Winter 12-9-2003

A Stage Model of Knowledge Management Systems Diffusion Process: Findings from an Australian Study

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Abstract

This study presents a stage model of knowledge management systems (KMS) diffusion process. It then provides empirical test of the sequence of KMS diffusion process in Australia. Structural equation modelling (SEM) using LISREL is used as the analytical tool for the empirical tests. The results show that all the hypotheses related to the sequence of the KMS diffusion process are significant. This is an important and significant finding. It clearly demonstrates how KMS adoption and diffusion phenomenon should be planned in Australian organizations. The results of the study add value to the literature of knowledge management. Also, the results provide practical and applicable suggestions to those companies, which are embarking on the adoption and diffusion of knowledge management system in Australia or elsewhere.

Key words: Knowledge Management Systems, Adoption and Diffusion, Structural Equation Modelling, LISREL

1. Introduction

As a result of the tough competition in the market place and the shift from resourced-based economy to knowledge-based economy, companies are looking at more and more in gaining competitive advantage through managing and maximizing their most valuable asset – "knowledge". Although knowledge and knowledge management are not new concepts, knowledge management systems (KMS), which involve the application of IT systems and other organizational resources to manage knowledge strategically in a more effective and systematic way (Alavi & Leidner 1999), are relatively recent phenomenon. While the KMSs (or some variations) are widely applied in organizations, the topic of KMS has not been well explored by the researchers and scholars in an empirical way. Among the limited literature on KMS, which centers on cases of successes and failures of KM project applications and/or presents factors of successes and/or failures, there is a scarcity of empirical studies of KMS, especially in the area of adoption and diffusion of KMS. This paper reports the findings of an Australian study of the factors impacting on the diffusion of KMS in organization.

The paper is organized as follows. Section 2 presents relevant background to the study on knowledge management systems and model of innovation diffusion. The research method, which combines exploratory filed study, empirical pilot study, and national survey, is presented in section 3. Section 4 presents the development of the proposed hypotheses tested in the study. Results are presented and discussed in section 5 in detail. Finally, conclusions are presented in section 6.

2. Background

Knowledge Management System (KMS) is a broad way or approach to deal with the generation, preservation, and sharing of both tacit and explicit knowledge within and outside of the organization, which essentially involves the applications of Information Technology systems and other organizational resources (Alavi & Leidner, 1999). While the publicity related to organizational learning, intellectual capital, and knowledge management may pass with time, the need to effectively and systematically manage the knowledge will not diminish. Knowledge is more and more recognised by the organization as a key organizational asset for sustaining its competitiveness in the market place (Huber 2001). At present, applying computer-aided knowledge management system and the aggressive acquisition and retention of knowledge workers are two major knowledge management activities (Huber 2001). Companies are embarking on knowledge management systems to seek competitive advantage (Gottschalk 1999).

Alavi and Leidner (1999) report a survey regarding the issues, challenges, and benefits of knowledge management systems by collecting data from 109 participants of an executive development program, who are chief information officers (CIO), information systems managers, and general functional managers, representing a range of countries (Australia, Canada, Germany, Israel, Luxembourg, the Netherlands, Saudi Arab, South Africa, Spain, Switzerland, and the United States), industries, and organizations. The results of the survey indicate that, given the fact that knowledge management systems are only recent phenomenon, more and more companies were

adopting knowledge management systems. 44.63% of the respondents indicated that their organizations either have an existing KMS or are considering developing a KMS. Meanwhile 10.91 % of organizations are developing a KMS. The survey also uncovers some other interesting findings of the characteristics of KMS: (1) KMS were most commonly initiated by senior management (such as senior general managers, senior IS managers, and senior functional mangers), (2) the range of investment on KMS was from US$25,000 to 50,000,000. But KMS budget was related to size of the organization, the current level of infrastructure, and the scope of knowledge management initiative, (3) the most common KMS technologies were browser, electronic mail, and search retrieval tools. The authors also report that KMS were designed to gain the benefits in the perspectives of process results and organizational outcomes. The perceived KMS benefits for organizational outcomes included increased sales, decreased costs, higher profitability in financial area, improved customer services, better targeted marketing in market area, and improved project management, personal reduction in general areas. Meanwhile, the perceived benefits of KMS for process were primarily referred to the improvement in the communication (i.e., enhanced communication, faster communication, more visible opinions of staff, increased staff participation) and enhanced efficiency (i.e., reduced problem solving time, shortening proposal times, faster results, faster delivery to market, greater overall efficiency).

Some of the common applications of KMS are: (1) organizing and sharing/transferring of internal benchmarks/best practices (2) constructing corporate knowledge directories, such as corporate yellow pages, people information archive, etc. (3) creating knowledge networks and knowledge maps; among many others (Alavi & Leidner, 2001). In the past, many information systems (IS), such as management information systems, executive information systems, decision support system, knowledge-based systems, etc., have been focusing on the codified/explicit knowledge. Knowledge management systems provide the opportunities to extend the operating scope of information systems through facilitating organization's effort in managing both tacit and explicit knowledge (Alvi & Leidner, 2001).

Some examples of KMS applications in organizations include: Beckman Laboratory's "K-Entex" to share and disseminate knowledge (Pan & Scarborough, 1999); Xerox's "Eureka" to allow its 25,000 service representatives to share their collective technical wisdom (Bowen, 1999); Ernst & Young's "Ernie", an Internet based consulting service, resulting in a complete redefinition of the consulting industry and lead to what could be called "retail consulting" (Sarvary, 1999); AMP's "AMP Connect", a multilingual Internet catalogue of AMP products, to allow customers to access the information 24 hours a day; British Petroleum's "Virtual Teamwork Project" using videoconferencing to speed up the solution of critical operation problems by saving millions of dollars in travel costs and downtime each year; Anderson-consulting's "Knowledge Exchange" to assist its clients in using knowledge to improve their operations and develop long-range strategies; Kim's "K-World" to manage knowledge globally (Thierauf, 1999); among many others.

Although KMS has been studied widely over the last several years, it has not received considerable scholarly attention. The existing research and studies on KMS consist primarily of general and conceptual principles of KMS and case descriptions of such systems in a handful of leading organizations. Those case descriptions also mainly focus on the issues of the process of implementing KMS (e.g., Davenport 1998, Ernst & Young, 1999), objectives of KMS (e.g., Davenport, 1998; Thierauf, 1999), critical factors of the successful KMS (e.g., Davenport, 1998; Skyrme & Amidon, 1998; Brand, 1998; Pan & Scarbrough, 1998), the characteristics of KMS leaders and laggards (e.g., Skyrme & Amidon, 1998), KMS applications in various business areas (e.g., Thierauf, 1999). The majority of research, (such as Thierauf, 1999; Chait, 1999; Pan & Scarbrough, 1999; and Sarvary 1999), have only covered the general and conceptual principles of building/creating and implementing knowledge management systems. Literature on the KMS diffusion could not be found at present, except the work by Scarbrough & Swan (2001). The authors used management fashion model to explain the diffusion of knowledge management.

In this paper, we focus on the diffusion process of KMS in Australia. Specifically, we want to identify the sequence of stages of KMS diffusion process.

Literature suggests that past research on diffusion of innovations have focused on the relationships of various factors (i.e. what factors influence and determine diffusion process) (the factor approach) or on understanding the various stages of diffusion process (the stage approach). Research on the factor approach generally resembles the typical diffusion studies which examine some form of adoption of innovations by individuals, which is the dependent variable. While research on the stage approach has studied the processes by which new technologies and systems are created and incorporated into the organizations (Prsecott & Conger 1995; Wolcott et al. 2001).

It is believed that KMS adoption and diffusion is a multifaceted phenomenon that takes place in a variety of ways over time (Wolcott et al. 2001). Rogers (1995) suggests a five-stage of innovation diffusion model: agenda-setting, matching, redefining/restructuring, clarifying, and routinizing. The five stages model can be simplified into three broad phases: Initiation, Adoption,

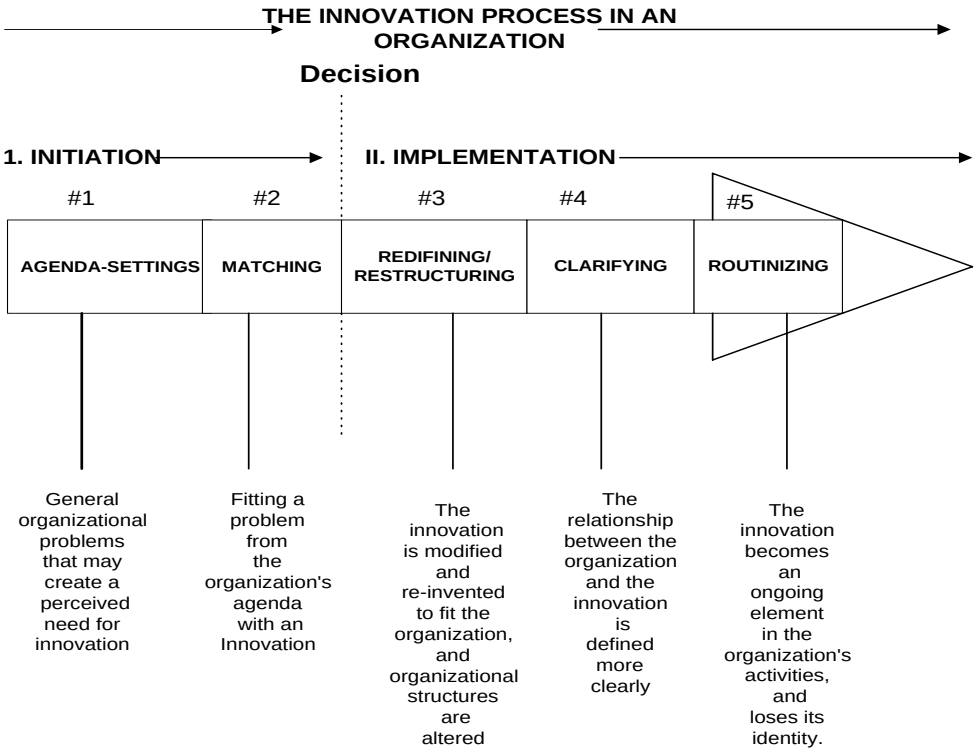

Figure 1: Five Stages of the Innovation Diffusion Process (Rogers 1995)

and Implementation. The initiation stage deals with the information gathering, conceptualizing, and planning for the adoption of an innovation, leading up to the decision to adopt (adoption stage). In the implementation stage, all of the events, actions, and decisions involved in putting an innovation into use are executed (see Figure 1).

At the same time, past studies, such as Kwon & Zmud 1987; Huff & Munro 1985; Cooper & Zmud 1990; Nilakanta & Scamell 1990, Brancheau & Webtherbe 1990; Gerwin 1988; Cash & McLeod 1985; Lewin 1952; Nolan 1973; Kanter 1988; Walton 1989; Applegate 1992; Grover & Goslar 1993; Rogers 1995; Rai 1995; Carter et al. 2001, among many others, have provided some various stage models of innovation diffusion, but they basically start with the initiation stage and finish with the diffusion stage. For example, Kwon and Zmud (1987) report such a stage model for innovation implementation process of initiation $\rightarrow$ adoption $\rightarrow$ adaptation $\rightarrow$ acceptance $\rightarrow$ use $\rightarrow$ incorporation. The study reported in this paper tested a six-stage of KMS diffusion process of initiation $\rightarrow$ adoption $\rightarrow$ pilot implementation $\rightarrow$ organic growth $\rightarrow$organizational implementation$\rightarrow$ diffusion (sustained use), which is part of a comprehensive KMS adoption and diffusion model (see Figure 2) and is derived from field studies and literature review (Xu 2003).

3. Research Method

This study uses a mixed methodology approach. The research was carried out in three stages: field study, pilot survey, and national survey (top 1500 companies). In the first stage, a comprehensive model of KMS diffusion in organizations through a combination of literature review and qualitative field study was produced. Six companies took part in this phase, which resulted in eight interviews with key person(s) in the companies. The interviews were transcribed by the researchers and the contents were analysed thoroughly using a structured process. The content analysis and further refinement resulted in 16 factors and 72 unique variables. Company specific individual diffusion models were first developed which were then combined to develop a comprehensive KMS diffusion model. In the second stage, a questionnaire was developed based on the combined model. Twelve West Australian companies were randomly selected for the pilot study. The questionnaire was distributed to 125 functional and senior level managers in these companies. 25 valid responses were received. The results of the pilot survey proved the effectiveness of the questionnaire. Finally, the data of the study is collected through surveying the top 1,500 organizations (based on revenue) in Australia. The questionnaires were distributed to 1500 managers in those companies, who appeared to be most relevant to our study. In the end, there were 285 valid responses. The data of the national survey was analysed

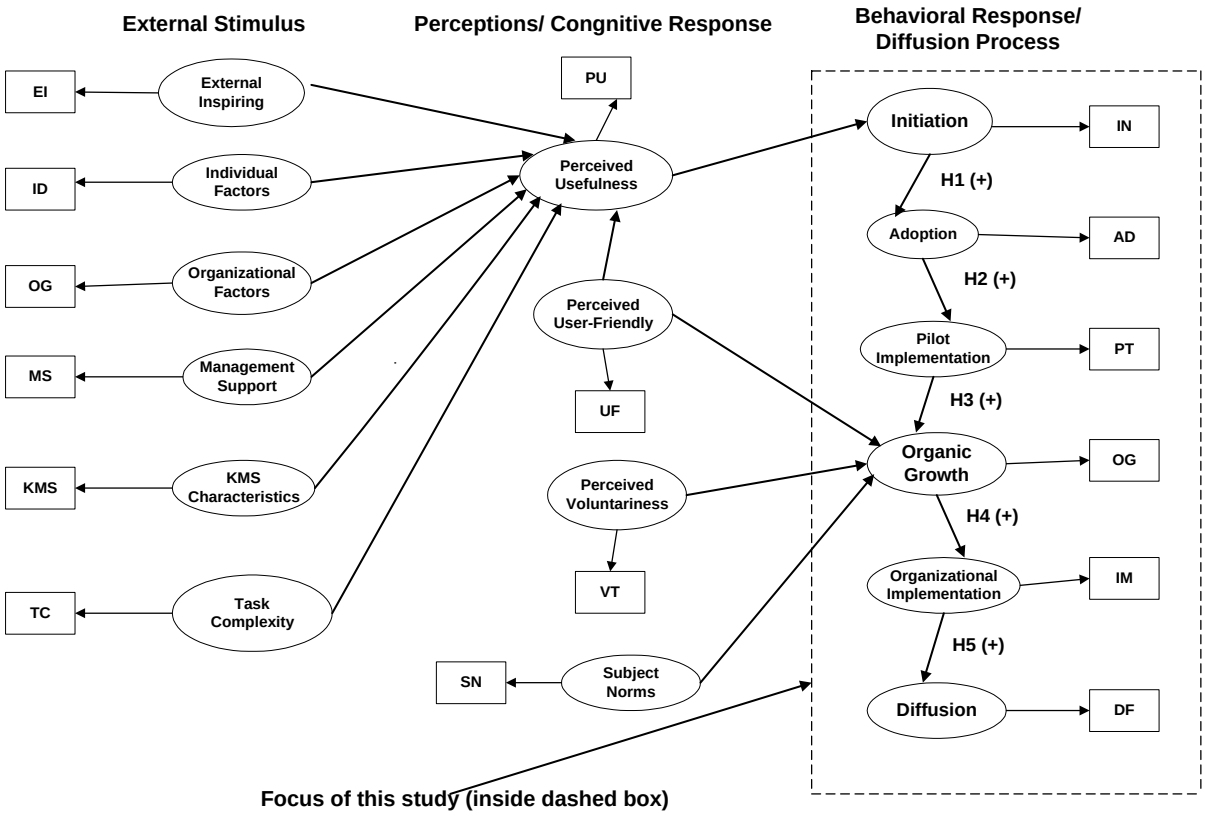

Figure 2: The Research Scope of This Study

through Structural Equation Modelling approach using LISREL, which resulted in a valid KMS adoption and diffusion model. The details of the three phases of the study can be found in Xu, Quaddus & Wood (2001); Quaddus, Xu & Wood (2002); and Quaddus & Xu (2002), respectively.

4. Hypotheses Development

During the field studies many participants talked about their organizations' dream of knowledge management system. There exists a shared opinion among the interview participants that organizations should have a knowledge management system to manage and control their knowledge in a more systematic and effective way. Brooking (1999) suggests that the best way to initiate a knowledge management system is to look at the real knowledge resource in the organization and see how that resource can be best managed.

After organization's effort in scanning the alternative solutions to effectively manage knowledge and researching in people's knowledge needs as well as available applications, a decision is made whether to adopt a KMS or not. In the case of successful initiation of KMS, which is reflected by that KMS meets the organization's needs to manage knowledge and KMS is the best solution to control its knowledge assets, organization will make an adoption decision.

Organization should go through pilot tests until satisfaction of people's knowledge management needs is met (Phillips Fox 1998). Organizations should build their knowledge management systems with the users. When they are developing their knowledge management systems, they should listen to the users and act on what they suggest. That will help enhance the value of the systems and facilitate the users' 'buy-in'/acceptance of the systems.

When an organization is implementing a knowledge management system, it has the option to try and test the knowledge management system in smaller subset of users to begin with, instead of targeting all the potential users in the entire organization. The organization may limit the initial use of KMS to a single function (i.e., production, marketing, R & D) to a single division, and expand the use of KMS into the whole organization after having adequate experience with the system (Bansler & Havn 2002). The process of pilot-testing of a KMS with smaller and usually more homogeneous subset users may greatly facilitate the success of starting up the system. Benefits of

going through pilot-testing stage in a smaller and more homogeneous group users are: Firstly, it enables the system designers to better address individual users' interests and needs and achieves a good "fit" between the system and organizational context. Secondly, it can entice and educate the users to use the system by allowing organization to focus on certain part of the organization and thus take into the local characteristics of that specific part of organization, such as circumstances, values, etc., into consideration when the organization is planning to implement the system. Thirdly, the success of the first implementation in one part of the organization will have a positive influence on perceptions of the system in other parts of the organization, which will in turn lead to subsequent implementations. Fourthly, in the worst scenario, even the pilot implementation is eventually not successful in spite of careful planning and intensive efforts in achieving the critical mass of KMS use, the losses are more limited and in a smaller scale (Bansler & Havn 2002).

Meanwhile, organizations should persuade and educate people to use the knowledge management system. The most difficult part in knowledge management systems from cultural perspective is making people to understand that sharing knowledge and using the systems will bring benefits not only to the organization but also to themselves (Brooking 1999).

Pilot implementation is important in putting a knowledge management system into organization since it provides organization opportunities to optimise their knowledge management system and make adjustment on their structure and culture to facilitate the successful implementation of knowledge management system in organization. Meanwhile organic growth plays important role in putting a knowledge management system into organization, since it makes people interested in knowledge management system. Also, it gives people the capability to use the system.

Following the stages of pilot implementation and organic growth, it is time to implement the knowledge management system in the whole organization since both organization and individuals are ready for the knowledge management system. Organizational implementation deals with putting knowledge management system in every corner of the organization and every one in organization is expected to use the system. In organizational implementation stage people normally try to use all the functions of the system instead of limited usage in the stage of pilot implementation. It is noted that, factors such as optimized knowledge management system, pro-knowledge management structure and culture, people's willingness and interests in using the knowledge management system, and people's ability to use the system, can not guarantee the success of organizational implementation of knowledge management system. In order to successfully implement knowledge management system in the whole organization, organizations should take pro-active actions.

One of the most frequently asked questions about knowledge management systems is "how do you know people will use them"? (Brooking 1999, p.128). Instead of compensating employees for sharing their knowledge, organization should make people understand that use of knowledge management system is part of their job to comply and is a part of culture -"the way we do things around here" (Brooking 1999, p.128).

After organizations implement the knowledge management system in the whole organization, people in the organization start to use the system. At this stage, organizations face another challenge - how to make sure people's sustained use of knowledge management system. Sustained use of knowledge management system means that people will use the system and using system has become a part of business as well as a part of people's life. For the purpose of achieving people's sustained use of the system, organizations should promote best practices of knowledge management and knowledge management system, keep on providing what people want in knowledge management system, encourage people's more usage and involvement in knowledge management and knowledge management system, make using the system as a part of the business, and make using the system a part of people's life in organization.

Gray (2000) suggests that increased number of employees specializing in knowledge management arising from the use of KMS will result in more increased use of the system. The author proposes that increased solution effectiveness through the use of KMS will lead to the enhanced perceptions of usefulness of KMS, which links to the higher level use of KMS.

As per the above the discussion, the following five hypotheses, related to the sequence of the KMS diffusion process, are suggested:

Hypothesis 1: Successful "Initiation" of KMS positively influences the "Adoption" of KMS in organizations.

Hypothesis 2: Successful "Adoption" of KMS positively influences the "Pilot Implementation" of KMS in organizations.

Hypothesis 3: Successful "Pilot Implementation" of KMS positively influences the "Organic Growth" of KMS in organizations.

Hypothesis 4: "Organic Growth" of KMS positively influences the "Organization-wide Implementation" of KMS.

Table-1 Results of Hypothesis Testing

Structural Relations Independent → Dependent Variables	**Hypothesis**	**Standardized Path Coefficient β(t-value)**	**Significance of Hypothesis (5% level)**
Initiation → Adoption	H1	0.872 (20.291)	Yes
Adoption → Pilot Implementation	H2	0.915 (20.429)	Yes
Pilot Implementation → Organic Growth	H3	0.171 (2.101)	Yes
Organic Growth → Organizational Implementation	H4	0.994 (26.816)	Yes
Organizational Implementation → Diffusion	H5	0.995 (28.018)	Yes

Hypothesis 5: "Organization-wide Implementation" of KMS positively influences the "Diffusion" of KMS in organizations.

5. Results and Discussions

5.1 Hypothesis Testing

The set of hypotheses (H1-H5) deals with the diffusion process of KMS and is tested using the t-value. The path is statistically valid or significant at the level of 5% if the t-value is greater than ±1.96. Results of the structural model analysis in LISREL are presented in Table-1. A number of previous studies have dealt with various stages of the diffusion process in general and in specific applications (see Rogers 1995 and Quaddus 1995; among many others). To the best of researchers' knowledge no empirical test of the sequences of these stages are available in the literature. Almost every diffusion process starts with initiation of some kind and ends with the large scale spread in use of the technology. In this study similar approach in determining the diffusion stages of KMS had been taken. However, it is noted that the diffusion stages in this study are first determined from the literature and then further refined during the qualitative field study process. The results show that all the hypotheses related to the sequence of the KMS diffusion process (H1 – H5; Table-1) were significant.

5.2 Further Analysis by Examining Direct, Indirect and Total Effects

After testing hypotheses, the model of KMS adoption and diffusion is further analysed by examining the total (i.e., direct and indirect) effects of structural part of the model. Total effect is the sum of direct effect and indirect effect. Direct effect is between two latent variables, which are connected or linked by a directed line or one-way arrows. In LISREL, a direct effect is measured by structural coefficients. An indirect effect between two latent variables, where there is no single straight line or arrow directly linking them, is defined when the second latent variable may be reached from the first latent variable through the mediation of one or more other variables. An indirect effect is reflected by the product of the structural coefficients of all involved latent variables (Joreskog & Sorbon 1996a; Schumacker & Lomax 1996).

The effects among stages of KMS diffusion process are reported in Table-2. Initiation of KMS had significant direct effect on adoption (H1, $\beta = 0.872$ with $P<0.001$). Initiation had significant but indirect effects on pilot implementation (0.798 with $P<0.001$), organic growth (0.136 with $P<0.05$), organizational implementation (0.135 with $P<0.01$), and diffusion of KMS (0.135 with $P<0.05$), mainly through adoption. The total effect of initiation on adoption (0.872) is greater than its total effect on pilot implementation (0.798), organic growth (0.136), organizational implementation (0.135), and diffusion of KMS (0.135). This implies that Adoption is the best choice after the initiation in the KMS diffusion process rather than pilot implementation, organic growth, organizational implementation, and diffusion of KMS. In other words, when an organization embarks on the adoption and diffusion of KMS, it is necessary to go through the stage of initiation before it proceeds to other stages of KMS diffusion process. Similarly adoption had significant direct effects on pilot implementation (H2, $\beta = 0.915$ with $P<0.001$) and significant indirect effects through pilot implementation on organic growth (0.156), organizational implementation (0.155), and diffusion of KMS (0.155). The total effect of adoption on pilot implementation (0.915) is greater than its impact on organic growth (0.156), organizational implementation (0.155), and diffusion (0.155). This indicates that pilot implementation is the next stage of adoption in the KMS diffusion process rather than organic growth, organizational implementation, and diffusion. While pilot implementation had significant direct effect on organic growth (H3, $\beta = 0.171$ with $P<0.05$) as well as significant indirect effect on organizational implementation ($\beta=0.170$ with $P<0.05$) and diffusion (0.169 with $P<0.05$), organic growth is the best candidate for the subsequent stage after pilot implementation in the KMS diffusion, since its total effect on organic growth (0.171) is greater (even slightly) than its total effect on organizational implementation (0.170) and diffusion (0.169). Organic growth had significant direct effect on organizational implementation (H4, $\beta = 0.994$ with $P<0.001$) and significant indirect effect on diffusion (0.989 with $P<0.001$). Organizational implementation is

Table 2: Prediction of Stages of KMS Diffusion Process

Independent Factor→ Dependent Factor	**Direct Effect**	**Indirect Effect**	**Total Effect**	**Tested Hypothesis (Accepted ?)**
Initiation → Adoption	0.872***	0	0.872***	H1 (Yes)
Initiation → Pilot Implementation	0	0.798***	0.798***	
Initiation → Organic Growth	0	0.136*	0.136*	
Initiation → Organizational Implementation	0	0.135*	0.135*	
Initiation → Diffusion	0	0.135*	0.135*	
Adoption → Pilot Implementation	0.915***	0	0.915***	H2 (Yes)
Adoption → Organic Growth	0	0.156*	0.156*	
Adoption → Organizational Implementation	0	0.155*	0.155*	
Adoption → Diffusion	0	0.155*	0.155*	
Pilot Implementation → Organic Growth	0.171*	0	0.171*	H3 (Yes)
Pilot Implementation → Organizational Implementation	0	0.170*	0.170*	
Pilot Implementation → Diffusion	0	0.169*	0.169*	
Organic Growth → Organizational Implementation	0.994***	0	0.994***	H4(Yes)
Organic Growth → Diffusion	0	0.989***	0.989***	
Organizational Implementation → Diffusion	0.995***	0	0.995***	H5 (Yes)

*P < 0.05, ** P<0.01, ***P<0.001

the better immediate linking stage after organic growth than diffusion in the KMS diffusion process, since the total effect of organic growth on organizational implementation (0.994) is higher than the total effect of organic growth on diffusion (0.989). Finally, organizational implementation had significant direct effect on the diffusion of KMS (H5, β= 0.995 with P<0.001). In summary, KMS diffusion consists of six stages: initiation, adoption, pilot implementation, organic growth, organizational implementation, and diffusion in that order.

6. Conclusions

This research identified six stages of KMS diffusion based on the results from selected Australian companies as: initiation, adoption, pilot implementation, organic growth, organizational implementation, and sustained use/ diffusion of KMS. The identification of six-stages of KMS diffusion process is an important finding. In prior studies, researchers have come out with various stage models of innovation diffusion. But this study brings out a new stage of diffusion -organic growth, which reflects the individual learning and use of KMS. It also highlights the need for pilot implementation before the whole organizational implementation. The KMS adoption and diffusion model shows the detailed stages of KMS diffusion from “initiation” to “sustained use”. The direction of arrow indicates the sequence of the KMS diffusion stages.

The results have both managerial and research implications. The results of this study will add value to the literature of knowledge management. Organizations, which are practicing knowledge management or are preparing to embark on knowledge management system should plan the process carefully in accordance with the sequence of these six stages. A clear planned sequence, as follows, can be adopted for the effective diffusion process of KMS.

- ⇒ Research the organization’s challenges and people’s needs regarding knowledge, i.e., identify the important knowledge domains for organization.
- ⇒ Search for suitable applications for KMS.
- ⇒ Develop a KMS plan/strategy.
- ⇒ Allocate a budget for KMS.
- ⇒ Appoint a Knowledge Manager or a Chief Knowledge Officer.
- ⇒ Build up/ Set up KMS.
- ⇒ Test KMS through pilot implementation on a limited basis in the organization and optimise the system according to feedback.
- ⇒ Work on the organizational culture and structure to facilitate the implementation of KMS.
- ⇒ Entice and educate people to use the KMS.
- ⇒ Provide people with continuous training and support to encourage their use of KMS.
- ⇒ Encourage people to go through the process of self-learning.
- ⇒ Implement the KMS throughout the organization.
- ⇒ Cut off people’s old means of accessing knowledge.
- ⇒ Develop organizational wide interest in using a KMS.
- ⇒ Monitor and check people’s usage of KMS.
- ⇒ Keep on providing the knowledge people want in the KMS.

⇒ Promote best practice.
⇒ Develop and encourage people's sustained use of KMS.
⇒ Make KMS and using KMS a part of business.

Finally, even though the research was conducted in Australian organizations, its results will apply to different organizations in various countries across the globe because of its generic approach.

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