ANTECEDENT FACTORS OF KNOWLEDGE SHARING IN RESEARCH SUPERVISION

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ANTECEDENT FACTORS OF KNOWLEDGE SHARING IN RESEARCH SUPERVISION

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Abstract

Today’s economy is a knowledge-based economy in which knowledge is a crucial facilitator to individuals, as well as being an instigator of success. Due to the impact of globalisation, universities face new challenges and opportunities. Accordingly, they ought to be more innovative and have their own competitive advantages. One of the most important goals of universities is the promotion of students as professional knowledge workers. Therefore, knowledge sharing and transfer at the tertiary level between students and supervisors is vital in universities, as it decreases the budget and provides an affordable way to do research. Knowledge-sharing impact factors can be categorised in three groups, namely: organisational, individual, and technical factors. Individual barriers to knowledge sharing include: the lack of time and trust and the lack of communication skills and social networks. IT systems such as e-learning, blogs and portals can increase the knowledge-sharing capability. However, it must be stated that IT systems are only tools and not solutions. Individuals are still responsible for sharing information and knowledge. This paper proposes a new research model to examine the effect of individual factors, organisational factors (learning strategy, trust culture, supervisory support) and technological factors on knowledge sharing in the research supervision process.

Keywords: Knowledge management, knowledge sharing, research supervision
1. **INTRODUCTION**

Nowadays, universities face new challenges and opportunities due to globalisation and the development of new technology such as the internet and e-learning. Students’ and lecturers’ demands have changed and they expect to be able to use new technology for research supervision. Supervisors and students are more mobile than before and the demand for flexible research supervision and training is increased. Universities should be able to compete in the international environment, as well as absorbing international students and fulfilling new needs. They should compete comfortably in a knowledge-based economy and society. The main output of universities is research results and new knowledge that should be managed by using knowledge-management techniques. Knowledge-sharing and transfer in universities between students and supervisors is vital for universities, as it can decrease the budget and provide an affordable way to do research. The important objective of universities is to improve students’ skills and educate them to become expert knowledge workers. Yet, the lack of efficiency and effectiveness in the supervision process is one of the challenges that universities face.

It has been acknowledged that one of the greatest challenges in universities is the ability of managers to encourage students and supervisors to exchange their knowledge, experience and ideas among themselves (Zhao, 2001). Therefore, investigating knowledge-sharing factors in the research supervision domain is important in order to enhance knowledge sharing in this domain. Knowledge is now considered to be an asset in an organisation, yet many researchers have concluded that most employees within an organisation are reluctant to share their knowledge (Nonaka and Takeuchi, 1995). The same situation seems to exist in universities; hence, it is worthwhile to investigate the factors that affect knowledge sharing in the research supervision process. Effective knowledge sharing between supervisors and students can be a factor for innovation which leads to a competitive advantage for the university (Jackson et al., 2006). A supervisor should devote more time in order for each student to transmit his or her knowledge to them; some of this knowledge is common for all students and all students need them. Identifying knowledge-sharing factors and improving them can lead to a solution to this problem. Studies have shown that effective knowledge sharing improves overall performance.

The first objective of the present study is to extract the antecedent factors of knowledge sharing from the literature which are suitable and adaptable to the research supervision domain. Accordingly, in this study, most of the antecedent factors of knowledge sharing are extracted from the literature, as well as key success tips in relation to knowledge sharing that are extracted from a research supervision model. We also use a knowledge management model for research supervision (Zhao, 2003) as a superior and based model for factor selection and adaption. The second objective of this research is to develop a research model of knowledge sharing in the research supervision domain. After extracting the relevant knowledge-sharing factors for the research supervision domain, we develop a research model to examine the impact of independent variables on knowledge sharing in the research supervision domain. The independent variables are: the ability of students to share, the culture of the university, knowledge-sharing social networks, flexible structure and design, supervisor support, learning strategy, and IT systems. The research supervision domain is the dependent variable. Based on the literature, we divide the adaptable factors into three categories, namely, individual, organisational and technological factors, and we rely on evidence from the literature to propose one hypothesis for each factor. The third objective of this research is to empirically validate the proposed research model in a real case study setting. For this purpose, a survey questionnaire was developed by preparing measurement items to examine each construct and 150 questionnaires were distributed. We analyse the data by using Smart PLS. The research concentrates on the supervision process of postgraduate students at the Universiti Teknologi Malaysia. The respondents for this research were postgraduate students of the Faculty of Computing at the Universiti Teknologi Malaysia.

In this paper, some supervision models are first mentioned, and the key success points of knowledge sharing are then summarised. Subsequently, the research method is described. The result factors which
are important for knowledge sharing in the research supervision domain are then presented. This is followed by a discussion of the results of our study of a real case; finally, the contributions and limitations of the study are noted, before a summary of the study is presented in the conclusion.

2. Research Supervision Models

In this study, three supervision models were reviewed and used to propose the key success tips of knowledge sharing. These are the supervisory management styles model, the blended postgraduate supervision model, and the knowledge management model, each of which is discussed in this section.

The supervisory management style (SMS) model was proposed by Gatfield and Alpert (2002). It suggested a four quadrant supervisory style management grid which highlights the understanding of the supervisory style and its changes during the supervisory period. The authors argued that supervisors tend to assume that they know which elements of the supervisory process and management styles are more appropriate for success. This model emphasises the following points:

- Supervisors’ support
- Skills of students to manage research and their ability to communicate and collaborate.

The blended postgraduate supervision (BPS) model was proposed by De Beer and Mason (2009) who noted that blended learning is mostly offered in three ways; in the classroom, in the virtual classroom and through online courses. They argued that postgraduate supervision is very similar to blended learning in these delivery methods, with the exception being that there is rarely classroom instruction but rather face-to-face interaction between students and supervisors. The main idea is to provide students with links on web pages that allow students to access various topics either internally through Web CT or the internet. This is an opportunity for students to discuss and consult with their supervisor and use different technology in order to create and share knowledge (De Beer and Mason, 2009). Research is an important way of learning for postgraduate students, in that it allows them to enrich their experiences and extend the boundaries of their knowledge. The use of IT-based communication, social media, online databases and e-learning systems can improve their ability to capture, transfer and share knowledge (De Beer and Mason, 2009). In the area of blended postgraduate supervision, the role of supervisors is to represent the key sources of information to be accessed by students in face-to-face consultations and via the internet and libraries, and then evaluate what the student has gained from it.

Thus, this model emphasises the following points:

- Using web technology
- Using IT-based communication
- Supervisors’ support.

The knowledge management model for the supervision process is the superior model from which we choose knowledge-sharing impact factors, since it is the only research supervision model which is specific for knowledge management and knowledge sharing. Using this approach, we can choose factors which are specific to a research supervision environment. This model was proposed by Zhao (2003). In order for students to graduate successfully, the supervisory process is vital. It is a complex and subtle process. A systematic knowledge-sharing approach is then needed to assist both supervisors and students to obtain, share and apply knowledge. A knowledge-sharing approach means the supervisor focuses on assisting students in order to enhance the knowledge-sharing ability in research supervision. This knowledge-sharing ability refers not only to the skill of using superior technological resources to manage information, but also to the ability to make a decision about selecting and using information (Zhao, 2001, 2003). Furthermore, Zhao maintained that postgraduate supervision encompasses knowledge management
and believes that the effectiveness of supervision can be enhanced by integrating its concepts. Figure 2 depicts the knowledge management model for research supervision.

Knowledge management is an academic advantage and economic resource that promotes the quality of a university and manages the research supervision as a knowledge acquisition process in order to add value to the university. It is also an indicator for governments by which to judge the quality of a particular university. The process of learning occurs when individuals share their knowledge, since knowledge is embedded in the minds of people. The key knowledge-sharing success tips emphasised in the knowledge management model are shown in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Key success tips for knowledge sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flexible structure of university</td>
</tr>
<tr>
<td>2</td>
<td>Learning strategy which leads to a systematic knowledge-sharing approach in a university</td>
</tr>
<tr>
<td>3</td>
<td>Supervisors’ support to enhance knowledge-sharing ability in research supervision (also mentioned in supervisory management style model and blended postgraduate supervision model)</td>
</tr>
<tr>
<td>4</td>
<td>Knowledge-sharing social networks among students and social networks of experts (supervisors and lecturers)</td>
</tr>
<tr>
<td>5</td>
<td>Culture of university</td>
</tr>
<tr>
<td>6</td>
<td>Knowledge-sharing ability of students (also mentioned in supervisory management style model)</td>
</tr>
<tr>
<td>7</td>
<td>Knowledge repositories through guiding students to present and publish their works</td>
</tr>
<tr>
<td>8</td>
<td>IT systems (also mentioned in blended postgraduate supervision model)</td>
</tr>
</tbody>
</table>

Table 1. Key knowledge-sharing success tips in knowledge management model

3. **Methodology**

A quantitative research method was adopted for the research. The quantitative method gives a clear indication of the requirements of the target users, as well as an understanding of the mechanisms of the postgraduate supervision process. In later stages, this understanding helps to devise the most appropriate set of features for the research model and its evaluation. In order to conduct research, it is necessary to have a blueprint that guides the plan of the research project. The following phases are the main steps in our research:

- Extract relevant antecedent factors of knowledge sharing
- Develop a research model of knowledge sharing
- Empirically validate the proposed research model.

3.1 **Extract Relevant Antecedent Factors of Knowledge Sharing (Phase 1)**

In this study, we conducted a systematic literature review to extract knowledge-sharing impact factors and adapt them for the research supervision domain. That review looked at 27 studies, being quantitative research that examined knowledge-sharing factors in different case studies (Khosravi and Ahmad, 2013). These papers were published from 2000 until 2012; among them, three papers were published in a conference. One is in the form of a book chapter and another is in the form of a Master’s thesis, while the rest were published in journals. Twelve (12) papers were obtained from Google Scholar, a further 11 of them were obtained from the Web of Knowledge database, and the rest were obtained from Scopus. From all of these papers,
88 knowledge-sharing impact factors were extracted. Fifty-two (52) of the knowledge-sharing impact factors are organisational factors, 25 are individual factors and 11 are technical factors. From these papers, 11 examined knowledge-sharing factors in educational environments (universities and other educational institutions). Our aim was to extract suitable features for a research supervision domain from these 88 factors. Our criteria for selection came from the research supervision models, especially Zhao’s knowledge management model (2003) which is currently the only model of knowledge management in research supervision. Therefore, based on key knowledge-sharing success tips from the knowledge management model in research supervision, we chose the factors from a total of 88 knowledge-sharing factors and matched them to each of the tips. The result is shown in Table 2. This table is ordered according to the type of factor (individual, organisational and technical) and educational iteration (the number of papers which have used these factors to investigate knowledge sharing in an educational environment) and non-educational iteration.

The first factor is an individual factor, namely, the knowledge-sharing ability of students. This factor was supported by one educational paper (the scope of the paper is aimed at a university or other educational institute) and three non-educational papers. The number of papers that supported this factor was sufficient to select it as an appropriate and adaptable factor for the supervision domain. The next factor is an organisational factor, namely, the culture of the university, which was strongly supported by five educational papers and six non-educational papers. It is therefore obvious that this factor is suitable for the supervision domain. In addition, five other research works examined this factor in an educational environment. The next factor is flexible structure, which was supported by an acceptable number of educational papers (three papers) and four non-educational papers. This factor had enough evidence to justify its use in our proposed research model but was not used because our respondents were postgraduate students who may not have had enough knowledge about the flexible structure of the university. The fifth factor, supervisor support, was supported by one educational paper and three non-educational papers. Hence, it has an acceptable number of iterations to be used for the supervision domain. The learning strategy is the sixth factor. The learning strategy factor was not supported by any educational papers but was supported by six non-educational papers. This factor has not been examined before in an educational environment. It is suitable for the supervision domain and had an acceptable number of iterations but had not been supported by educational papers. The next factor is a technical factor, namely, IT systems, which was strongly supported by four educational papers and three non-educational papers. It is acceptable for a supervision domain. The knowledge repository factor was not supported by educational papers and was supported by only one non-educational paper, so it did not have enough iteration in the literature and was not acceptable for inclusion in this domain. The results of the factor selection for the supervision domain are shown in Figure 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Factor</th>
<th>Type</th>
<th>References</th>
<th>Educational iteration</th>
<th>Non-educational iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge-sharing ability of</td>
<td>Individual</td>
<td>Van den Hooff et al. (2003); Wahlroos (2010); Wangpipatwong (2009); Riege</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Culture of university</td>
<td>Organisational</td>
<td>Agarwal et al. (2012); Boden et al. (2012); Chen and Cheng (2012); Cheng et al. (2009); Hassandoust et al. (2011); Rad et al. (2011); Rhodes et al. (2008); Riege (2005); Sohail and Daud (2009); Tsai et al. (2012); Wahlroos (2010)</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
3 Knowledge-sharing social networks Organisational Chen et al. (2012); Chen and Chen (2009); Chen and Cheng (2012); Chow and Chan (2008); McEvily et al. (2003); Rad et al. (2011); Riege (2005); Willem and Scarbrough (2006); Yue Wah et al. (2007) 3 6

4 Flexible structure and design Organisational Agarwal et al. (2012); McNeish and Mann (2010); Rad et al. (2011); Rhodes et al. (2008); Riege (2005); Willem and Scarbrough (2006); Yue Wah et al. (2007) 3 4

5 Supervisor support Organisational Chen et al. (2012); Chen and Cheng (2012); Wahlroos (2010); Wangpipatwong (2009) 1 3

6 Learning strategy Organisational Chen et al. (2012); Chen and Cheng (2012); Klein (2008); Matzler and Mueller (2011); McNeish and Mann (2010); Rhodes et al. (2008) 0 6

7 IT systems Technological Agarwal et al. (2012); Cheng et al. (2009); Rad et al. (2011); Rhodes et al. (2008); Riege (2005); Wahlroos (2010); Wangpipatwong (2009) 4 3

8 Knowledge repository Technological McNeish and Mann (2010) 0 1

Table 2. Results of factor selection process, sorted by type and iteration

3.2 Develop a Research Model of Knowledge Sharing (Phase 2)

Based on the process of factor selection for the research supervision domain, the conceptual research model of this study is presented in Figure 1.

Figure 1. Conceptual research model

Scientists categorise knowledge-sharing factors with different methods, but most research works divide them into three sub-groups, namely, technical factors, individual factors and organisational factors (Cheng et al., 2009). Organisational factors refer to the factors that have not developed from individual personalities; rather, they are related to the environment of the organisation and the relationship between persons in the organisation. They are organised as external factors. Individual factors are extracted from individual personality traits like beliefs, attitudes and feelings. They are internal factors. Technological factors are related to IT such as software and hardware for knowledge management systems, which are used in sharing activities. Riege (2005) discussed potential knowledge-sharing barriers and divided them into individual, organisational and technological barriers. A study was done by Wangpipatwong (2009) to consider the impact factors that influence knowledge sharing among students. He categorised these
factors into three domains, namely, classroom, individual and technological domains. Wahlroos (2010) also categorised these factors into individual, organisational and technological aspects.

3.2.1 Ability of Students to Share

In the knowledge management model for supervision, Zhao (2003) stated that supervisors focus on guiding students in order to improve knowledge management skills. The ability to manage knowledge helps students to improve their ability to manage advanced IT resources, and enhances their ability to select the right information (Raisinghani, 2000). This approach improves critical thinking which is an important ability for a research dissertation. In the supervisory management style model, Gatfield and Alpert (2002) noted that the students’ levels of motivation and management skills are an important element of the success of a full supervision process. They explained that the ability of students to communicate and share knowledge is one of the dimensions of this model. Riege (2005) noted that there are some individual barriers to knowledge sharing such as the lack of communication skills and social networks, diversity in national culture, a lack of trust, time shortage and more emphasis of position status. This led to the following hypotheses:

H1: Students’ ability to share positively influences knowledge sharing in research supervision.

3.2.2 Culture of the University

Zhao (2003) noted that flexible structures and the development culture of the university are the key prerequisites of knowledge management in motivating students to create and share new knowledge. The process of learning occurs when individuals share their knowledge, since knowledge is embedded in the minds of people. Hence, a knowledge management approach can enhance the process of learning in universities.

Tsai et al. (2012) examined the organisational culture factor and identified reciprocal relationships as a major antecedent of knowledge-sharing intention. Tsai et al. (2012) proposed a conceptual framework for knowledge sharing. In his model, the culture of an organisation has an impact on the intention to share knowledge. He stated that culture was obvious in all aspects of an organisation such as the values, mission and people’s behaviour, and also the culture embedded in the organisation’s assumptions and core values. Tsai et al. (2012) explained that organisational culture is produced by a feeling and similar understanding through the sharing mechanism, from inside and outside the organisation’s members. Therefore, the following hypothesis was proposed:

H2: The educational culture of the university has a significant and positive influence on knowledge sharing in research supervision.

3.2.3 Knowledge-Sharing Social Networks

Zhao (2003) stated that the use of knowledge-sharing social networks among students is one of the popular knowledge-sharing approaches used to enhance learning. These networks use IT such as social media, weblogs and teleconferencing. Zhao also mentioned that networks of experts (supervisors and lecturers) are among the most important infrastructure elements of knowledge sharing in universities. Some researchers have identified social networks as an important organisational knowledge-sharing factor (Chen and Chen, 2009; Chen and Cheng, 2012; Chow and Chan, 2008; Wang and Noe, 2010). A social network means that the staff interactions and communications with each other in both informal and formal ways (Huang et al., 2009; Kim and Lee, 2006). Huang et al. (2009) stated that informal and formal communication and relationships between employees have an important effect on knowledge sharing. Formal communications like training courses and work teams help staff to share knowledge. Therefore, the following hypothesis was proposed:
H3: Social networks among students have a significant and positive influence on knowledge sharing in research supervision.

3.2.4 Supervisor Support

One dimension of the supervisory management style model is supervisor’s support. Hence, the support of the supervisor plays an important role in all related activities of the supervision process, especially knowledge sharing. The blended postgraduate supervision model also emphasises the fact that, without the support of supervisors, the process of using new technology to facilitate supervision and knowledge sharing will not be successful. In blended postgraduate supervision, the role of supervisors represents a key source of information to be accessed by students in face-to-face consultations and via the internet and libraries, and the knowledge which the student has gained from it is then evaluated. The use of technology facilitates creativity and communication, which improves motivation (De Beer and Mason, 2009). In the knowledge management model proposed by Zhao (2003), a knowledge-sharing approach means the supervisor focuses on supporting students in order to improve their knowledge-sharing skills. In this model, supervisors’ support is vital for the knowledge management approach and for successful knowledge sharing in the research supervision process. Therefore, the following hypothesis was suggested:

H4: Supervisor support positively influences knowledge sharing in research supervision.

3.2.5 Learning Strategy

Learning strategy in this study refers to the strategy of the university to improve the learning process. This strategy can enable and motivate the university managers to find and provide new solutions to enhance the quality of education. This strategy covers all aspects of education. Therefore, it should improve the process of research supervision as part of the learning process for research students by using mechanisms such as knowledge sharing. An appropriate learning strategy in a university which leads to a systematic knowledge-sharing approach is needed to assist both supervisors and students to obtain, share and apply knowledge. A knowledge-sharing approach means that the supervisor focuses on assisting students in order to enhance their knowledge-sharing ability in research supervision (Zhao, 2003).

Organisational learning is derived from the ability to learn from other employees and the culture of openness within an organisation. These factors could have a significant effect on the knowledge-sharing process in the organisation (Rhodes et al., 2008). Van Den Brink (2001) stated that the learning strategy in organisations is one of the most effective organisational enablers for knowledge sharing. In a university, which is a knowledge-based organisation, an appropriate learning strategy is vital to contribute to knowledge sharing and publishing. The following hypothesis was therefore proposed:

H5: Learning strategy has a significant and positive influence on knowledge sharing in research supervision.

3.2.6 IT Systems

Many researchers have pointed out that IT systems are an important mechanism in knowledge management (Agarwal et al., 2012; Bharadwaj, 2000; Cheng et al., 2009; Wahlroos, 2010). Davenport and Prusak (1998) found that the use of IT systems had a positive relationship with knowledge sharing. They concluded that IT improves an organisation’s performance and increases the rate of knowledge sharing within the organisation. In the blended postgraduate supervision model, the online software application facilitates the supervision process (De Beer and Mason, 2009). In the knowledge management model of Zhao (2003), students and supervisors use IT systems (such as the email system and e-learning) to communicate and share knowledge. Thus, using IT systems can lead to a more flexible and high quality research supervision process. Therefore, the hypothesis was derived as follows:
H6: The use of IT systems has a positive and significant influence on knowledge sharing in research supervision.

3.3 Empirically Validate the Proposed Research Model (Phase 3)

To examine our hypotheses, in the first phase, we extracted measurement items from the literature and changed them according to our domain. In this step, we extracted five questions for each variable; next, we consulted five experts in order to validate the content of the constructs, to ensure that our constructs were related to each variable and suitable for the research supervision domain. The next step was face validity, in which we asked ten postgraduate students to fill in the forms and give feedback on the questionnaire. The questionnaire was revised based on their suggestions. In the second phase, we distributed our survey questionnaire among 30 postgraduate students in the Faculty of Computing to check the reliability of the questionnaire. After the pilot study and ensuring the reliability of the survey questionnaire, we distributed our survey questionnaire among 187 postgraduate students in the Faculty of Computing (real study) and checked the convergent validity and discriminant validity. The partial least squares (PLS) technique allowed us to use measures about the internal consistency, discriminant validity and convergent validity of the research model. These measures calculate the strength of associations among the definite constructs (Hulland, 1999). Internal consistency, discriminant validity and convergent validity are the fundamentals that the research model should have. After analysing all the data, demographics and descriptive statistics based on the structural equation modeling (SEM) method, we conducted path analysis by using Smart PLS and t-values on the path in order to determine whether or not our hypotheses are supported. The results on internal consistency (Cronbach alpha, item loading and composite reliability) were obtained for seven constructs in the real study (N=150). The results show that internal consistency for all the constructs was confirmed because of two reasons:

1. The results showed the alpha value and composite reliability of all the constructs are acceptable values that support adequate internal consistency because they are greater than the recommended value (more than 0.70) (see Table 3).
2. The item loadings of all the measures with their respective constructs are more than 0.70 (see Table 3).

<table>
<thead>
<tr>
<th>Construct</th>
<th>Valid</th>
<th>Missing</th>
<th>Cronbach Alpha</th>
<th>Composite Reliability</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS: Ability of students to share</td>
<td>150</td>
<td>37</td>
<td>0.856641</td>
<td>0.913058</td>
<td>0.778068</td>
</tr>
<tr>
<td>CU: educational Culture of university</td>
<td>150</td>
<td>37</td>
<td>0.873225</td>
<td>0.912955</td>
<td>0.723918</td>
</tr>
<tr>
<td>SN: Social networks</td>
<td>150</td>
<td>37</td>
<td>0.868503</td>
<td>0.910677</td>
<td>0.718748</td>
</tr>
<tr>
<td>SS: Supervisor support</td>
<td>150</td>
<td>37</td>
<td>0.852637</td>
<td>0.900635</td>
<td>0.694104</td>
</tr>
<tr>
<td>LS: Learning strategy</td>
<td>150</td>
<td>37</td>
<td>0.842941</td>
<td>0.905428</td>
<td>0.761799</td>
</tr>
<tr>
<td>IS: IT systems</td>
<td>150</td>
<td>37</td>
<td>0.911763</td>
<td>0.938080</td>
<td>0.791373</td>
</tr>
<tr>
<td>KS: Knowledge sharing</td>
<td>150</td>
<td>37</td>
<td>0.829490</td>
<td>0.886559</td>
<td>0.661632</td>
</tr>
</tbody>
</table>

Table 3. Cronbach alpha and composite reliability of real study (N=150)

Convergent and discriminant validity are the prerequisites the proposed model should possess. When each construct has an average variance extracted (AVE) of at least 0.5, we can be sure about the convergent validity (Ifinedo, 2011; Lin et al., 2012). The AVE determines the average variance shared in a construct, with high AVE indicating that the spread data has low variance. Adequate discriminant validity is assured when two conditions are met. First, each item should have an item loading greater than 0.6 on its respective construct. Second, the square root of the AVE which is providing a measure of the variance shared between a construct and its indicators of all the constructs should be larger than all other cross-correlations, and no item should load highly on any other constructs (Chen and Cheng, 2012; Ifinedo, 2011). The R^2 indicates the percentage of a construct’s variance in the model, and the predictive power of the model for dependent variables highlighted with it (Chow and Chan, 2008; Ifinedo, 2011; Lin et al., 2012). The path coefficients (β) indicate the strength of the relationship.
between the independent and dependent variables (Ko et al., 2005). The hypotheses testing were done by following Chin’s (1998) guidelines; Chin recommended that the path significance be estimated through t-test values by using the bootstrapping procedure. Normally, a t-value >2 means a significant level. In addition, based on previous studies, a p-value <0.05 confirms that the related hypothesis is significant (Ifinedo, 2011). The results are reported in Table 4 and Figure 3. This approach is consistent with recommendations and use in previous studies published in information systems journals (Lin et al., 2012).

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path coefficient</th>
<th>t-values</th>
<th>p-values</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: Ability of students to share</td>
<td>0.257606</td>
<td>3.729358</td>
<td>0.000271612</td>
<td>Support ***</td>
</tr>
<tr>
<td>H2: educational Culture of the university</td>
<td>0.178563</td>
<td>2.327217</td>
<td>0.021291133</td>
<td>Support **</td>
</tr>
<tr>
<td>H3: Social networks</td>
<td>0.170086</td>
<td>2.393706</td>
<td>0.017914941</td>
<td>Support **</td>
</tr>
<tr>
<td>H4: Supervisor support</td>
<td>0.163350</td>
<td>2.197555</td>
<td>0.029514277</td>
<td>Support*</td>
</tr>
<tr>
<td>H5: Learning strategy</td>
<td>0.030527</td>
<td>0.528810</td>
<td>0.597718871</td>
<td>Not Supported</td>
</tr>
<tr>
<td>H6: IT systems</td>
<td>0.252477</td>
<td>3.580798</td>
<td>0.000462081</td>
<td>Support ***</td>
</tr>
</tbody>
</table>

Table 4. Summary of the results

The results revealed that all the preceding constructs together accounted for 85% of the variance in the dependent construct: knowledge sharing (R2=0.85). The ability of students to share (β=0.257606, t-value=3.729358>2, p<0.001) and IT systems (β=0.252477, t-value=3.580798, p<0.01) were found to have the greatest impact on knowledge sharing in the research supervision domain; however, the impact of the culture of the university (β=0.178563, t-value=2.327217>2, p=0.021291133<0.05), social networks (β=0.170086, t-value=2.393706>2, p=0.017914941<0.05) and supervisor support (β=0.163350, t-value=2.197555>2, p=0.029514277<0.05) is not significant on knowledge sharing in the research supervision domain. On the other hand, learning strategy (β=0.030527, t-value=0.528810<2, p=0.597718871>0.05) was not found to have an impact on knowledge sharing. Therefore, only five hypotheses (H1, H2, H3, H4 and H6) from six hypotheses were supported. The results are discussed in the next section.

Figure 3. Smart PLS 2.0 results for the tested relationships
4. Discussion and Findings of the Research

This study presents the statistical results from a survey questionnaire distributed among students of the Faculty of Computing at the University of Technology, Malaysia. The results indicate that the most important individual factor in the research supervision domain, namely, the ability of students to share knowledge, has the greatest impact on knowledge sharing in the supervision process. More than 80% of the respondents had more than six years of computer experience. Computer experience is an important ability that plays a significant role in knowledge sharing. Hence, this study confirms that an individual factor such as the ability of students has a positive impact on knowledge sharing in research supervision. Van den Hooff et al. (2003) also found that an individual’s ability and willingness to share have positive effects on knowledge sharing.

In the eyes of students, the culture of the university has a significant impact on knowledge sharing in the research supervision process. The results are consistent with the findings from Sohail and Daud (2009) who noted that the culture of a university has an impact on knowledge sharing among the university staff. The results are also confirmed by the findings of Connelly and Kelloway (2003) who noted that a positive social interaction culture is a significant predictor for a positive knowledge-sharing culture. The results confirmed a positive relationship between social networks and knowledge sharing in the research supervision. Chen and Chen (2009) also noted that social network ties are significantly related to a knowledge-sharing intention. The results showed a positive relationship between supervisor support and knowledge sharing in research supervision, but the supervisor support factor did not have the highest impact on knowledge sharing in this study. The results did not confirm a positive relationship between learning strategy and knowledge sharing in research supervision. The results are consistent with the findings from Rhodes et al. (2008) who noted that the learning strategy factor did not have a significant impact on knowledge sharing.

The overall results on the organisational factors (culture of the university, social networks, supervisor support, learning strategy) show that organisational factors have a positive impact on knowledge sharing in research supervision. However, in comparison with individual and technical factors, the effect of the organisational factors on knowledge sharing in research supervision in the case investigated in this study was not strong. For example, the relationship between learning strategy and knowledge sharing in research supervision was not confirmed. In addition, other organisational factors, such as supervisor support, had a very weak impact on knowledge sharing in research supervision. Most of the Faculty of Computing respondents stated that their ability to share knowledge was very high. Further, they reported that the IT systems at their university strongly supported knowledge sharing; however, most of the students stated that they only sometimes shared their knowledge about their research with others. Hence, the rate of sharing knowledge was low between students. This can be seen by the fact that organisational factors like knowledge-sharing strategies and supervisor support are the most important factors that activate and use individual and technical factors to facilitate knowledge sharing. Therefore, in the case of the Faculty of Computing at the University of Technology, Malaysia, because of the lack of integration between learning strategies and knowledge-sharing strategies, as well as the weakness of the supervisor support of knowledge sharing, the overall rates of knowledge sharing between students were not high. For example, most of the students did not know that some other students had carried out research in very similar areas. Thus, they were not able to share their knowledge and help each other to improve their research and the research supervision process.

The results suggest that individual factors, such as the ability of students to share knowledge and use technology to share knowledge, are a fundamental base for knowledge sharing. However, organisational factors are the most important drivers by which to use other factors to enhance knowledge sharing. The results show that IT systems have a significant effect on knowledge sharing in the research supervision process. According to the fourth objective of this study, technological factors such as IT systems are found to have a positive impact on knowledge sharing in research.
The main goal of this study was to propose the antecedent factors of knowledge sharing in research supervision. Based on a structural model test, it is found that the proposed research model could help to confirm the most important antecedent factors of knowledge sharing in research supervision. This is because $R^2$ (which indicates the power of the model for the dependent variable, namely, knowledge sharing) was 85%.

5. **Research Contributions and Limitations**

This study can assist university managers and research supervisors to understand which factors are effective for knowledge sharing in the research supervision process, in order to improve the performance and quality of the supervision process. Studies have shown that effective knowledge sharing can improve overall performance, efficiency and effectiveness in the supervision process and can enhance innovations in universities. The primary goal of a knowledge-sharing approach towards research supervision is to enhance the quality of research education, by which students’ learning and research experience is transformed. Knowledge sharing helps to decrease the budget and is an affordable way of doing research in universities. It also aids students to complete their postgraduate degrees within the regulated timeframe. The results of this research could prompt university managers to provide structures that would motivate students and supervisors to share their knowledge. This motivation can be in the form of rewards, recognitions, status, or enhancement of reputations. Many studies have been conducted to verify the impact of different factors on knowledge sharing in organisations. However, this study is among the first of its kind to empirically examine the antecedent factors of knowledge sharing in the context of research supervision. The research has some limitations. Only a single university was used; therefore, the findings may not be statistically relevant for other universities. An Asian university was used and therefore the results may not be relevant across different cultural settings. Thus, the findings of this study may not be applicable to a differing social context.

In general, the conclusions derived from a large number of studies are likely to be more reliable. One obvious issue is the inadequate number of studies on knowledge-sharing impact factors in an educational environment. The size of the sample of some studies in the literature was limited and, hence, care should be taken when generalising the findings of these studies. Although the knowledge-sharing impact factors extracted in this study were based on extant research findings, due to the rapid change in the business environment, these knowledge-sharing factors may have changed over time.

6. **Conclusion**

This study developed a research model to examine the effect of individual, organisational and technological factors on knowledge sharing in the research supervision domain. The development of this model was based on systematically analysing and extracting all the knowledge-sharing impact factors and then choosing the ones that can be adapted to the relevant domain. This was in accordance with research supervision models for the research supervision domain. The development of the research model was then followed with an evaluation.

A number of conclusions can be drawn from the findings of the study. First, the only important individual factor in the research supervision domain was the ability of students to share knowledge. This factor had the greatest impact on knowledge sharing in the supervision process. Second, in the eyes of students, the culture of the university, social networks and supervisor support all had a significant impact on knowledge sharing in the research supervision process. However, the supervisor support factor was not found to have the highest impact on knowledge sharing in this study. In addition, a positive relationship was not found to exist between a learning strategy and knowledge sharing in research supervision. Third, the results showed that the use of IT systems had a significant effect on knowledge sharing in the research supervision process. The overall results of the organisational factors (culture of the university, social
networks, supervisor support, learning strategies) showed that organisational factors had a positive impact on knowledge sharing in research supervision. However, in comparison with individual and technical factors, the effect of organisational factors on knowledge sharing in research supervision in the case investigated in this study was not strong. All the knowledge-sharing impact factors that were adapted from the literature for the proposed model were related to more iterative factors which are used in different domains. As a result, new studies can use this model to examine these antecedent factors in other domains. Researchers can also extend this model by using it in other universities with different cultures.

Further research in other higher education institutions is needed to empirically assess the effect of individual, organisational and technological factors on knowledge sharing in the research supervision domain. In addition, it is recommended that new research should be undertaken to assess not only the impact of individual, organisational and technical factors on knowledge sharing in the supervision domain, and also assess the effect of knowledge sharing on the quality of both the learning experience and the research process. Understanding the effect of knowledge sharing could also enhance the completion rate of students and promote critical thinking.

References
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