposition 2.** The five categories of medical knowledge flow barriers are not independent; they affect one another.

6. Phase II study

6.1. Research method

A questionnaire was developed to test the propositions: 22 questions (see Appendix A) were developed with each item...
Table 3
Themes and statements regarding associations between knowledge flow barriers

<table>
<thead>
<tr>
<th>Associations between barriers</th>
<th>Representative statements (Interview quotes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS → KT</td>
<td>Doctors’ distinct characters (KS) lead to distinct physician–patient communications (KT)</td>
</tr>
<tr>
<td>KS → OrCon</td>
<td>Senior surgeons (KS) from a medical center in Taipei (OrCon) monopolized critical surgeries and failed to offer young doctors opportunities</td>
</tr>
<tr>
<td>KS → Mec</td>
<td>Some doctors (KS) have not learned how to use computers (Mec)</td>
</tr>
<tr>
<td>KR → KS</td>
<td>Ex 1. Those who are more willing to learn (KR) are the ones I (KS) would share knowledge with Ex 2. More and more young doctors (KR) are unwilling to acquire more knowledge. They spend time on sports and entertainment</td>
</tr>
<tr>
<td>KR → KT</td>
<td>Talent and courage (KR) are essential elements for doing well in surgery (KT)</td>
</tr>
<tr>
<td>KR → Mec</td>
<td>The problem exists that some doctors (KR) never learned how to use computers (Mec)</td>
</tr>
<tr>
<td>KT → KS</td>
<td>Ex 1. 1 (KS) do not share my knowledge unless it is evidence-based (KT) Ex 2. There is basic medical knowledge (KT) which you (KS) should share with all others Ex 3. For surgeons (KS), operations (KT) are regarded as critical knowledge for maintaining personal competence. For several GPs (KS), drug use (KT) is considered as their competitive advantage</td>
</tr>
<tr>
<td>KT → KR</td>
<td>I (KR) sometimes doubt whether the knowledge that senior doctors taught us is evidence-based (KT), or just based on their experience from specific cases (KT)</td>
</tr>
<tr>
<td>KT → Mec</td>
<td>Ex 1. Diagnosis and treatment (KT) are criteria you could easily find in textbooks (Mec) Ex 2. Although you can find standard operating procedures in textbooks (Mec), the contents are too rough (KT) for real work Ex 3. Mentorship (Mec) is an essential way of obtaining knowledge, especially for surgery (KT)</td>
</tr>
<tr>
<td>Con → KS</td>
<td>Ex 1. Visiting staff (VS) (Con) are too self-centered (KS) to share Ex 2. 1 (KS) don’t think it is necessary to share all knowledge with other physicians. It takes too much time (Con) Ex 3. Doctors (KS) are more willing to transfer knowledge to those at the same or lower levels of the hierarchy (Con) Ex 4. It is a society (Con) full of different specialties and sub-specialties. Everyone is good at his/her specific area (KS) Ex 5. Hospitals should set up reward systems (Con) to motivate knowledge sharing among physicians (KS)</td>
</tr>
<tr>
<td>Con → KR</td>
<td>Young doctors (KR) never challenge senior doctors (KS). It is a “culture” (Con)</td>
</tr>
<tr>
<td>OrCon → KT</td>
<td>Ex 1. We need more knowledge about methodologies for doing research. Policy (OrCon) has made research (KT) a requisite in teaching hospitals Ex 2. Organizational culture (OrCon) creates different physician–patient communication (KT). The culture which encourages us to care about patients’ feelings results in better communication between doctors and patients</td>
</tr>
<tr>
<td>Con → Mec</td>
<td>There is a lack of mechanisms (Mec) for facilitating knowledge flow, especially among different specialties and the same specialty at different hospitals (Con)</td>
</tr>
<tr>
<td>Con → KR&amp;KS</td>
<td>Lack of trust (Con) between knowledge sources (KS) and receivers (KR) hinders flow</td>
</tr>
<tr>
<td>Con → KT → KS</td>
<td>Doctors (KS) are not willing to share knowledge about their research (KT) because the outcome will become part of their personal credits (Con) in their career</td>
</tr>
<tr>
<td>Mec → KR</td>
<td>Ex. Medical records (Mec) are very useful for young doctors (KR)</td>
</tr>
<tr>
<td>Mec → Con</td>
<td>Ex 1. Telemedicine (Mec) facilitates interactive knowledge integration. It solves problems of time and space (Con) in knowledge flow Ex 2. Relevant knowledge flow platforms (Mec) should be setup to solve this problem (Con)</td>
</tr>
</tbody>
</table>

measured on a five-point Likert scale (from “strongly disagree” to “strongly agree”). After the survey was reviewed by academic and practicing experts, a survey was conducted between February and April, 2004 at the National Cheng Kung University Hospital. It was selected because it:

1. is one of the best medical centers in southern Taiwan;
2. has the largest variety of specialists (23 clinical departments) and physician echelons; and
3. expressed great interest in our research and was willing to facilitate the study.

The individual physician was the sampling unit and stratified sampling was used according to the population of each specialty division. Sampling sizes of visiting staff to resident, and to intern groups were 3.5 to 3.5, to 1, respectively. With a population of 500 in the hospital, 300 physicians from seventeen clinical divisions were selected as the subjects.

6.2. Results

6.2.1. Sample characteristics and non-response analysis

A total of 129 usable responses were returned, yielding an effective response rate of 43.0%. No significant differences were found between the responding and non-responding returns in terms of sex, hierarchy, seniority or specialty, based on independent sample t-tests with a p-value >0.10.

We compared two time-dated groups of respondents. First-wave returns were received within one month of initiation. Subsequent responses, coded as second-wave, were used as surrogates for non-respondents. The two waves were compared again in terms of sex, hierarchy, seniority and specialty. No t-tests were statistically significant at the 0.10 level, providing evidence that there was no non-response bias.

6.2.2. Factor analysis, reliability and validity testing

Factor analysis was conducted to assess the constructs. The Kaiser–Meyer–Olkin (KMO) measure was used to determine their
adequacy (greater than 0.80); in contrast, a construct with a KMO lower than 0.5 is perceived as inappropriate. A KMO measure of our sample indicated that the 22 measurement items for medical knowledge flow barriers had a KMO measure of 0.82. However, the factor loadings of items 12 “physicians lack time for knowledge flow”, 15 “Knowledge sources/knowledge receiver don’t know the other end of the knowledge flow”, and 21 “too many medical specialties” were lower than 0.5 and were therefore removed, and the remaining 19 barriers were factored into five sets with Eigenvalues larger than 1, accounting for 71% of the variance of the items. The factor loadings for the final solution are shown in Table 4.

Although the factor loadings of the removed items were lower than 0.5, their factor loadings were very close to those on two other selected factors after rotation. Therefore, their removal does not mean that they are not barriers for medical knowledge flow. In contrast, these three items obtained considerable support from the samples with means for items 12, 15 and 21 of 3.6, 3.4 and 3.4, respectively.

Cronbach’s alpha for each of the five factors were greater than 0.79, revealing satisfactory reliability for the survey instrument. The criterion validity of each factor was satisfactory, with each of the item-to-total correlations at least 0.5, and mostly greater than 0.6. The results of reliability and validity testing are presented in Table 4.

These generally indicate the fitness of the model (see Fig. 3), except for the finding that the “lack of mechanism” item has been regrouped with items 13, 14, 16, and 20. Finally, we named the five factors as knowledge source barriers, knowledge receiver barriers, knowledge transferred barriers, knowledge flow context barriers and organizational context barriers. Thus Proposition 1 was revised to be.

### Table 4
Factor analysis, reliability testing and validity testing for medical knowledge flow barriers

<table>
<thead>
<tr>
<th>Factor no. and name</th>
<th>Measuring item no. and content</th>
<th>Factor loading</th>
<th>Item-to-total correlation</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge source barriers</td>
<td>1. Maintaining prestige</td>
<td>0.89</td>
<td>0.89</td>
<td>0.94</td>
</tr>
<tr>
<td>2. Maintaining competence</td>
<td>0.85</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Knowledge receiver barriers</td>
<td>3. Doubt about whether the knowledge is updated</td>
<td>0.58</td>
<td>0.50</td>
<td>0.81</td>
</tr>
<tr>
<td>4. Lack of absorptive capacity</td>
<td>0.82</td>
<td>0.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Lack of positive attitude</td>
<td>0.79</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. NIH syndrome</td>
<td>0.73</td>
<td>0.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Knowledge transferred barriers</td>
<td>7. Difficulty of concrete expression</td>
<td>0.76</td>
<td>0.70</td>
<td>0.88</td>
</tr>
<tr>
<td>8. Uncertain nature</td>
<td>0.89</td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Complex nature</td>
<td>0.88</td>
<td>0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Difficulty of standardization</td>
<td>0.89</td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Not evidence-based</td>
<td>0.52</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Knowledge flow context barriers</td>
<td>13. Poor relationship between knowledge source and receiver</td>
<td>0.61</td>
<td>0.62</td>
<td>0.79</td>
</tr>
<tr>
<td>14. Lack of communication between knowledge source and receiver</td>
<td>0.71</td>
<td>0.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Lack of sharing culture</td>
<td>0.74</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Lack of sharing culture</td>
<td>0.74</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Distance between the echelons of knowledge source and receiver</td>
<td>0.58</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Lack of mechanisms</td>
<td>0.70</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Knowledge transferred barriers</td>
<td>17. Lack of reward</td>
<td>0.86</td>
<td>0.77</td>
<td>0.83</td>
</tr>
<tr>
<td>18. Lack of performance appraisal</td>
<td>0.88</td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Lack of leadership</td>
<td>0.67</td>
<td>0.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Organizational context barriers</td>
<td>20. Lack of leadership</td>
<td>0.67</td>
<td>0.54</td>
<td></td>
</tr>
</tbody>
</table>

### Proposition 1 (revised)
Medical knowledge flow barriers can be classified into five categories: knowledge source barriers, knowledge receiver barriers, knowledge transferred barriers, knowledge flow context barriers, and organizational context barriers.

### 6.2.3. Associations between the five knowledge flow barriers

Simple Pearson’s correlation and canonical correlations were conducted to test the correlations among the five medical knowledge flow barriers. Both indicated that there were significant associations between them (see Table 5).

Hair et al. [11] suggested using three criteria for determining how canonical functions should be interpreted: (1) the level of statistical significance; (2) the magnitude of the canonical correlation; and (3) the redundancy measure for the percentage of variance accounted for by the two sets. In our findings, most canonical-Rs were substantial between any two medical knowledge flow barriers (mostly larger than 0.40, except for that between knowledge source barriers and knowledge transferred barriers, which was 0.34). This suggested that there was considerable correlation between any two medical knowledge flow barriers. In addition, our results showed that each of the redundancy indices in the correlations was larger than 5%, supporting the satisfactory explanatory power of the correlation (see Table 6).

Consequently, Proposition 2 was supported.

### 7. Phase III study

#### 7.1. Research method

A Delphi study was employed for two rounds: the first was held at the end of April 2004; after the data analysis for the first round
survey; the second was conducted one month later. Twenty experts were selected as the panel. The people were selected from physicians in the middle hierarchy of management—the divisional directors in hospitals, who serve as the communication platform between physicians in the upper and lower echelons; they have worked with many physicians and better understand the ecosystem of medical knowledge flow. To avoid any subjective bias, the 20 panelists were selected from 14 distinct specialties and 12 distinct hospitals.

In the Delphi study, the panelists were asked for comments on the two propositions. A Likert seven-point scale and an open column were provided for respondents. Panelists were asked to write down comments particularly when they did not agree with a proposition. All responses were returned from the first round. Agreement of more than 80% among the 20 panelists occurred as the majority opinion. If there were five or more disagreements (completely through slightly disagree) from the panelists, the proposition was revised. Consequently, a revised study document with descriptive statistics and comments was mailed for the second round. All 20 responses were returned. As in the first round, any proposition with fewer than four disagreements was accepted as a “successful proposition”.

7.2. Results

In the first round, one panelist disagreed with both propositions: for Proposition 1 he expressed “slight disagreement” and presented a distinct opinion toward the “knowledge source barrier”, saying that he believed that the barrier existed in surgical but not in internal specialties. Nevertheless, since half of the panelists were internal specialists and most of the internists agreed with the “knowledge source” barrier, it was concluded that the barrier existed not only in surgical but also in internal units. The competencies that internists kept to themselves were not “concrete” skills (such as operation procedures) but knowledge about drug use or diagnosis. After presenting the result to the panelists for second round consideration, the “slightly disagree” response was changed to “moderately agree” while one “moderately agree” was changed to “agree”. Thus, most of the panelists agreed with the proposition and Proposition 1 is deemed “correct”.

For Proposition 2, the panelist that “slightly disagreed” indicated that the association between “knowledge transferred” barrier and “organizational context” barrier was inexplicable. However, from the Phase I study results indicated that proper appraisal or reward systems may motivate the “standardization” and “concrete expression” of implicit medical knowledge. Conversely, the implicit characteristics of medical knowledge also led to difficulties concerning knowledge flow outcome measurement, and reduced the validity of the appraisal system. Consequently, knowledge transfer barriers and organizational context barriers were deemed to influence each other.

Table 6

<table>
<thead>
<tr>
<th>Independent variable (barrier)</th>
<th>Dependent variable (barrier)</th>
<th>Canonical-R</th>
<th>Significance level</th>
<th>RI [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge source</td>
<td>Knowledge receiver</td>
<td>0.49</td>
<td>0.00</td>
<td>22.04</td>
</tr>
<tr>
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Note: RI: redundancy index.

Fig. 5. Final model: revised CHAT applied to medical knowledge flow.
8. Conclusions

Our study partially supported Proposition 1 and fully supported Proposition 2. The revised Proposition 1 presented a new classification of medical knowledge flow barriers. Proposition 2 revealed the associations between the medical knowledge flow barriers. The final model is shown in Fig. 5.

8.1. Concluding remarks

Our approach was the first to emphasize the importance of context between “knowledge sources” and “receivers”, since previous studies concentrated only on the organizational context. It complemented the original CHAT theory and is the first to propose a holistic model concerning medical knowledge flow in terms of five knowledge flow barriers. It allowed for the complexity of the context and diversity of stakeholder perspectives.

In practice, the revised CHAT model can provide a clear blueprint for determining determinants and concrete plans for hospital managers who are interested in implementing knowledge management. The revised CHAT model can be employed as a tool for examining outcomes.

8.2. Management implications

The knowledge flow context is a space where participants can come and go in which their shared context can continuously develop. This space may be physical (office or business space), virtual (e-mails and teleconferences), mental (shared experiences, ideas, and ideals), or a combination of these. Knowledge is not necessarily transferred to those who lack absorptive capacity: knowledge barriers result in incorrect decision making and incompetent individuals make poor judgments and may damage their careers as well as those of others.

Knowledge flow barriers are not independent but inter-related. Managers should realize that change in one of the barriers have positive or negative effects on the overall outcome of knowledge flow. Hence, intervening measures should be taken carefully to enhance the medical knowledge flow success factors.

8.3. Research limitations

There were several limitations to our study. First, since few hospitals are performing medical knowledge management, its outcome is difficult to measure, and thus it could not be addressed in our study. Second, there is little evidence and there are few examples that show how medical knowledge flow barriers occur and how they affect each other. Lastly, since our work focused on medical knowledge, the results may not be generalizable to other industries.

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Appendix A. Measurement items for medical knowledge flow barriers

1. The knowledge source wants to maintain his prestige.
2. The knowledge source wants to maintain his competence.
3. The knowledge receiver doubts whether the knowledge is updated.
4. The knowledge receiver lacks absorptive capacity.

References

Chinho Lin is a distinguished professor of the Department of Industrial and Information Management & Institute of Information Management at National Cheng Kung University, Taiwan, ROC. He received his Ph.D. in Business Administration from the City University of New York. His works have been published in Information & Management, Decision Support Systems, Decision Sciences, European Journal of Operations Research, International Journal of Production Research, Journal of Operational Research Society, and other journals. His current research interests include knowledge management, supply chain management, quality and reliability management, and technology management.

Bertram Tan is Dean of the College of Management, and a professor of the Institute of Business Administration at Kun Shan University of Technology, Taiwan (ROC). He has a B.S. and an M.S. in industrial management from National Cheng Kung University. He is a doctoral candidate in MIS at Nova Southeastern University. His current research interests include production and operations management, general management, and management information systems.

Shofang Chang is an associate professor of Chia Nan University of Pharmacy & Science. She received her M.P.H. in Healthcare Administration from Columbia University in New York, and a Ph.D. in Business Administration from National Cheng Kung University in Taiwan. Her current research interests include supply chain management, healthcare quality management, and knowledge management.