High Educ (2016) 71:525–556
DOI 10.1007/s10734-015-9922-6

Enhancing knowledge sharing and research collaboration among academics: the role of knowledge management

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Published online: 11 July 2015

Abstract Although knowledge sharing (KS) has been acknowledged as important, universities face issues that may hinder active sharing among its faculty members such as the absence of trust among its members or insufficient incentives rewarded to those who deserved it. The aim of this research is to focus on the impact of knowledge management (KM) factors in encouraging KS among academics. As such, this study sheds insights into existing literature through the inspection of the KM factors in one single KM-KS-Collaboration research model that provides an influential theoretical contribution for research in related fields because it suggests that faculty members' KS is positively related to openness in communication and face-to-face interactive communication. A self-administered questionnaire using a quota-sampling method with 421 usable responses from 94 professors, 154 associate professors, and 173 senior lecturers were gathered. Partial least squares was employed for a series of data analyses: measurement and structural models assessment. From the analysis, all constructs have composite reliability values more than 0.7 and demonstrate adequate convergent and discriminant validity by having average variance extracted value greater than 0.50. The findings revealed that members' KS is influenced by trust, organizational rewards, organizational culture, KM system quality, openness in communication and face-to-face interactive communication whereas research collaboration is strongly influenced by KS. This study has reinforced the understanding of KM factors, KS and research collaboration within the context of academic staff in research universities.

Keywords Knowledge management · Knowledge sharing · Research collaboration · Research universities · Academic staff

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Introduction

The research universities have been recognized as knowledge-based organizations (Goddard 1998), which revolve around several key knowledge processes: knowledge creation; knowledge dissemination and learning (Trifonova and Ronchetti 2006). A university's strategic approach in knowledge management (KM) can lead to the subsequent advancement and growth advantage that come hand in hand with knowledge sharing (KS) because collaboration in research is the breeding base for new knowledge. As such, making KS the central focus cannot be taken lightly (Chen et al. 2009a, b).

Each research university has its own set of faculty members working on projects with knowledge and working experience in research work for a number of years. This demonstrates that KS is necessary to the university in general and specifically to the faculty members' career advancement, reputation, and self-empowerment (Patel and Ragsdell 2011). Through research collaboration via KS, the research universities are able to support their academic staff in sharing their knowledge, thus helping them in their research work by allowing them to create new theories and ideas and establish new research principles. Sadly, it seems that numerous establishments including research universities are still unable to grasp the importance of KM, resulting in the slow absorption of implementing KM initiatives and activities in their institutions. As postulated by Graeme Mackay (i.e., a principle consultant of International Computers Limited), KS only happens when the right KM environment takes place. Consequently, besides encouraging academic staff to share their knowledge, it is also imperative that the research universities should not take KM lightly since KS does have a long-term impact on collaborative research work. Thus, concentrating on the importance of KM in academic institutions is necessary so as to understand the readiness of universities in maintaining a knowledge-based society for sharing quality resources, expertise, research practices, and collaboration (Jandaghi et al. 2014; Petrides and Nodine 2003). Since institutions manage, combine and share knowledge among their academic staff, KS should be highly encouraged and consistently practiced in the culture of academic institutions to support Malaysia's knowledge-based economy—a thrust mentioned in the Seventh Malaysian Plan (1996–2000) necessary for achieving Vision 2020.

In this study, the KM factors are separated into (1) individual, (2) organizational, (3) technological, and (4) communication factors, which are crucial for enabling KS to occur. The research universities will need to be aware and provide necessary KM conditions to encourage faculty members to (1) trust each other, (2) work together (i.e., collaborate) as a team, (3) be motivated to share ideas and (4) engage in discussions through distinct communications methods, particularly on how to share information and knowledge in order to generate new knowledge (Van den Brink 2003). These conditions have been proposed as prerequisite to allow knowledge to be shared to further support and strengthen collaboration among faculty members in research universities (Chen et al. 2009a, b; Fong and Chu 2006; Suhaimee et al. 2006).

However, several obstacles are found to impede KS. A principle barrier dominating at individual level concern is lack of trust (Azudin et al. 2009). As emphasized by Fong and Chu (2006), the lack of trust, fear among academic staff towards KS and their resistance to change are barriers for KS and the greatest KM obstacle to overcome. The university sees the lack of trust in terms of KS among faculty members (in both knowledge receivers and givers) as detrimental towards KS. A related analysis done by Lee and Al-Hawamdeh (2002) found that acquired knowledge gained during working years lead to a vast amount

of knowledge and skills. These will be lost if not properly cultivated. Therefore, Riege (2005) cautioned that research universities must ensure that the most concise and accurate knowledge is transmitted as most members are unlikely to share without trust.

At the organizational level, researchers outlined the main organizational barriers to KM, which concern (1) lack of management and administrative directive in terms of the gains and values of KS practices, (2) lack of top management support and participation, (3) no rewards or rather lack of transparent rewards in monetary and non-monetary terms for encouraging the sharing of knowledge, and (4) existing organizational culture that does not provide sufficient support for sharing practices (Chen et al. 2009a, b; Fong and Chu 2006; Subramaniam 2007). Riege (2005) added that the lack of managerial and leadership (i.e., organizational) support in terms of on-going support, training and clear guidelines can compromise KS practices in universities.

An additional significant discussion on issues pertaining to the barriers of technological findings include: (1) employees' unrealistic expectation on KM system, (2) mismatch between employees' needs with that of an integrated KM system and processes that restrict sharing practices, (3) lack of integration of KM system processes; lack of compatibility between diverse information technology systems and processes and (4) insufficient training in familiarizing with the KM system and processes are among the principle setbacks concerning technology usage (Chen et al. 2009a, b). The resistance and hesitance to accept technologies in KS is most likely due to the perception that it is a hassle to use technology. As such the use of KM systems (to collect, store and distribute knowledge) made available by research universities is still very much an obstacle (Riege 2005). Inevitably, this reluctance has deterred and prevented collaborative research among members.

More recently, published literature has emerged concerning poor and restricted communication that discourage the sharing of knowledge (Chen et al. 2009a, b; Cleaveland and Eliis 2014). Cohen and Levinthal (1990) stated that KS involved constant verbal interaction and communication between faculty members in order to achieve improved performance. Cormican and Dooley (2007) and Riege (2005) argued that the lack of effective communication fundamental to the effectiveness of KS will hinder the transfer of knowledge. The lack of extensive, continuous, and rich communication Beck et al. (2003) will in turn lead to the lack of or ineffective communication climate in research universities. That has a direct influence on the level of confidence and devotion among faculty members towards KS. Based on this, barriers to communication must be isolated in allowing KS and research collaboration to exist (Reid and Bardzki 2004).

This study, therefore investigates "How does KM factors influence faculty members to share knowledge that will further drive research collaboration in Malaysian research universities?" It is known that no prior empirical studies that directly explored the influence of KM factors i.e., individual, organizational, technological and communication factors on the KS in the university context. Motivated by the issues mentioned, this research aims to examine the influence of the individual (i.e., trust, knowledge self-efficacy, reciprocal benefits), organization (i.e., top management support, organizational rewards, organizational culture), technological (i.e., KM system infrastructure and KM system quality) and communication contexts on KS and research collaboration among academics in research universities. The research model and hypothesized relationships are tested by data collected by academics (including professor, associate professor, and senior lecturer) based at research universities in Malaysia. Furthermore, the findings of this study contribute to empirical research on theoretical studies that focuses on the communication factor (Zhuge 2008), which may be a significant KM factors that influences KS among academic staff.

Theoretical background

This study investigates the KM factors: individual, organizational, technological, communication and its contextual factors that influence KS among academic staff in supporting research collaboration within research universities in Malaysia. The following sections explain each of the individual-organizational-technological-communication KM factors.

Individual KM factors

Trust is central to KS (Jain et al. 2015). It is recognized as the willingness of a faculty member to engage in a strong relationship with his or her colleague, which will further lead to the sharing of knowledge with those that he or she trusts. With the absence of trust, academics (i.e., knowledge contributors) in universities do not have the assurance that the knowledge seekers will not exploit the knowledge against their interest. Conversely, knowledge seekers do not have the certainty that the knowledge contributors are eagerly offering the appropriate type of knowledge (Yusof and Suhaimi 2006). As a result, a low volume of knowledge is shared among faculty members (Currall and Judge 1995) as they are more likely to hide what they know. In certain conditions, the choice to exchange knowledge is based on trust (Huemer et al. 1994). Therefore in KM, this study argues that trust is a vital factor in the link between knowledge provider and recipient in an academic institution (Yusof and Suhaimi 2006). This is considered to be the first step towards an effective KS especially when it comes to creating and sustaining KS among academic staff within research universities.

Knowledge self-efficacy, derived from self-efficacy theory (Stone 1974) is the belief that an individual would value his or her knowledge. Termed as individual's opinions about the importance of shared knowledge to other members, knowledge self-efficacy speculates on an individual's achievement level in addition to the willingness to undertake a task, which is partially derived from the individual's beliefs about his or her competence and ability at sharing. Luthans and Church (2002) highlights that knowledge self-efficacy is usually demonstrated among faculty members who understood that their knowledge can facilitate in resolving work-related matters and improve work efficacy. It has been proposed that self-efficacy encourage faculty members to have faith in their ability to share valued knowledge with their colleagues (Bock et al. 2005; Kankanhalli et al. 2005; Lin et al. 2009; Wasko and Faraj 2005). This is because members who have greater self-efficacy are more inclined to accomplish interrelated behavior as compared to those with little self-efficacy (Hsu et al. 2007). In such cases, faculty members having greater self-efficacy are persuaded to share their knowledge with others while those who have little self-efficacy are less inclined to contribute their knowledge because they assume that their contribution would not bring benefit or have any positive impact on the university.

Reciprocity refers to the degree in which a faculty member has faith in which he or she can enhance mutual relationships with others through his or her KS (Bock et al. 2005). Reciprocity can inspire KS when faculty members in the universities who share their knowledge with others assume that they stand to gain from their sharing behaviors because they expect to receive useful knowledge in return (Davenport and Prusak 2000). For that reason, reciprocal knowledge can be defined as future knowledge requests that are met by others (Kankanhalli et al. 2005). Essentially, Lin (2007a, b) described that reciprocal behavior in a faculty/school can offer a sense of shared gratitude; inspiring knowledge providers to improve their relationships with each other and to be able to expect future help

from others, thereby ensuring an on-going supportive KS. Several researchers (Lin et al. 2009; Lin 2007a, b) regard the significance of reciprocal benefits as significant because it facilitates KS among academic staff, allowing them to attain long-term collaboration in research universities (Bock et al. 2005; Kankanhalli et al. 2005). Therefore, it can be anticipated that if the faculty members have faith that they can acquire reciprocal benefits from others by contributing their knowledge, they have a higher possibility to perceive KS positively and consequently have greater inclination to impart what they know within their university.

Organizational KM factors

In KM, top management support has always been regarded as one of the main possible influences on organizational information (Connelly and Kelloway 2003), particularly when it comes to the KS climate in universities (Lin 2007a, b; Lin et al. 2009). Top management support in universities include the conveying of message that KS is vital to an institution's performance, such as contributing towards financial support and other funds for infrastructure and for significantly expanding its knowledge sphere (Xu and Quaddus 2012). It is assumed that if there is a lack of dedication and participation from top management, KS would not succeed in academic institutions (Liebowitz and Beckman 1998). Top management support, for example, faculty/school deans and department heads who exhibit behaviors of KS themselves and getting other influential faculty members to publicly share their knowledge also act as a driver of overall research collaboration.

Rewards are necessary in KM to stimulate faculty members' performance and to support a university's strategy, to attract and retain faculty members with the knowledge, expertise, and skills necessary to realize the university's objectives, in order to form an encouraging KS background and structure (Kilmann 1989). Fair and objective performance-based rewards will boost the enthusiasm of faculty members towards the generation of fresh knowledge and sharing them (O'Dell and Grayson 1998). Organizational rewards ranging from financial motivation such as better stimulus and bonuses to non-monetary benefits such as promotion incentives and career security (Davenport and Prusak 2000) shape the behavior of faculty members (Cabrera and Bonache 1999). Faculty members would develop a greater willingness to share knowledge by offering their knowledge to others, only if they believe that they can receive expected incentives from the university's top management. As a whole, rewards stimulate KS as members are given incentives for their work (McDermott and O'Dell 2001).

In universities, the key to sustained KM is the organizational culture that forms an environment in which information and expertise can exist (Lemken et al. 2000). As observed by Gupta and Govindarajan (2000), culture is a major player in assisting KS since an effective culture is crucial for effective KS in universities. Hooff and Huysman (2009) acknowledged that organizational culture is related to KS in the sense that actual interactions between faculty members create organizational culture. Soliciting feedback, asking questions, providing instructions or advice on what needs to be done, asking others for help, request for teamwork (in terms of collaborations), asking for advice, giving advice on what needs to be done and most importantly why it needs to be done, enquiring on whether members would do differently and also the sharing the know-how and know-why information should be the common cultural activities among faculty members. Therefore, to ensure that the KM inspires KS works, universities must begin by first implementing the culture that recognizes KS as part of its practice. As a matter of fact, a study performed by De Long and Fahey (2000) discovered that culture affects KS by 80 %. It appears that

Stoddart (2001) also emphasized that KS in universities will only work if its culture promotes it.

Technological KM factors

Knowledge management system infrastructure refers to the information technologies that allow KM-related activities, such as web-based storage, virtual communities, Internet, intranet, groupware, video conferencing, group support systems, distance education tools, online group discussion, portal technology, instant messaging (i.e., Blackboard, WebCT), and e-mail (Lin 2011). By doing so, KM system infrastructure is able to capture and share knowledge in the university by allowing common access to information. Universiti Putra Malaysia (UPM), for example developed a KM portal, known as UPM KM Portal that acts as a corporate repository for the input of the curriculum vitae of faculty members and knowledge assets by providing instant access and reviews to experts in the university, thereby allowing executive decision-making and the identification of intellectual wealth attained by UPM. A well-built KM system infrastructure permits universities to develop existing social networks and encourage communication primarily amongst research teams and departments that are physically apart, thus accomplishing successful collaborative research events (Pan and Leidner 2003). Therefore, KM system infrastructure allows easy access among faculty members to share their knowledge, especially those who are too pre-occupied to work face-to-face on research-related matters (Connelly and Kelloway 2003). Jarvenpaa and Staples (2001) observed that KM system infrastructure increased both technical and social connectivity in universities by facilitating information and KS. Hence, the research universities must therefore decide on the most appropriate KM system infrastructure that can be provided as a platform, which consists of digital media, computer storage, Web technologies, system software, application software, networks, and information technology tools.

Knowledge management system quality refers to the quality of knowledge offered by the KM system (Lin 2011) that consists of knowledge availability, dependability, precision and significance that is highly valued by individuals of an institution (Nelson et al. 2005). Kulkarni et al. (2007) proposed that higher-learning institutions require sophisticated KM systems which are accessible and effortlessly leverage KM practices among academic staff. To encourage KS beyond the confines of a university, a KM system should provide appropriate functions with excellent qualities (Alavi and Tiwana 2002). KM system quality is an enhanced construct that originates from system quality in the information system field (Wu and Wang 2006), which may comprise of accessibility, user-friendliness for retrieval and input, search ability, flexibility in meeting needs, stability, documentation and response speed (Kulkarni et al. 2007). Universities with better KM system availability and sophisticated KM system quality have a higher possibility of generating sources of sustainable development and growth in KM. This study anticipates the higher the KM system quality, the more knowledge will be shared by academic staff.

Communication KM factors

In KM, openness in communication is distinguished as the extent to which individuals are keen to exchange their opinions with each other, even if it opposes the sentiments of the majority. It is this open and honest communication among academic staff (Kim and Ju 2008) that acts as major and positive stimuli on KS in establishing a learning culture in universities (Marquardt and Reynolds 1994). In universities, open communications occur

when faculty members are able to express their ideas with one another, such as in a conversation or debate. Most importantly, in an open communication, the eagerness of the members to converse will further enhance their working relationships if they are consciously aware of the advantages in sharing knowledge. In doing so, the research universities can provide various open and regular contact activities such as conferences, seminars, workshops and KS sessions to discuss views, concepts, and knowledge. Such opportunities will make members realize the gains derived from sharing their knowledge, will further enhance their willingness to communicate with each other (Kim and Ju 2008).

Face-to-face interactive communication in KM refers to personal communication by means of verbalized dialogues and body language while conversing (Alavi and Tiwana 2002). Since most knowledge is shared socially (Smith and McKeen 2003), face-to-face interactive communication among faculty members has been an essential activity in influencing KS. Whenever members in universities communicate or talk with each other regarding their work, knowledge has been imparted (Connelly and Kelloway 2003). Sharing of knowledge can occur via face-to-face interactive communications via networking with other members or recording, arranging and seizing knowledge from others (Cummings 2004). Previous studies in academic institutions have indicated that individuals obtain two-thirds of their information from face-to-face interactive communication and only one-third from documents (Davenport and Prusak 2000). This denotes that members are highly expected to turn to friends and colleagues for answers to their research problems rather than other sources of information (Cross and Baird 2000). As a type of effective communication, face-to-face interactive communication considers conversation between members as an effective channel for KS as it eases the transition and expansion of the more severely ingrained TK. For example, KS can happen between academic staff through conversations over a cup of coffee with the purpose of helping each other in work-related matters so as to perform in a more efficient manner. Connelly and Kelloway (2003) observed that whenever a faculty member participates in face-to-face interactive communication, it will indirectly reduce the status differentials that exist among them. When status differentials have been reduced, it may encourage interaction among members, which may in turn increase KS.

KS and research collaboration in research universities

At present, numerous research literature identified KS as the most important and desired KM process that knowledge-intensive academic institutions should look forward to. As stated by Gurteen (1999), KS carries four items of importance: (1) to create new knowledge to achieve competitive advantage, (2) to carry on the knowledge because when members leave, their knowledge depart along with them, (3) many universities have a problem of 'we do not know what we know' due to the fact that expertise imparted and harnessed in one segment of the faculty/school is not brought together in another and (4) to accelerate change in technological, organizational and individual perspectives since "50 % of what we knew 5 years ago is probably obsolete today" (p. 2).

Laycock (2005) confirms that, in knowledge-focused universities, effective on-going collaboration among academic staff is highly dependent on KS. In research universities, KS is highly dependent on effective on-going research collaboration such as research and development that not only recognized the importance of adding value, but also in creating new value (Laycock 2005). Multiple collaborations bring faculty members together to solve issues or to participate and discuss common work tasks, allowing intense interaction, exchanges of ideas and the application of knowledge from members (Powell 1998). In fact,

multiple collaborations that each member has within and across research teams or centers are the fundamental basis of KS in universities (Argote et al. 2003).

The KM-KS-Collaboration research model proposed in this study consist of the KM factors (i.e., the individual-organizational-technological-communication), KS and research collaboration constructs. The KM-KS-Collaboration research model is shown in Appendix 1.

Methods

Sample and data collection

A quota-sampling method was used to ensure that all three subgroups (i.e., professors, associate professors and senior lecturers) in the academic staff population are adequately represented. Quantitative research design by utilizing self-administered questionnaire (i.e., Internet and drop-off surveys) was engaged for gathering data from the sample of faculty members in the five research universities, in Malaysia: (1) Universiti Malaya (UM), (2) Universiti Kebangsaan Malaysia (UKM), (3) Universiti Teknologi Malaysia (UTM), (4) Universiti Putra Malaysia (UPM) and (5) Universiti Sains Malaysia (USM). As discussed, the proposed KM-KS-Collaboration research model was evaluated using a sample of academics involving professors, associate professors and senior lecturers as respondents. All respondents are full-time academic staff since the number of part-time academic staff is insignificant in Malaysian universities. The reason for choosing professors, associate professors and senior lecturers from the five research universities as respondents in this current study is because these faculty members are avid researchers. For instance, they are known to actively share their knowledge through published journals and conferences, conducting workshops and seminars etc. This indicates that they belong to the category which frequently shares their knowledge. Thus, the focus of this research is to find out the KM factors that encouraged them to disclose their knowledge.

Constructs are operationalized by using 7-point Likert scales that require respondents to provide a response along a range of probable answers, varying from 1 (representing strongly disagree) to 7 (representing strongly agree). To ensure a true account of sampling size, the records at the Ministry of Higher Education have revealed a total population size of 9776 academic staff in these five research universities. Apparently Cohen et al.'s (2011) guideline is met since the sample size obtained (i.e., $N = 421$) exceeds the minimum required for conducting this study.

In this study, two types of pre-test methods were conducted: (1) expert panel—the instrument was judged and determined if any problems exists, and (2) field survey—utilized a minor sample denoted as 'pre-test' (Zikmund et al. 2009). A sampling frame for a pre-test that correspond with the population of selected academic staff based at five research universities. As for the pre-test sampling size, 200 questionnaire sets were distributed to the faculty members in these five universities. The first step concerned the distribution of the draft to a team of three experts. Each expert is a professor from three separate universities (i.e., USM, UPM and UKM). All three experts are renowned and avid researchers in the area of KM. At the stage of the second procedure, a total of 200 questionnaire sets were disseminated to faculty members. Twenty-five compatible questionnaire sets were gathered (13 % response rate). To evaluate the reliability, Cronbach's coefficient alpha was scrutinized, demonstrating that each scale item had elevated alpha scores higher than 0.70. Subsequently for the reliability estimation, the idea was to measure

convergent and discriminant validity of items using the confirmatory factor analysis. Nevertheless, it was impossible to achieve this owing to the small sample size (i.e., $N = 25$). Thus, validity assessment was done following the final data collection and subsequently reviewed as part of PLS in the data analysis section.

A total of 1000 questionnaire sets were distributed to academic staff based at five research universities (i.e., 200 questionnaire sets to each university). For the first wave of the survey, only 37 effective responses were successfully gathered. For the second wave of the survey, more proactive steps were taken in order to encourage participation including gentle reminders and by extending the participation period, hence yielding an additional 384 responses. As for the Internet and drop-off surveys, there were 215 early responses received from the Internet survey as compared to the drop-off survey with a total of 216 responses. These produced a total of 431 valid and useful replies from both Internet and drop-off surveys for data analysis. From this total, ten returned questionnaires were invalid and discarded because significant and essential portions of the questions were left unanswered. From a total of one thousand questionnaires, 421 responses were deemed usable. The total response rate of this study was 42.1 %. Basic information of the respondents and activities are depicted in Appendix 3.

Measurement items

In this study, scale items have been adapted to signify the sharing of knowledge among academic staff in research universities. The instruments employed in this study have been based on the assessment of relevant KM and KS literature, which comprises of 55 items (see Appendix 4).

Data analysis and results

Non-response bias

To test for non-response bias (i.e., as referred to the time trend extrapolation technique) suggested by Armstrong and Overton (1977), the t tests were undertaken by treating late respondents as non-respondents. Since late respondents had completed the survey only after a series of extensive reminders, they are representative of non-respondents. A comparison was made on the initial group of respondents (first wave survey) with the final group of the respondents (second wave survey) on vital demographic profiles for instance the position in the institution, years of working experience, years of service, age, gender, nationality, ethnicity and area of specialization. The results from the comparison t tests revealed that there were no significant differences among the two groups ($p > 0.05$) i.e., early respondents and late respondents in respect of position ($t = 0.901$, $p = 0.37$), age ($t = 0.062$, $p = 0.96$), gender ($t = 0.675$, $p = 0.50$), and ethnicity ($t = 0.316$, $p = 0.75$). Similarly, another comparison was made on the Internet surveys and drop-off surveys. The results from the comparison t tests revealed that there were no significant differences among the two groups ($p > 0.05$) i.e., early respondents and late respondents in respect of position ($t = 1.595$, $p = 0.11$), age ($t = 1.816$, $p = 0.07$), gender ($t = -0.986$, $p = 0.33$), and ethnicity ($t = 0.757$, $p = 0.45$). For that reason, it can be deduced that the responses are representative of the majority of academic staff in the five research universities based

in Malaysia. The non-response bias did not seem to be a concern nor was it a significant issue in the present study (Armstrong and Overton 1977).

Common method variance (CMV) analysis

In order to diminish or control the extent to which the CMV can occur in this study, two types of statistical procedures were implemented: (1) Harman's single-factor test and (2) inter-construct correlations. The test revealed the rotated solutions of twelve factors with one factor. Based on the Harman's single-factor test conducted in this study, the results revealed ten constructs with eigenvalues greater than 1, which accounted for 74.47 % of the total variance while the first construct only accounted for 41.02 % of the variance. The principal components factor analysis shows that each principal factor describes a roughly equal variance of 55 % $\left(\frac{41\,\%}{75\,\%} = 54.67\,\%\right)$. Inter-construct correlations of over 0.90 raises suspicion of common method variance (Bagozzi et al. 1991). The correlations ranged from 0.10 to 0.80, which did not have any correlations of 0.90 or higher, thus indicating that there is no single factor that influences all constructs (Pavlou et al. 2007).

Measurement model

The measurement model proceeded in two phases i.e., convergent and discriminant validity analyses. All of the 55 items had loadings greater than the recommended value of 0.70. This implies that an additional 50 % of the variance is distributed among the measurement item along with its theorized construct. The composite reliability values, which illustrate the extent to which the construct indicators indicate the latent construct, ranged from 0.871 to 0.953, beyond the recommended value of 0.80 indicate adequate convergent consistency, with a majority of them that is greater than 0.90. The results of the average variance extracted were in the range of 0.629 and 0.833, whereby each average variance extracted value was well above the recommended level of 0.50. This indicates adequate convergent validity of items in each construct. Overall, the result shows that this study's measurement model has provided adequate internal consistency and convergent validity.

Next, the discriminant validity was tested. Based on the results, all square roots of average variance extracted exceeded the off-diagonal elements in their corresponding row and column. Also, all off-diagonal elements are lower than square roots of average variance extracted (bolded on the diagonal), which indicates satisfactory discriminant validity. Thus, the result confirmed that the Fornell and Larcker's (1981) criterion are met.

Structural model

There are four conditions that should be analyzed in measuring the structural model: (1) path coefficient (β), (2) coefficient of determination (R^2), (3) predictive relevance (Q^2) and (4) global measure of goodness of fit (GoF).

Path coefficient

By employing the findings from the path assessment, the acceptance or rejection of the proposed hypotheses is determined (see Appendix 4). From the findings, the supported hypotheses (i.e., H1–H11) are significant at slightest level of 0.10, have expected sign

direction (i.e., positive) and consist of a path coefficient value (β) varying from 0.101 to 0.601 and its associated t value that ranges between 1.493 and 14.816.

Within the individual context, trust, with the t value of 1.493 has a significant and positive influence on KS, with the path coefficient ($\beta = 0.124$) at $p < 0.10$ significance level. Thus, H1 is supported in the research results. Knowledge self-efficacy has no significant relationship on KS with the path coefficient ($\beta = -0.027$) and t value = 0.543 as it is not statistically important, thus H2 is not supported. Unexpectedly, the results also found that reciprocal benefits have no relationship on KS. Findings revealed that the path coefficient, $\beta = -0.052$ and t value of 0.748 for H3 is not statistically significant and, therefore does not support the results.

Within the organizational context, top management support does not have a statistically significant relationship with KS. H4 is not supported. The path coefficient between the two constructs was 0.033 with t statistics 0.489. The statistically strong significant positive relationship between organizational rewards and KS is found in this research having path coefficient ($\beta = 0.199$) and t statistics = 5.262 at $p < 0.01$ level. Thus, H5 is supported. The results also supported H6 in which organizational culture has a positive effect on attitudes toward KS with the path coefficient, $\beta = 0.175$ and t value of 1.925 at $p < 0.05$.

Within the technological context, the results of this research do not support H7. This indicates that there is an insignificant positive correlation between KM system infrastructure and KS with the path coefficient ($\beta = 0.011$) and t statistics of 0.148. The statistical positive relationship between KM system quality and KS is found to have the path coefficient ($\beta = 0.196$) and t statistics =2.791 at $p < 0.01$ level. Thus, H8 is supported.

Within the communication context, H9 is also supported by the research results. The path coefficient between the two constructs was 0.243 with t statistics =3.287 at $p < 0.01$ significance level. H10 is supported by the research results, as well. The results indicate that the path coefficient was 0.101 with t value =1.504 at $p < 0.10$ significance level. Finally, H11 that looks into KS as having a positive effect on research collaboration is also supported in the results of this study. The results indicate that the path coefficient was 0.601 with t value of 14.816 at $p < 0.01$ significance level. In summary, H1, H5, H6, H8, H9 and H10 are supported whereas H2, H3, H4 and H7 are not.

Coefficient of determination (R^2)

In this study, the bootstrapping generated 1000 samples from 421 cases. Approximately 57.6 % of the variance in the level of KS can be explained by the KM factors. Overall, the model indicates that KS explains approximately 36.1 % of the variance in research collaboration.

Predictive relevance (Q^2)

As shown in Appendix 5, the values of cross-validated redundancy Q^2 (F^2) for the outcome construct of research collaboration is 0.215 (i.e., omission distance of 5) and 0.222 (i.e., omission distance of 10), which are larger than 0.20. This suggests that the research model exhibits acceptable predictive ability (Chin 2010). The cross-validated communality Q^2 (H^2) is greater than 0.60 for both the constructs. This indicates that the constructs are highly measured (Chin 2010). Overall, since the estimated model has satisfactory communality and redundancy Q^2, the results of the Q^2 analysis further confirms that the model measures are adequate and that the structural model has satisfactory predictive relevance for the outcome construct of research collaboration.

Goodness of fit (GoF)

Based on the communality indexes and calculations of R^2 values (Ringle et al. 2005), the average communality index and average R^2 value were calculated as 0.734 and 0.469 respectively. Thus,

$$\text{GoF} = \sqrt{\overline{0.734}} \times \sqrt{\overline{0.469}} = 0.587$$

In the current model, a GoF value of 0.587, exceeding the cut-off value of 0.36 for large effect sizes of R^2 is considered as good. It demonstrates a high level of goodness of fit (Wetzels et al. 2009).

Discussion

This section provides the discussions relevant to the research questions posed (see Appendix 2 and 4).

Individual context

Trust

Trust, with the t value of 1.493 has a significant and positive influence on knowledge sharing, with the path coefficient ($\beta = 0.124$) at $p < 0.10$ significance level. This result is consistent with the study of Usoro et al. (2007), which suggests that maintaining faculty members' level of trust towards knowledge sharing positively supports research collaboration. Thus, hypothesis 1 is supported in the research results, which hypothesizes a positive relationship between faculty members' level of trust with their sharing of knowledge with each other. Since trust needs time to build, Davenport and Prusak (2000) suggested that the university management should focus on creating opportunities for academic staff to interact, whether formally or informally via regular monthly meetings, to promote dialogues among themselves. This fosters KS and creates a pleasant work environment that contributes to trust (Sveiby and Simon 2002). For example, the readiness of the academic staff to disclose their experiences and personal knowledge is higher when there is trustworthiness among colleagues. On the contrary, the enthusiasm to share their knowledge will be lower with those that they dislike or mistrust. Abrams et al. (2003) stated that in order for faculty members to be known as trustworthy sources of knowledge, they should disclose their expertise and limitations by making clear both what they know and don't know, besides they should admit it when they don't know something rather than claiming to know everything. In addition, members should defer to colleagues who know more than they do about a particular topic. By doing so, he or she is able to provide others with the confidence that he or she can be trusted.

Knowledge self-efficacy

Knowledge self-efficacy has no significant relationship on knowledge sharing with the path coefficient ($\beta = -0.027$) and t value = 0.543 as it is not statistically important. Contradictory to the expectation from (Bryant 2005), hypothesis 2 does not support the results where knowledge self-efficacy does not have a statistically significant relationship with

knowledge sharing. To alleviate this situation, the university management can intensify the responsiveness of knowledge self-efficacy among members by making them aware of the importance in sharing their knowledge and the impact it has on their university's performance. For instance, an extremely self-efficient faculty member can be recruited by choosing individuals who are passionate and have great intellectual capacity (Parker 1998). Since Bryant's (2005) research implies that universities are able to enrich KS by strengthening the self-efficacy of faculty members through continuous practice, role modeling and positive communication, universities should therefore pay more attention to faculty members' self-efficacy by providing useful feedback to improve their KS endeavors. Willingness to share, however, is not a basis for faculty members to part with their knowledge if they think that they have nothing worthy to contribute to others. Apparently, a member who has a higher belief in expecting knowledge in return from their colleagues will tend to share more, in order to receive knowledge in future. This further encourages the sense of competence and confidence among faculty members and in turn spurs them to engage in KS (Lin 2007b). However, academic staff with minimal knowledge self-efficacy in conveying their thoughts relating to their knowledge or when answering questions posed to them may still have the determination to share their knowledge if others are perceived to be willing to share. Moreover, from the social exchange theory perspective, the cost (i.e., the time and energy needed to generate their knowledge) and benefit (i.e., organizational rewards) provided by the universities should at least be equal in order to inspire faculty members to accomplish their practices in sharing (Kankanhalli et al. 2005).

Reciprocal benefits

Unexpectedly, the results also found that reciprocal benefits have no relationship on knowledge sharing, thus differing from the findings reported by Chiu et al. (2006). Findings revealed that the path coefficient, $\beta = -0.052$ and t value of 0.748 for hypothesis 3 is not statistically significant and, therefore does not support the results that reciprocal benefits do not have a statistically significant relationship with knowledge sharing. In order to improve this situation, the university management could communicate with faculty members by highlighting the advantages of sharing knowledge, thus facilitating stronger relationships among members in the university (Chiu et al. 2006). Perhaps one plausible reason that reciprocal benefits has no effect on KS is that when reciprocal relationships among academic staff evolve to more intense levels and further solidified once trust is valued, this renders reciprocal exchange of social benefits as less essential, since the focal point on KS will switch to other vital determinants such as openness in communication and organizational culture, where members share openly and knowledge gained from respective members are utilized. This finding is consistent with the argument by (Quinn et al. 1996), since sharing is viewed as additional work that takes time, academic staff will need to have some self-motivation to share voluntarily with colleagues. This is because some of the faculty members may not expect reciprocal benefits from sharing since they doubt the returns of reciprocal benefits.

Organizational context

Top management support

Hypothesis 4 is not supported by the data results of this study as discovered by Wee (2012). The path coefficient between the two constructs was 0.033 with t statistics 0.489. Results indicated that top management support does not have a statistically significant relationship

with knowledge sharing. It is therefore recommended that upper management provide adequate funds, incentives and rewards in order to motivate their members to become more efficient and competent in sharing knowledge (Lau and Yip 2008). For example, top management can encourage and provide funds that enable academic staff to present their research findings at conferences. Besides, there is a need to accomplish a strong relationship between top management and faculty members by expressing the importance of KS for the success of the university as a whole. In addition, an understanding of KM as a primary necessity in research universities should be recognized and supported by top management before KS can deliver institutional-wide benefits that can be useful to the research universities. The lack of upper management interest occurs because many other areas require their focus and attention. Unfortunately, KS has not yet reached the top of their agenda. Past research has shown that there has been a lack of management concern and commitment towards KM initiatives, as reflected in the lower priority placed on the development and expansion of KM strategies in universities (Keramati and Azadeh 2007). This is despite the fact that research has shown that support from top management does play a critical role in ensuring the success of KM in universities particularly by encouraging an internal environment that fosters KS.

Organizational rewards

As proven by Hall (2001), the statistically strong significant positive relationship between organizational rewards and knowledge sharing is found in this research having path coefficient ($\beta = 0.199$) and t statistics $= 5.262$ at $p < 0.01$ level, which concludes that if organizational rewards increase, knowledge sharing among faculty members at institutions of higher learning would increase positively. Thus, hypothesis 5 is supported, which hypothesized that organizational reward had a strong significant positive impact on knowledge sharing. This proves that emphasis needs to be placed on rewards as it is a critical predictor of knowledge sharing, especially the lure of money, promotion or awards. Simply put, knowledge sharing occurs only when its rewards exceed its costs. It is found that monetary benefits such as bonuses tend to be more suitably linked to specific results or special accomplishments when it concerns sharing (Bartol and Srivastava 2002). Nevertheless, there is a need for the university management to properly encourage KS, which is by aligning the university's reward schemes to accurately account for the knowledge contributions of members. Creating appropriate rewards, recognition and compensation to drive KS is essential. The university management must be aware that faculty members may be motivated to share their knowledge by the sense of pride they feel when their knowledge is shared and used. Thus, KM skills including KS should form part of the periodic performance evaluation of members. Academic staff can be assessed based on the acquisition of new skills and knowledge, undertaking new projects or responsibilities, contributions to the community or research team or contributions to the development of another member. When establishing an incentive scheme, universities should take into consideration, as a minimum requirement, the quality of the knowledge shared, i.e., the use of KM system infrastructure by faculty members for the submission and posting of their research work.

Organizational culture

The results also supported hypothesis 6 and is consistent with the study of Hooff and Huysman (2009) in which organizational culture has a positive effect on attitudes toward knowledge sharing with the path coefficient, $\beta = 0.175$ and t value of 1.925 at $p < 0.05$

indicating that if organizational culture increases, knowledge sharing attitudes among academic staff in research universities would increase positively. The university management could look into ways of emphasizing efforts towards cultivating a co-operative working environment among academic staff. For instance, each member can be encouraged to work and cooperate with others in research teams or departments. Such high levels of KS in groups are more likely to foster close and mutual relationships among members within the faculty/school, which can further increase KS between members.

Creating a clear vision, objectives and values of a university linked to faculty members' knowledge is effective and beneficial in promoting a KS culture (Hooff and Huysman 2009). Such a culture at research universities allows relevant knowledge to be to be found, eases the active interaction between members, increases awareness and develops an environment of trust, reciprocity and self-efficacy. Therefore, the willingness of academic staff to convey their valuable knowledge is influenced by the organizational culture of the university itself. This shows that a university with strong organizational culture in KS activity will further encourage higher enthusiasm among staff towards knowledge sharing. In fact, organizational culture not only influences the successful achievement of KS, but also the morale of faculty members and their productivity (Lai and Lee 2007). As a result, research universities are able to strengthen their organizational culture by means of KS activities within their institutions in order to encourage their academic staff to share their valuable knowledge.

Technological context

KM system infrastructure

The results of this research does not support hypothesis 7. This indicates that there is an insignificant positive correlation between KM system infrastructure and knowledge sharing with the path coefficient ($\beta = 0.011$) and t statistics of 0.148. Thus, this finding is inconsistent with the study of (Hansen 1999). The university management could explore issues in the design and implementation of an effective KM system infrastructure by basing it on the issues identified in the university first before developing and implementing it. It is important for universities to understand the benefits of the KM system infrastructure, establish an integrated and integrative technology architecture that supports database, communication plus search and retrieval functions. The university management ought to note that technology makes possible the connections that enable KS, but there is no guarantee that members are going to share their knowledge by using them. Therefore, without KM system infrastructure, the available knowledge can still be accessible through personal interactions that encourage faculty members to share especially their tacit knowledge (i.e., personalization strategy) through direct person-to-person interactions. As a result, the university management could focus on the KM system infrastructure in its ability to identify, capture and transfer critical tacit knowledge since it takes a long time to learn tacit knowledge and a good KM system infrastructure facilitates the transference of tacit knowledge among faculty members. Also, the university management could look into possible ways of rewarding members through their research work presented in the form of theses, published journals and knowledge dissemination during conferences using the KM system infrastructure available at the universities so as to share their work with others. Through such means, faculty members will be encouraged to make good use of the available KM system infrastructure.

KM system quality

The statistical positive relationship between KM system quality and knowledge sharing is found to have the path coefficient ($\beta = 0.196$) and t statistics $= 2.791$ at $p < 0.01$ level, which concludes that institutions' KM system quality increases the likelihood of faculty members sharing their knowledge with others. Thus, hypothesis 8 is supported in the research results as determined by Lin (2011), indicating that KM system quality had significant positive effects on faculty members' knowledge sharing. Effective KM system quality can reduce the risk of losing valuable knowledge of members, besides allowing them to have an easy and quick sharing process. Better KM system quality enhances the effectiveness, accessibility and capability thus allowing the leveraging of KS practices (Kulkarni et al. 2007). If the KM system in research universities is able to offer precise, dependable and reliable knowledge, the KM system would be able to produce swifter performance and more developed KM practices. Therefore, the easy access to internal and external information sources of knowledge such as online databases and data repositories are crucial and relevant to the research efforts of faculty members, which ultimately impact upon the performance of the university especially when it concerns the accuracy and timeliness of knowledge shared among supporting members. Based on this, universities with higher KM system quality are able to benefit members by enabling them to work more effectively and therefore boost their research performance. With regard to the third research question, this study confirms that the KM system quality (i.e., technological factor) has a significant effect on KS. This is a contrast when compared to the matter of KM system infrastructure, which has an insignificant influence on KS among faculty members.

Communication context

Openness in communication

Hypothesis 9 is also supported by the research results. The path coefficient between the two constructs was 0.243 with t statistics = 3.287 at $p < 0.01$ significance level. The strong openness in communication among faculty members as supported by the findings from (Kim 2003), indicates a positive impact on their knowledge sharing practices. Indeed, active openness in communication, in terms of disclosure of both personal and task-related knowledge via clear, unambiguous communication is essential to universities. In open communication, the socialization and externalization phases introduced by Nonaka and Takeuchi's (1995) SECI model needs to be adapted in universities. SECI involves the knowledge conversion between tacit (i.e., possessed by individuals) and explicit knowledge (i.e., easily transmitted to others) that constitutes the essence of knowledge creation in research universities. From the perspective of tacit to tacit knowledge (i.e., socialization) phase, the discussion of research issues, potential solutions and successful outcomes between academic staff should be encouraged in places such as corridors and pantries. Such open communication through socialization can be stimulated among academic staff in order for them to share their learning experiences (i.e., know-how) with others in the faculty/school to produce effective research work. As for the externalization phase (i.e., from tacit to explicit), members should have access to research information available at research databases should the need arise for further discussion among members on certain issues or when deliberating on actions relating to their research projects. Since most

dialogues are impromptu and informal, such as those occurring during unscheduled meetings, informal seminars or during coffee break conversations, it is therefore wise for the university management to encourage externalization by providing them with easy access of knowledge repositories, which will further expand their tacit knowledge (i.e., knowledge asset) when open communication among members take place.

Face-to-face interactive communication

Hypothesis 10 is supported by the research results, as well. The results indicate that the path coefficient was 0.101 with t value = 1.504 at $p < 0.10$ significance level. As supported by the result from (Pierce 2002), the face-to-face interactive communication among faculty members strengthens their knowledge sharing positively. The feedback and opinions from upper management such as faculty/school deans and department heads are essential as they can exert their influence and authority so that members participate in KS. In face-to-face interactive communication, the sharing of tacit and explicit knowledge occurs through socialization and externalization exhibited in the SECI model that can be adapted by research universities. In the socialization (i.e., tacit to tacit knowledge) phase, face-to-face communication through informal social interaction and shared experience via meeting, training and brainstorming sessions among faculty members can support this type of interaction. In face-to-face interactive communication, socialization typically occurs in a traditional apprenticeship (i.e., mentorship program) involving transfer of skills and experiences to others, where members are able to acquire tacit knowledge needed in their research work through hands-on experience, such as learning up on the usage of data analysis tools needed for their research, which make them better researchers as a result. As for tacit to explicit knowledge conversion (i.e., externalization), the combined tacit knowledge among several researchers generated through face-to-face interactive communication enables the release of diverse research work by faculty members such as newly created research concepts through publications. This can be done through formal instruction using the practical approach. For example, at workshops where this method allows members to instantaneously provide updated feedback through face-to-face interaction besides permitting them to exchange and generate new ideas/knowledge within a shorter time period.

Implications

This research has attempted to provide a KM-KS-Collaboration research model that can be used to further the understanding of the KM factors. This new model has extended the current research of KM factors (i.e., the individual-organizational-technical-communication factors) by investigating their influence on KS. This association emphasizes the necessity to investigate these four KM factors in order to enhance KS within the university context, which has not been done in previous research conducted in Malaysia. Moreover, this KM-KS-Collaboration research model can be regarded as the most influential theoretical implication for research in related fields because it suggests that faculty members' KS is positively related to openness in communication and face-to-face interactive communication (i.e., communication factors). Furthermore, KS among faculty members is mainly the result of trust (i.e., individual factors) and not knowledge self-efficacy and reciprocal benefits. This model also conceptualizes that organizational rewards and organizational culture (i.e., organizational factors), and KM system quality (i.e., technological

factors) would motivate members to share knowledge. Meanwhile, members' KS among academic staff would encourage research collaborations within research universities based in Malaysia.

Higher-learning institutions should create an atmosphere of trust by reinforcing the climate of trust among their faculty members. As a result, that allows members to share their ideas and thoughts with whom they trust; to work together; to be interested in the different viewpoints and experiences of others; to have the courage to express opinions; to allow enquiries; to take chances; to be involved actively in team discussions and to be inspired to share knowledge with each other (Van den Brink 2003). This can be done by reinforcing trust through periodic social events and outdoor discussions such as conferences, workshops, seminars, etc. to encourage informal friendships among members This consequently, enforces a decree upon faculty members to share their knowledge actively (von Krogh 1998).

It is suggested that rewards must apply to staff of different levels in the university in order to win over faculty members of various positions and encourage them to share their knowledge with others. In addition, upper management should explicitly identify behaviors that they wish to encourage by providing incentives that reward positive behaviors. The university management should implement a system of rewards as it is an effective method for motivating academic staff especially in terms of publishing papers from research conducted (i.e., written contributions) and reaching out to communities by contributing ideas and through innovative solutions (i.e., communities of practitioners).

Through this study, it is also found that the willingness of faculty members to share valuable knowledge is affected by the organizational culture within the research university itself. This proves that higher-learning institutions should strive in enabling its members to propose new ideas and knowledge for generating fresh opportunities and to foster a positive culture of social interaction in practicing KS among faculty members. Direct mechanisms intended for establishing a sharing culture should be promoted by the university management. These can include hosting regular seminars and workshops aimed at providing an avenue for members from various research teams or departments to 'mix and mingle' with each other in order to share experiences and knowledge. The university management should also emphasize efforts to cultivate organizational citizenship behavior among their academic staff. High levels of organizational citizenship can foster mutual social exchange relationships among members within the faculty/school as well as other members throughout the university. Close reciprocal relationships that are developed among academic staff facilitate the sharing of knowledge. In addition, the faculty/school deans and department heads should maintain an open and conducive environment that welcomes new ideas, considers criticism and constantly strives for unity among the academic staff. When faculty deans and department heads are impartial without being demeaning, the academic staff will feel more at ease to engage in KS.

The quality of the KM system should be the focus as it facilitates members in their efforts to share their explicit knowledge and act as a practical means of knowledge integration in research universities (Zyngier 2001). However, even though KM system is an outstanding factor of data and information sharing in universities, it can never be a substitute for rich interactivity and communication that take place among humans.

It is imperative for the university management to understand that openness in communication facilitates the success of faculty members' KS within research universities. The capability of faculty members to build awareness towards support and shared frames of reference with each other is one of the main conditions that permit teamwork and interconnection amongst faculty members with various backgrounds in terms of fields and

levels of expertise (Sarker and Sahay 2004). Also, the university management should support the provision of feedback from referent communities to the academic staff who participate (or do not participate) in KS. The opinions and feedback from the members' referent groups (i.e., colleagues, faculty/school deans, department heads and vice chancellor) are important in the sense that they can exert the necessary pressure on academic staff to engage in KS as well as enhance their individual sense of self-worth.

Limitations and directions for further research

There may be other KM factors that can influence KS other than the variables used in this study. This study, however, did not take into account all the KM factors that are vital for KS. Thus, in future other variables such as commitment (Ye et al. 2006), self-image (Ye et al. 2006), and organizational structure (Lin et al. 2008) can be reviewed further. Moreover, the significance of inter-faculty/school and inter-university levels of different faculties/schools within research universities in regards to KS have not been considered in this study. In addition, although the study included faculty members from a variety of faculties/schools consisting of different areas of specializations, the findings are deemed to be applicable to research universities only.

Some directions for future research: (1) to assemble longitudinal information that offers a much clearer understanding of the recommendations by the proposed model of temporal causality, (2) to include other levels or positions that are held by all the faculty members such as lecturers and tutors when examining KS in universities so as to strengthen the generalization of results in order to predict faculty members' KS, and (3) to further explore specific type of knowledge self-efficacy, reciprocal benefits, top management support and KM system infrastructure that would more likely encourage KS in higher-learning institutions, i.e., focus on knowledge creation self-efficacy that discusses views from learners on their abilities to articulate their thoughts and experiences, producing knowledge from diverse sources and also on being trained by others through the personification of explicit into tacit knowledge (Chen et al. 2009a, b).

Conclusions

This research plays a major part relating to the individual-organizational-technological-communication relationship literature by proposing findings that recommend a model for examining the standpoint of faculty members from the five research universities. This model provides a deeper understanding of the influence of KM in enabling faculty members' KS relating to the support of research collaborations within research universities in Malaysia by examining the association between individual, organizational, technological and communication context on KS besides observing the establishment of KS with regard to supporting research collaborations in one single model.

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1

See Fig. 1.

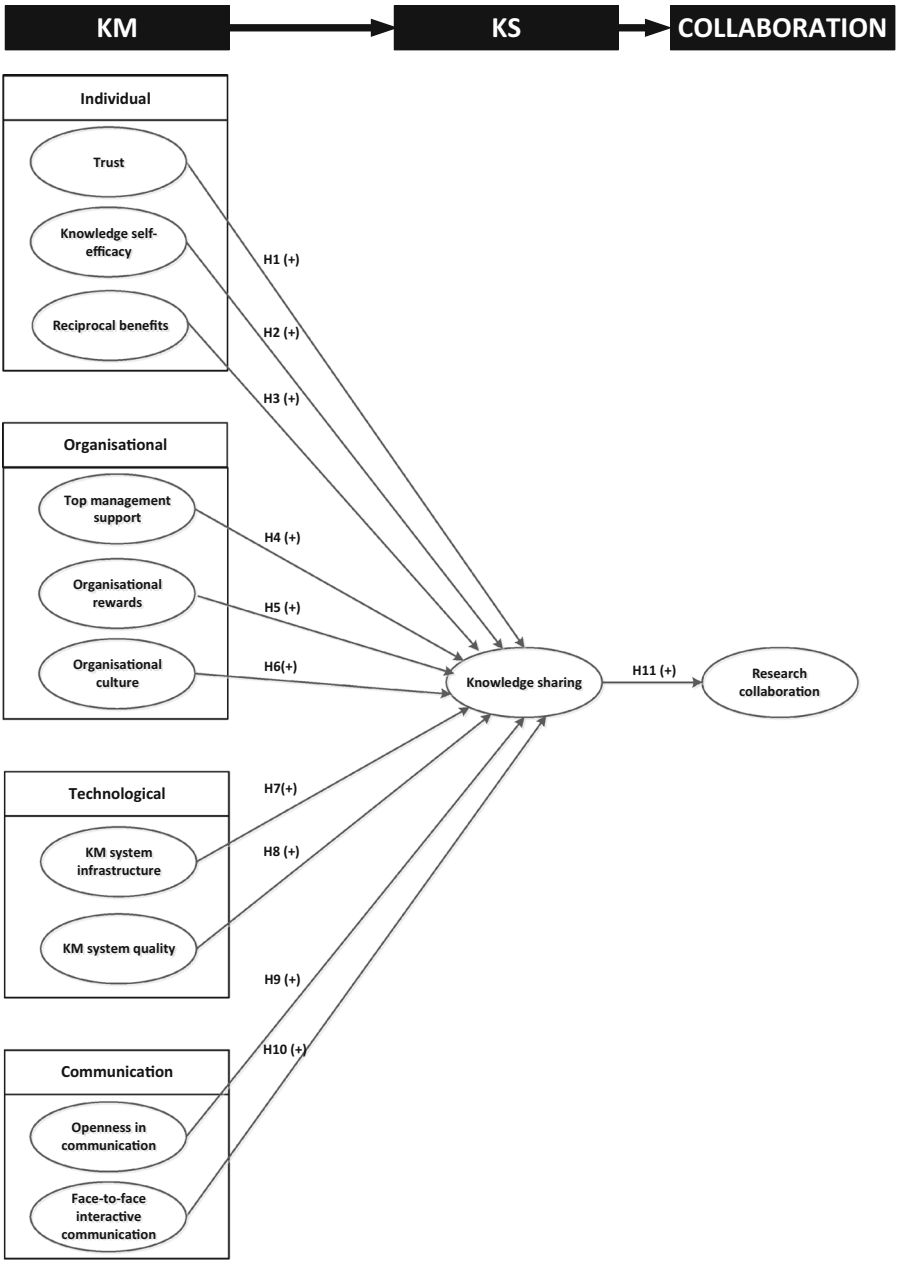

Fig. 1 The individual-organizational-technological-communication KM enablers (the KM- KS-Collaboration research model)

Appendix 2

See Table 1.

Table 1 Research questions and research hypotheses

Research questions and research hypotheses	
Research question 1: How do trust, knowledge self-efficacy, and reciprocal benefits (i.e., individual KM enablers) influence faculty members to share knowledge?	
H1	Trust has a positive relationship with knowledge sharing
H2	Knowledge self-efficacy has a positive relationship with knowledge sharing
H3	Reciprocal benefits have a positive relationship with knowledge sharing
Research question 2: How do top management support, organizational rewards and organizational culture (i.e., organizational KM enablers) influence faculty members to share knowledge?	
H4	Top management support has a positive relationship with knowledge sharing
H5	Organizational rewards have a positive relationship with knowledge sharing
H6	Organizational culture has a positive relationship with knowledge sharing
Research question 3: How do KM system infrastructure and KM system quality (i.e., technological KM enablers) influence faculty members to share knowledge?	
H7	KM system infrastructure has a positive relationship with knowledge sharing
H8	KM system quality has a positive relationship with knowledge sharing
Research question 4: How do openness in communication and face-to-face interactive communication (i.e., communication KM enablers) influence faculty members to share knowledge?	
H9	Openness in communication has a positive relationship knowledge sharing
H10	Face-to-face interactive communication has a positive relationship knowledge sharing
Research question 5: How does the sharing of knowledge among faculty members influence research collaboration?	
H11	Knowledge sharing has a positive relationship with research collaboration

Appendix 3

See Table 2.

Table 2 Profile of the respondents, research work, publication, knowledge sharing involvement

Demographic profile	*n*	%
Name of institution		
Universiti Kebangsaan Malaysia	79	18.8
Universiti Malaya	55	13.1
Universiti Putra Malaysia	116	27.6
Universiti Sains Malaysia	117	27.8
Universiti Teknologi Malaysia	54	12.8
Position in this institution		
Professor	94	22.3
Associate professor	154	36.6

Table 2 continued

Demographic profile	*n*	%
Senior lecturer	173	41.1
Years of working experience		
1–5	55	13.0
6–10	103	24.5
11–20	143	34.0
21 and above	116	27.5
Missing	4	1.0
Years of service in current institution		
1–5	118	28.0
6–10	92	21.8
11–20	132	31.4
21 and above	76	18.1
Missing	3	0.7
Age (years)		
30 and below	6	1.4
31–40	116	27.6
41–50	168	39.9
51–60	109	25.9
61 and above	19	4.5
Missing	3	0.7
Gender		
Male	226	53.7
Female	193	45.8
Missing	2	0.5
Nationality		
Malaysian	391	92.8
Others	28	6.7
Missing	2	0.5
Ethnic group		
Malay	271	64.3
Chinese	79	18.8
Indian	39	9.3
Others	26	6.2
Missing	6	1.4
Did you pursue your studies outside of Malaysia?		
Yes	318	75.5
No	91	21.6
Missing	12	2.9
Highest educational qualification completed		
Doctoral degree	330	78.3
Masters degree	84	20.0
Others	2	0.5
Missing	5	1.2

Table 2 continued

Demographic profile	*n*	%
Area of specialization in this institution		
Education	37	8.9
Humanities	28	6.7
Arts	16	3.8
Social science	50	11.9
Behavioral science	6	1.4
Business administration	59	14.0
Economics	25	5.9
Law	6	1.4
Physical science	14	3.3
Mathematics	9	2.1
Computer science	21	5.0
Agriculture	9	2.1
Life science	19	4.5
Medical science	21	5.0
Health-related	18	4.3
Engineering	49	11.6
Manufacturing	4	1.0
Construction	8	1.9
Architecture	2	0.5
Others	17	4.0
Missing	3	0.7
Years in conducting research work		
None	5	1.2
1 year and below	10	2.4
2–5 years	119	28.3
6–10 years	112	26.6
11–15 years	78	18.5
16–20 years	34	8.1
21–25 years	24	5.7
26 and above	30	7.1
Missing	9	2.1
In an average year, how many conference papers do you publish?		
1–5	262	62.3
6–10	81	19.2
11–20	26	6.2
21–30	11	2.6
31–40	9	2.1
41–60	2	0.5
61–80	1	0.2
81 and above	7	1.7
Missing	22	5.2

Table 2 continued

Demographic profile	*n*	%
In an average year, how many journal papers do you publish?		
1–5	268	63.7
6–10	73	17.3
11–20	35	8.3
21–30	10	2.4
31–40	5	1.2
41–60	4	1.0
61–80	1	0.2
81 and above	3	0.7
Missing	22	5.2
When is your institution most likely to make significant investment in knowledge sharing via knowledge management?		
Have already	273	64.9
1–2 years from now	56	13.3
2–4 years from now	41	9.7
Never	29	6.9
Missing	22	5.2
What is the recent changes taking place in your institution that encourages knowledge sharing among academics?		
The importance of knowledge sharing to the success of this institution is clearly understood by academics	79	18.8
High levels of participation in knowledge sharing are rewarded	27	6.4
I am valued for my research expertise/knowledge	43	10.2
I am encouraged to ask other academics for assistance when needed	32	7.6
Top management clearly supports the role of knowledge sharing	40	9.5
Sharing of knowledge with other academics is highly encouraged	74	17.6
Others	5	1.2
Missing	121	28.7
If there are NO changes, why?		
Hard to contact whom I need and/or don't know who needs to share knowledge	17	4.0
Possibility of having disadvantages by sharing knowledge	5	1.2
Possibility of losing competitive edges by sharing knowledge	6	1.4
Not enough systems to get reward by sharing knowledge	16	3.8
No systematic/official ways/routes for sharing knowledge	35	8.3
No appropriate communication channel for sharing knowledge	10	2.4
Others	4	1.0
Missing	328	77.9

$n = 421$

Appendix 4

See Table 3.

Table 3 Constructs and items used in the research model

Constructs	Items	References
Trust		
TR1	I trust my faculty/school academics in general	Developed based on Kim and Ju (2008) and Choi et al. (2008)
TR2	I trust the expertise of academics in my faculty/school	
TR3	When I face difficulties, I am willing to ask the academics in my faculty/school for help	
TR4	I believe that the academics in my faculty/school are honest	
TR5	I believe that academics in my faculty/school are knowledgeable in their area	
Knowledge self-efficacy		
KE1	I am confident in my ability to provide knowledge that other academics in my faculty/school consider valuable	Developed based on Lin et al. (2009) and Lin (2007a, b)
KE2	I have the expertise required to provide valuable knowledge to academics in my faculty/school	
KE3	It does make a difference when I share my knowledge with other academics in my faculty/school	
KE4	I can provide more valuable knowledge than most of the academics in my faculty/school	
Reciprocal benefit		
RB1	I strengthen ties between them and myself when I share my knowledge with academics in my faculty/school	Developed based on Lin et al. (2009) and Lin (2007a)
RB2	I expand the scope of my association when I share my knowledge with other academics in my faculty/school	
RB3	I expect to receive knowledge in return when I share my knowledge with academics in my faculty/school	
RB4	I believe that my future requests for knowledge will be answered when I share my knowledge with academics in my faculty/school	
Top management support		
TM1	In my faculty/school, top management thinks that encouraging KS among academics is beneficial	Developed based on Lin et al. (2009) and Lin (2007b)
TM2	In my faculty/school, top management always supports academics to share our knowledge with each other	
TM3	In my faculty/school, top management provides most of the necessary help to enable academics to share knowledge	
TM4	In my faculty/school, top management is keen to see that academics are happy to share knowledge with each other	
Organizational rewards		
OR1	I will receive a higher salary in return for sharing my knowledge	Developed based on Lin (2007a)

Table 3 continued

Constructs	Items	References
OR2	I will receive increased promotion opportunities in return for sharing my knowledge	
OR3	I will receive increased job security in return for sharing my knowledge	
OR4	I will receive a higher bonus in return for sharing my knowledge	
Organizational culture		
OC1	In my faculty/school, the management expects academics to actively contribute to the registration of knowledge	Developed based on Hooff and Huysman (2009)
OC2	In my faculty/school, the management expects academics to actively contribute to the transmission of knowledge	
OC3	In my faculty/school, the management stresses the importance of knowledge to the success of the institution	
OC4	Management expects academics to actively contribute to the registration of knowledge at my faculty/school	
OC5	Management expects academics to actively contribute to the transmission of knowledge at my faculty/school	
OC6	Management stresses the importance of knowledge to the success of the institution at my faculty/school	
OC7	Management expects academics to actively contribute to the registration of knowledge at my faculty/school	
KM system infrastructure		
KI1	My institution uses a KM system that allows academics in my faculty/school to collaborate with each other	Developed based on Lin (2011) and Lee and Choi (2003)
KI2	My institution uses a KM system that allows academics in my faculty/school to communicate with each other	
KI3	My institution uses a KM system that allows academics in my faculty/school to search necessary knowledge	
KI4	My institution uses a KM system that allows academics in my faculty/school to access necessary knowledge	
KI5	My institution uses a KM system that allows academics in my faculty/school to store specific types of knowledge that includes explicit knowledge (e.g. documents) and tacit knowledge (e.g., personal/experience-based knowledge)	
KM system quality		
KQ1	The knowledge provided by the KM system at my institution is relevant to my research work	Developed based on Lin (2011) and DeLone and McLean (2003)
KQ2	The knowledge provided by the KM system at my institution is accurate	
KQ3	The knowledge provided by the KM system at my institution is always up-to-date	
KQ4	The operation of the KM system at my institution is dependable	

Table 3 continued

Constructs	Items	References
KQ5	The KM system at my institution makes knowledge easy to access	
Openness in communication		
OP1	Open communication among academics at my faculty/school is helpful when it comes to research-related activities/tasks	Developed based on Kim and Ju (2008)
OP2	I interact with academics at my faculty/school in exchange of research knowledge	
OP3	I will not hesitate to ask academics at my faculty/school to share knowledge with me if I need it	
OP4	I am actively willing to share my knowledge with academics at my faculty/school when they ask	
Face-to-face interactive communication		
FC1	There is a high level of F2F interaction among academics	Developed based on Al-Alawi et al. (2007)
FC2	Language is not a problem when communicating with other academics	
FC3	Teamwork discussion among academics on research-related matters takes place through F2F meetings	
FC4	Research collaboration among academics takes place through F2F meetings	
Knowledge sharing		
KS1	Academics share research reports and documents that include publication materials/documents and research project reports	Developed based on Yang and Chen (2007)
KS2	Academics share research project's guidelines, methodologies, and models	
KS3	Academics share research knowledge gained from conferences, workshops, and seminars	
KS4	Academics share know-how from research experiences such as securing research grants/funds	
KS5	Academics share know-where and know-whom of conferences, workshops and seminars at the request of others	
Research collaboration		
RC1	I prefer to work collaboratively with other academics in my faculty/school rather than work alone	Developed based on Kim and Ju (2008) and Lee and Choi (2003)
RC2	If I have options, I prefer to work with other academics in my faculty/school than to working independently	
RC3	The academics in my faculty/school were satisfied with current levels of collaboration	
RC4	There is a willingness to collaborate across departments and research centers at my faculty/school	

Appendix 5

See Table 4.

Table 4 Partial least squares structural model results

Hypothesis	Relationship	Path coefficient (β)	SE	*t* value	Result
H1	Trust → Knowledge sharing	0.124	0.083	1.493*	Supported
H2	Knowledge self-efficacy → Knowledge sharing	−0.027	0.050	0.543	Not supported
H3	Reciprocal benefits → Knowledge sharing	−0.052	0.069	0.748	Not supported
H4	Top management support → Knowledge sharing	0.033	0.068	0.489	Not supported
H5	Organizational rewards → Knowledge sharing	0.199	0.038	5.262***	Supported
H6	Organizational culture → Knowledge sharing	0.175	0.091	1.925**	Supported
H7	KM system infrastructure → Knowledge sharing	0.011	0.072	0.148	Not supported
H8	KM system quality → Knowledge sharing	0.196	0.070	2.791***	Supported
H9	Openness in communication → Knowledge sharing	0.243	0.074	3.287***	Supported
H10	Face-to-face interactive communication → Knowledge sharing	0.101	0.067	1.504*	Supported
H11	Knowledge sharing → Research collaboration	0.601	0.041	14.816***	Supported

Beta, regression weight; SE, standard error, *t* values are computed through bootstrapping procedure with 421 cases and 1000 samples

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix 6

See Table 5.

Table 5 Results of the blindfolding estimations

Construct	R^2	Omission distance = 5		Omission distance = 10	
		F^2	H^2	F^2	H^2
Knowledge sharing	0.576	0.439	0.768	0.443	0.768
Research collaboration	0.361	0.215	0.655	0.222	0.655

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