Editorial

This issue of the Electronic Journal of Knowledge Management illustrates the evolving thinking around KM. Some of the papers are conceptual, providing insights on various issues of current concern in the KM world, including the relationship between KM and IT, other address the implementation of KM systems.

Waheed Akbar Bhatti and Arshad Zaheer examine the links between intellectual capital and organizational performance. They propose a conceptual model that addresses the moderating role of intellectual capital competencies in developing an effective organisational KM strategy. Of particular interest is their recognition that IC is a dynamic asset, involving structure and process and that the effective mobilisation of IC is necessary to achieve innovation and strategic success.

Namjoo Choi, Kuang-Yuan Huang and Aaron Palmer provide us with an interesting theoretical paper on the links between effective use of Web 2.0 applications (social media) to facilitate innovation. They provide a framework that demonstrates how individual and organisational use of Web 2.0 applications are useful agents to facilitate informal networks and span organisational boundaries. They discuss how the weak ties and improved absorptive capacity established can increase relational, structural and cognitive social capital. The paper will be useful to anyone interested in understanding how to take the use of social media beyond personal activity and achieve a positive organisational impact. We would encourage researchers to find ways to build on these concepts in empirical work.

Konstantinos Samiotis, Nenad Stojanovic and Spyridon Ntioudis discuss the concept of attention management, drawing on issues identified in the study of three eastern European public sector organisations. While their paper focuses on the public sector, it should be of interest to all types of organisation.

They suggest that a significant challenge found in many public sector knowledge environments is not the availability of information, but rather whether and how a user can find the needed information. They present a conceptual Attention Management Framework along with a suggested development methodology illustrating its use in a prototype Enterprise Attention Management System (EAMS).

While dealing with somewhat more structured systems use, the case study paper by Tarek Khalil, Kamal Atieh, Abd Ulghafoor Mohammad and Fadi Bagdadlianis complements the work of Choi et al. Drawing on the theory of planned behaviour and social exchange theory, they look at the benefits and challenges in the building and use of a community of practice for teachers in Syria. Surveying some 214 teachers, they found that an effective implementation of an online community of practice can have a positive impact on knowledge sharing. Notably, they found that the social influence of management and peers positively affects knowledge sharing behaviours and that reciprocal benefits, reputation enhancement and extrinsic rewards all had a positive influence. Not surprisingly, they also found that those teachers who believed that "knowledge is power" were less likely to engage in knowledge sharing behaviours.

The two papers by Choi et al and Khalil et al discussed above examine different perspectives in IT use to support knowledge management and remind us of the major role played by Knowledge Management Systems (KMS). As Takudzwa Deve and Gilford Hapanyengwi point out in their paper on a proposed KMS architecture, views on what constitutes a KMS vary considerably and they suggest that these systems are often just groups of technologies brought together, without any underlying conceptual framework to determine their integration. They provide us with a clear discussion of the current situation and debate on approaches for KMS implementation and give some guidance on how Generic Knowledge Management System Architecture might be developed.

Finally, the construction industry shares with the IT industry the dubious reputation of having the highest levels of project management problems (typically measured by time delays and cost overruns). In
construction, many of the delays occur in the design phase. Zohreh Pourzolfaghar and Rahinah Ibrahim suggest that the activity-focused approach to project management needs to be enhanced to include knowledge flows and, in prior work, proposed a possible knowledge flow model. This paper uses the simulation tool SimVision to assess the impact on project performance of varying the project team expertise in the tacit-dominated conceptual design phase of the building projects. They found that the experts’ levels of skill considerably affect the performance of the project, but that explicitly including knowledge flows within the project activity has a significant positive affect.

Enjoy the issue.

Ken Grant
Editor
Examining the Social and Technical Factors Influencing School Teachers Knowledge Sharing Intentions in a Teachers Online Professional Community

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Abstract: There is a growing recognition to the importance in using online communities of practice (COPs) as a model for teacher's professional development and as a knowledge management platform. The objective of this research was to examine factors that promote or discourage school teachers’ knowledge sharing intention in their online professional community. The finding of the research provides empirical support for the overall structure theorized in the research model. Knowledge sharing intention was predicted by teachers’ attitude towards knowledge sharing, subjective norm and perceived behavioral control. The teachers’ perceptions of reciprocity, extrinsic rewards were positively associated with attitude towards knowledge sharing. The perceptions of loss of knowledge power had a negative effect on the attitude. Organizational climate positively influenced teachers’ subjective norm. Additionally, facilitating tools and technology was positively associated with high levels of perceived behavioral control towards knowledge sharing. Based on the findings, the study discussed implications for the theory and practice

Keywords Knowledge management; knowledge sharing intention; theory of planned behavior

1. Introduction

Knowledge Management is ingrained in many disciplines, including business, economics, psychology, and information management and experiments are just beginning in education. Knowledge management is, in fact, in tune with the culture of education and education should be leading the way in making knowledge management a key part of its culture, education should be the natural home of the discipline (Sallis and Jones, 2002). Researchers in education field and knowledge management suggested the creation of online communities of teachers as a new teachers’ professional development model and as knowledge management platform, a community of practice can provide both tacit and explicit knowledge sharing opportunities among teachers. (Petrides and Nodine, 2003).

(Yang and Chen, 2007) argued factors impacting knowledge sharing should be the most important consideration in any knowledge management effort, the basic assumption of this research is to uncover factors that motivate or inhibit teachers’ intentions to share knowledge in their online professional community.

2. Literature review

The original concept of “communities of practice” offered by (Lave and Wenger, 1991) they envisioned a model of apprenticeship, based on socialization-related learning. Learning activities include the adoption of knowledge that is shared by peers and subject-matter experts, as well as the discovery or creation of new knowledge. The basic assumption underlying the theory of cops is that engagement in social practice is the fundamental process by which we learn and so become who we are. Community of practice has been defined as "a group of people who share a concern, a set of problems, or a Passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger et al., 2002). There is much less literature available on KM in higher education than in business and industry (Santo, 2005). Thus understanding the motivations prompting people to share knowledge or participate in virtual communities in a business world examined firstly. Most recent studies regarding knowledge sharing in business and industry are based on different theories to find out factors affecting knowledge sharing. According to the theory of reasoned action (TRA) proposed by (Ajzen and Fishbein, 1980), beliefs and evaluations would affect individual’s attitudes while normative beliefs and motivation to comply would affect subjective norms. Next, attitudes and subjective norms would affect individual’s intention, and intention has influence on behavior in sequence. Based on the TRA, (Bock et al., 2005) find that attitudes toward and subjective norms with regard to knowledge sharing as well as organizational climate affect individuals’ intentions to share knowledge.
addition, they find that reciprocal relationships would affect individual’s attitudes toward knowledge sharing while both sense of self-worth and organizational climate would affect subjective norms. As for anticipated extrinsic rewards, they play a negative role on attitudes toward knowledge sharing. Whereas (Taylor, 2006) suggest that the group financial incentives inspired more knowledge sharing than did either tournament or piece-rate. Results suggest that managers should carefully consider incentive structures in computer-based systems because incentives potentially affect knowledge sharing. (Chang et al., 2008) adopt a cost-benefit framework to predict the users’ contribution behavior on blogs and forums. Their research results show that users’ intention toward knowledge sharing is affected by extrinsic benefits (reputation and reciprocity), intrinsic benefits (enjoy helping and self-efficacy), and costs (convenience and interaction). Although there is a growing recognition of the importance in using online COPs as a model for teachers professional development, moreover; teacher’s professional Virtual community acted as a knowledge management platform in education field, few empirical studies have been undertaken to identify how online COPs work and how they can be sustained in an educational community. Moreover; knowledge sharing motivation factors differ by national and ethnic cultures (Hambrick et al., 1998; Hutchings and Michailova, 2004) and these factors could not be generalized globally, and that impose to examine knowledge sharing motivation factors and strategies for each ethnic group.

3. Research Model and hypotheses

The research model (Figure. 1) uses theory of planned behavior (TPB) (Ajzen, 1991), and social exchange theory as theoretical framework and augments it with organizational climate factors that are believed to influence individuals’ knowledge sharing intentions, that influence knowledge sharing behaviors of teachers. The basic idea of the research model according to theory of planned behavior, that the primary determinants of an individual’s behavioral action are intention. Intention is an indication of individual’s readiness to engage in a behavior. Intention in turn is a function of individual’s attitude towards a behavior, subjective norm (SN) and perceived behavioral control (PBC) with each determinant weighted for its significance in relation to the behavior and population in question. Attitude toward the behavior refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question. Perceived Behavioral Control (PBC) is based on control beliefs. Control beliefs are beliefs about the perceived presence or absence of factors that may facilitate or impede the performance of behavior in interest. Subjective Norm (SN) is based on normative beliefs. Normative beliefs are beliefs about the perceived social pressure from important referent group to perform or not to perform a specified behavior. Normative beliefs together with the motivation to comply with these referent group expectations determine the subjective norm.

Figure 1 -Research Model

TPB argues that the best predictor of behavior is intention which is determined by attitude and subjective norm and Perceived Behavioral Control. Thus, we hypothesized

**H1- there is a significant relation between teachers’ attitude toward knowledge sharing and teachers’ intention to share knowledge.**
H2 - there is a significant relation between teachers' subjective norm supportive of knowledge sharing and teachers' intention to share knowledge.

H3- there is a significant relation between teachers' perceived behavioral control towards knowledge sharing and teachers' intention to share knowledge.

Attitude towards knowledge sharing is formed from behavioral beliefs and refers to the degree of positive/negative feelings an individual has towards the intention to share knowledge with other members of the organization. Social exchange theory posits that social exchange engenders social rewards such as feelings of approval, status and respect. (He and Wei, 2009; Hsu and Lin, 2008; Shin et al., 2007; O'Dell and Grayson, 1998) Suggest that employees share their best practices because of their desire to be recognized by experts and peers, and that leading to the fourth hypothesis

H4- there is a significant relation between teacher’s reputation enhancement and teachers’ attitude toward knowledge sharing.

Knowledge sharing involves costs for the participants. These costs may include time, energy, potential loss of ownership, power etc. Previously published studies highlight the importance of economic incentives and observe that individuals engage in knowledge sharing when they expect to receive economic benefits such as increased pay, bonuses, job security, career advancement etc. for sharing knowledge (Ba et al., 2001; Davenport and Prusak, 1998; Chang et al., 2008; Hsu and Lin, 2008). This leads to the fifth hypothesis:

H5- there is a significant relation between teacher’s extrinsic rewards and teachers’ attitude toward knowledge sharing.

Social exchange theory (Blau, 1967) describes human behavior in terms of social exchanges. Social exchanges differ from economic exchanges in that the value in the exchange behavior is not clearly defined. Prior research suggests that individuals engage in knowledge sharing with the expectation that their future knowledge requests will be met by others. This leads to the sixth hypothesis.

H6- there is a significant relation between teacher’s Perceived Reciprocal relationship and teachers’ attitude toward knowledge sharing.

As knowledge is considered as a source of power, individuals may fear losing the power, if that knowledge is transferred to others. (Davenport and Prusak, 1998; Gray, 2001). Thus that leading to the seventh hypothesis

H7- there is a significant relation between teacher’s loss of knowledge power and teachers’ attitude toward knowledge sharing.

The subjective norm construct, defined as perceived social pressure to perform or not perform a behavior (Ajzen, 1991) Sociologists see social action as largely governed by institutional structures, e.g., social norms, rules, and obligations (Bock et al., 2005). Related to these institutional structures are three organizational climate factors for knowledge sharing, which we have derived from contextual factors in prior literature: fairness (a trusting climate), and affiliation (sense of togetherness). Organizational climate is the shared values, norms, meanings, beliefs, myths and underlying assumptions within an organization. Organizational climate guides the employees behavior by conveying to them what behavior is appropriate and desirable. Subjective norms are formed when employees internalize and evaluate organizational values and norms. Previously, the researchers identified two aspects of organizational climate as being particularly conducive to knowledge sharing: trust, and affiliation. The degree of trust has an impact on collaborative efficiency in the organization. (Bock et al., 2005). Therefore, trust is regarded as one of the important contextual factors affecting knowledge contribution in prior research. Trust is an implicit set of beliefs that the other party will refrain from opportunistic behavior and will not take advantage of the situation (Hosmer, 1995). Due to the nature of virtual community, trust has been recognized as a critical factor in fostering the voluntary online cooperation between strangers (Ridings et al., 2002; Hsu, et al, 2007). Finally, affiliation, defined as the perception of a sense of togetherness among an organization’s members, reflects the caring and pro-social behavior critical to inducing an organization’s members to help one another. This leads to the eighth hypothesis.

H8- there is a significant relation between teachers’ perceived organizational climate characterized by trust, and affiliation and teachers subjective norm toward knowledge sharing.

Information and communication technologies in the form of knowledge management systems (KMS) facilitate collaborative work and enable knowledge sharing, but only if they are actually used. Previous research in information systems suggests that individuals act in accordance to their beliefs about the availability and ease of use of the systems. So it is hypothesized that tools and technology that are perceived to be highly available and ease to use influence knowledge workers perceived behavioral control towards knowledge sharing. This leads to the ninth hypothesis.
H9 - there is a significant relation between teachers' perceived availability and ease of use of Tools and Technology and teachers' behavioral control towards knowledge sharing

4. Research methodology and analysis:

To test the proposed research model, we adopted the survey method for data collection, and examined our hypotheses by applying the partial least squares (PLS) method to the collected data. 363 school teachers enrolled in integrating technology in the education program in Syria were surveyed. All surveys were checked for quality of completion and completeness. Seven surveys with missing data and six other surveys containing incompatible answers were excluded. The remaining 214 questionnaires were used in the statistical analysis. We developed the items in the questionnaire either by adapting measures that had been validated by other researchers or by converting the definitions of constructs into a questionnaire format.

4.1 Analysis Method

PLS (Chin, 1998) was used as it allows latent constructs to be modeled either as formative or reflective indicators as was the case in our data, and it makes minimal demands in terms of sample size to validate a model compared to alternative structural equation modeling techniques. We used WarpPLS Version 1.00 in our analysis. Following recommended two-stage analytical procedures (Hair et al. 1998), confirmatory factor analysis was first conducted to assess the measurement model; then, the structural relationships were examined. Since the model contains a second-order variables (organizational climate), we created superior second-order constructs using factor scores for the first-order constructs (Chin, 1998).

4.2 Measurement Model

To validate our measurement model, two types of validity were assessed: convergent validity, and discriminated validity.

4.3 Assessment of the Structural Model

With the adequacy of the measurement model established, the structural model was evaluated and hypotheses were tested. The structural model indicates the causal relationships among the latent constructs in the research model. Assessment of structural model was done first by determining the predictive power of the model and second by analyzing the hypothesized relationships among the latent constructs proposed in the research model. The R-square values of the dependent variables determine the predictive power of the research model and the path coefficients evaluate the strength of the hypothesized relationships. Validation of structural model was accomplished with WarpPLS 1.0. The results of the analysis are depicted in Figure 2 and summarized in Table 3. As is evident from figure 2, the model has high predictive power. It explains approximately 79% of the variance in the knowledge sharing intention (INT). The attitude towards knowledge sharing (ATK), subjective norm (SNK) and perceived behavioral Control (PBK) respectively account for 65.6%, 19.6% and 4.4% of the variance. Additionally, 8 of the 9 paths were found to be statistically significant. The standardized path coefficients ranged from 0.023 to 0.601. The overall fit of the model was good.
Table 1 - Research Hypotheses

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Results</th>
<th>Path Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1  There is a significant relation between teachers' attitude toward knowledge sharing and teachers' intention to share knowledge.</td>
<td>Accepted</td>
<td>0.723</td>
</tr>
<tr>
<td>H2  There is a significant relation between teachers' subjective norm supportive of knowledge sharing and teachers' intention to share knowledge.</td>
<td>Accepted</td>
<td>0.047</td>
</tr>
<tr>
<td>H3  There is a significant relation between teachers' behavioral control toward knowledge sharing and teachers' intention to share knowledge.</td>
<td>Accepted</td>
<td>0.223</td>
</tr>
<tr>
<td>H4  There is a significant relation between teacher's reputation enhancement and teachers' attitude toward knowledge sharing.</td>
<td>Not Accepted</td>
<td>0.036</td>
</tr>
<tr>
<td>H5  There is a significant relation between teacher's extrinsic rewards and teachers' attitude toward knowledge sharing.</td>
<td>Accepted</td>
<td>0.449</td>
</tr>
<tr>
<td>H6  There is a significant relation between teacher's Perceived Reciprocal benefits and teachers' attitude toward knowledge sharing.</td>
<td>Accepted</td>
<td>0.376</td>
</tr>
<tr>
<td>H7  There is a significant relation between teacher's loss of knowledge power and teachers' attitude toward knowledge sharing.</td>
<td>Accepted</td>
<td>-0.146</td>
</tr>
<tr>
<td>H8  There is a significant relation between teachers' perceived organizational climate characterized by trust and affiliation and teachers Subjective Norm toward knowledge sharing.</td>
<td>Accepted</td>
<td>0.443</td>
</tr>
<tr>
<td>H9  There is a significant relation between teachers' perceived availability and ease of use of Tools and Technology and teachers' behavioral control towards knowledge sharing.</td>
<td>Accepted</td>
<td>0.209</td>
</tr>
</tbody>
</table>

5. Discussion

We discuss the results in the following sequence: standard TPB constructs (Hypotheses 1, 2, and 3), psychological antecedents to these TPB constructs (Hypotheses 4, 5, 6, and 7), organizational climate (Hypotheses 8), and perceived behavioral control (Hypotheses 9).
5.1 Knowledge Sharing Intention

These findings are consistent with the findings of prior TPB related research (Taylor and Todd, 1995; Bock and Kim, 2002; Ryu et al., 2003; Lin et al., 2004). Attitude towards knowledge sharing had a strong effect on the behavioral intention to share knowledge with a path coefficient of 0.723. The high contribution of attitude towards knowledge sharing suggests that teachers with favorable attitudinal disposition are more likely to engage in knowledge sharing. Perceived behavioral control was found to have significant but moderate effect on behavioral intention with a path coefficient of 0.223, and subjective norm was found to have significant but weak effect on behavioral intention with a path coefficient of 0.047. The significance of subjective norm implies that teachers consider management and peer group expectations of knowledge sharing to be important. Teachers are likely to engage in knowledge sharing when they perceive that their management and peer group value knowledge sharing and are likely to praise the behavior. This finding emphasizes the importance of the social influence of top management and peer group in knowledge sharing. The impact of perceived behavioral control on the intention towards knowledge sharing indicates that teachers are motivated to engage in knowledge sharing to the extent they believe they have the time, resources and opportunities to do so.

5.2 Knowledge Sharing Attitude

The researchers applied a diversity of extrinsic and intrinsic motivational drivers such as extrinsic rewards, reciprocal benefits, reputation enhancement, and perceived loss of knowledge power as antecedents to attitude. Of these antecedents, only three of them emerged as significant predictors of teacher’s attitude towards knowledge sharing. These were reciprocal benefits, extrinsic rewards, loss of knowledge power. Reputation enhancement was found not to have a substantial impact, when all the motivators were included into the analysis.

5.2.1 Reciprocal Benefits

Correspond with social exchange theory, reciprocal benefits had a significant and positive moderate effect on the teacher’s attitude towards knowledge sharing with a path coefficient of 0.376. These finding consistent with the findings of prior research on information exchange, and open source programming communities where generalized reciprocity was consistently found to be an important predictor for knowledge contribution (Constant et al., 1994; Wasko and Faraj, 2000; Lakhani and von Hippel, 2000; Lerner and Triole, 2000). The significance of perceived reciprocal benefits provides some indication that teachers are likely to engage in knowledge sharing with the expectation of receiving future help from others in return for sharing knowledge.

5.2.2 Loss of Knowledge Power

Loss of knowledge power had a significant negative effect on the Teachers attitude towards knowledge sharing with a path coefficient of -0.146. This finding suggests that the more the teachers hold beliefs that sharing knowledge reduces their power within the organization, the less likely they are to engage in knowledge sharing. The finding agrees with prior published research that highlights the influence of knowledge on the distribution of power within institutions (Gray, 2001; Hall, 2004).

5.2.3 Reputation enhancement

Reputation enhancement demonstrated an insignificant, weak positive effect on the teachers’ attitude towards knowledge sharing with a path coefficient of 0.036, for this sample of teachers. Reputation enhancement were not as important as other perceived benefits such as reciprocity, extrinsic rewards and knowledge power. The finding disagrees with prior published research in developed countries (He and Wei, 2009; Hsu and Lin, 2008; Kankanhalli et al., 2005; Shin et al., 2007; Wasko and Faraj, 2005), and this finding could be justified as this research conducted in Syria which is a developing country where there are cultural, economic, and wage scale differences.

5.2.4 Extrinsic rewards

Correspond with Economic exchange theory extrinsic rewards had a significant and strong effect on the teacher’s attitude towards knowledge sharing with a path coefficient of 0.449. The finding agrees with prior published research (Bonner et al., 2000; Drago and Garvey, 1998; Gale, 2002; O’Dell and Grayson, 1998). That suggests institutions can encourage sharing by implementing an incentive system with particular focus on group-based financial incentives, the effectiveness of financial incentives to induce sharing prior to the formation of relational intimacy in newly formed groups. Contrary to, the finding disagrees with another prior published research that suggests that financial incentives...
are frequently ineffective (Bock and Kim, 2002) and (Bock et al., 2005) find that expected rewards are unrelated to knowledge-sharing attitudes.

5.3 Subjective Norm

5.3.1 Perceived Organizational Climate

Organizational climate characterized by two dimensions: affiliation, and trust were applied as an antecedent to subjective norm. Similar to (Bock et al., 2005) study, organizational climate was found to have substantial impact on subjective norm with a path coefficient of 0.443. The higher the perceptions of organizational climate to be conducive of knowledge sharing, the higher was the formation of subjective norm towards knowledge sharing. Organizational climate explained about 19.6 percent of variance in subjective norm towards knowledge sharing.

5.3.2 Perceived Behavioral Control

Tools and Technology
Tools and technology that facilitate knowledge sharing demonstrated a strong positive relationship with perceived behavioral control towards knowledge sharing at 0.21. This finding suggests that the teachers are inclined to use tools and technology to share knowledge; to the extent they have high perceptions regarding their availability and the ease of use. Tools and technology explained about 4 percent of the variance in the perceived behavioral control. This is a significant finding since institutions are investing heavily in the development and acquisition of information and communication technologies in the form of knowledge management systems (KMS).

6. Research contributions and limitations

The research has provided a number of contributions to the academic literature and practical application, from theoretical contribution. First, the study suggests a holistic perspective on the knowledge sharing intention by developing an intention based theoretical model using the theory of planned behavior (TPB) and augmenting it with constructs from social exchange theory, economic exchange theory. The predictors in the model explained about 79 percent of the variance in the behavioral intention to share knowledge, suggesting that the supposed model adequately conceptualizes the knowledge sharing intention. Second, this study extends prior research by identifying a variety of extrinsic and intrinsic motivational drivers that are likely to influence knowledge sharing intention in developing countries and provides empirical evidence regarding the efficacy of these motivational drivers.

From a practical contribution, the results of the study have many implications for educational institutions initiating or sustaining their teachers’ online community of practice as a model for professional development. First, prior to launching online community of practice, institutions should create an environment that is conducive to knowledge sharing. Institutions should develop and nurture cultural norms, practices and processes that build trust, collective cooperation and positive social interactions among teachers, and group-based incentives. Second, management should demonstrate its support for knowledge sharing. Supportive organizational climate and intensified management commitment towards knowledge sharing promotes knowledge sharing behaviors. The study findings indicate that teachers are likely to be influenced by the expectations of management and peer group in deciding to engage in knowledge sharing. So it may even be appropriate to exert some pressure on teachers to share knowledge through the social influence of top management and peer group. Third, the results of the study suggest that attitude towards knowledge sharing behavior affects intention and further the actual behavior of teachers. Institutions should promote knowledge sharing intention by managing factors that influence teachers’ attitude towards knowledge sharing. Institutions should structure the knowledge sharing initiatives in such a way that they support the social concerns teachers have for such things as realizing reciprocal benefits, extrinsic rewards system that compensate for knowledge power and time expended. Specifically, the level of teachers’ perceptions of reciprocity in the organization should be raised by promoting knowledge centric culture and by encouraging teachers to help their colleagues with the knowledge needs. The situations where knowledge needs have been answered must be publicized to demonstrate the positive impacts of knowledge sharing. Fourth, knowledge sharing is time consuming. Institutions should ensure that Teachers have time, resources and opportunities to engage in knowledge sharing. Institutions should allocate time for engaging in knowledge sharing behaviors by integrating it into the work processes. Time needed to engage in knowledge exchanges should not be viewed as a cost factor. Fifth, institutions should employ knowledge management systems to facilitate collaborative work and support knowledge sharing. The results of the study indicate that
teachers’ perception of facilitating tools and technology is an important factor in deciding to engage in knowledge sharing.

Finally. Few limitations could arise from the research methods used. First, the research setting for the current study was an educational institution. Respondents were limited to full-time school’s teachers. As such, the study may limit the extent to which finding can be generalized to the general work force. Future research should replicate the study’s findings with larger samples and in different contexts. The study should also be replicated in countries with non-Syrian cultures. Second, the study focuses on some of the motivating factors that influence knowledge sharing behaviors of teachers. As such, the antecedents explain only a portion of the variance in the dependent variable (actual knowledge sharing behavior). There may be factors which are not part of this study but may have significant influence on knowledge sharing behaviors.

7. Conclusion

Knowledge sharing has been recognized as the important enabler of knowledge management. To leverage knowledge resources and to support knowledge sharing, institutions are employing knowledge management systems as a platform for teachers’ professional development. While knowledge management systems are important, practical implementations have shown that the mere attainability of technology does not guarantee that knowledge will be shared. Citing the growing importance of knowledge sharing to the success of knowledge management and to the survival of organization, both academicians and practitioners have invited to the identification of factors that promote or discourage knowledge sharing intentions in the organizational context. This research endeavored to satisfy the gap in the extant research on knowledge sharing by examining the factors that influence the knowledge sharing intention of teachers. Drawing from multiple streams of research including social psychology, organizational learning, knowledge management, information systems, this research developed an integrated theoretical model and uncover three sets of critical factors: psychological, organizational and technological that are believed to affect the knowledge sharing behaviors. Using a survey of 214 teachers, the theoretical model was validated within the context of a single empirical study. The findings provided significant statistical support for the research model accounting for about 79 percent of the variance in the behavioral intention to share knowledge. 8 of the 9 hypothesized relationships were supported. Knowledge sharing intention was predicted by teachers’ attitude towards knowledge sharing, subjective norm and perceived behavioral control. The teachers’ perceptions of reciprocal benefits, organizational extrinsic rewards were positively associated with favorable attitude towards knowledge sharing. The perceptions of loss of knowledge power exerted a negative effect on the attitude. Organizational climate positively influenced teachers’ subjective norm.

In addition, facilitating tools and technology was positively associated with high levels of perceived behavioral control towards knowledge sharing. Based on the findings, the study debated theoretical and practical implications for sharing knowledge in the community of practice. Overall, the results of the study advance prior research in the area of knowledge sharing by shed light on the determinants of knowledge sharing intention of teachers. The research model profound our collective understanding of the underlying psychological processes that induce knowledge sharing intention. In addition to contributing to theory, the findings of the study also produce insights for practice. The insights could be used by educational institutions in developing realistic environments that are conducive to knowledge sharing. The study may limit the extent to which finding can be generalized to the general work force due to a single case study was examined. Future research should replicate the study’s findings with larger samples and in different contexts.

References


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Impacts of Adding Knowledge Flow to an Activity-Based Framework for Conceptual Design Phase on Performance of Building Projects

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Abstract: The construction industry suffers from an incomplete knowledge flow that leads to overrun cost and time. A considerable portion of this problem is attributable to the design stage which is a tacit knowledge-dominated area. Since knowledge tacitness results in an incomplete knowledge flow, we posit that adding the knowledge flows beside the workflow of the architectural conceptual design phase can attenuate both the overrunning cost and time. In order to fulfill such an objective, we integrated the Nissen multidimensional model – the knowledge flow theory for the enterprise life cycle – with Macmillan’s framework – the conceptual design framework – to test whether or not adding the knowledge flow to the conceptual design workflow could attenuate the cost and time overrunning. This paper elaborates on the process of validation testing by means of Simvision. Analysis of the results reveals that specifying the entity of the required knowledge during the conceptual design phase could reduce the cost and time overruns.

Keywords: Knowledge flow, tacit knowledge, knowledge transfer, workflow

1. Introduction

This paper comprehensively deals with the procedure of validating the extended knowledge-based framework (proposed by Pourzolfaghar et al., 2011) for the conceptual design phase of the building projects. Such a framework lends its basis to Macmillan’s (2001) conceptual design framework which entails a workflow for the conceptual design. In details, Pourzolfaghar et al. (2011) attempted to extend the activity-based framework of Macmillan’s by adding the required mechanical/electrical knowledge for the conceptual design phase. According to Nissen and Levitt (2004), knowledge flows enable the workflows and this is why they are indispensable for the organizational performance. Nissen (2006) also emphasizes that accompanying the required knowledge with the workflow can improve the performance. In this study, we attempted to prove through intellective validation by utilizing Simvision that the extended knowledge-based model would improve the performance of the project.

2. The Background Problem and Literature Review

It has been confirmed by numerous researchers such as Paulson (1976), Jin & Levitt (1996), Martinez (1998), Ibrahim (2005), Ibrahim & Paulson (2008), Ahmed (2005), Nissen (2006), and Ibrahim & Nissen (2007) that there is a problem with the knowledge transfer in the construction industry which leads to cost and time overruns in the building projects. In addition, some other researchers including Cronik (1991), Rounce (1998), Macmillan (2001), Pektas & Pultar (2005) have accentuated that the design which gives rise to the wasted time and cost would form a largest category. Simultaneously, Ibrahim and Fay (2006) contend that the design process is a tacit dominant stage while there is unfortunately scarcity regarding the literature on transferring the tacit knowledge as stated by Alavi and Leidner (2001). With support from Ibrahim & Paulson (2008) stating that the knowledge type contributes to the knowledge loss phenomenon, this study posits whether it is possible to mitigate the time and cost overruns if the transfer of the tacit knowledge is facilitated.

Nissen (2006) further explains in his multidimensional model for the product life cycle that the knowledge which is transferred to the other experts through sharing the experience is of a tacit type. According to his model, the tacit knowledge originates from a heavy mass while contributing to the long flow time. Henceforth, the knowledge transfer maybe improved through this phase by finding a way to convert the required tacit knowledge for the conceptual design stage to the explicit type. It is distinguished that numerous professionals from various fields such as mechanical, electrical, and structural professions are involved during the conceptual design stage. To date, several researchers have recognized mechanical and electrical considerations as the most problematic areas during the conceptual design phase.
According to some researchers such as Rounce (1998), a considerable amount of the wasted time is attributed to the design stage. Bearing in mind that the design stage is a tacit-dominated area and also considering the difficulty of organizing the tacit knowledge, Pourzolfaghar et al. (2014) proved that the knowledge capture can be improved when the design professionals know what the required knowledge is and when it is required during the conceptual design phase. Like so, the scholars endeavored to extend Macmillan’s (2001) activity-based framework into a knowledge-based framework with the aim of developing a tacit knowledge capture technique for the architectural conceptual design phase. In his multidimensional model, Nissen (2006) attempted to examine the knowledge movement among the experts through a project life cycle in terms of knowledge typology. Pourzolfaghar et al. (2011) tried to utilize the Nissen’s theory for detecting the knowledge movement between the experts during the conceptual design phase. According to Nissen, the knowledge that moves from an individual to a group is of the tacit type which afterward moves to the explicit level through the formalization step. In practice, Pourzolfaghar attempted to explicate the knowledge when it moves from an individual to a group. As such, the first two steps involved in the knowledge life cycle which lend their bases to the Nissen’s theory are simultaneously performed, contributing to a decline in the required time. It should be pinpointed that Pourzolfaghar et al.’s knowledge-based framework (2011) entails the entity of the required mechanical/electrical knowledge (Table 1 and 2).

Table 1. The Knowledge-Based Framework for the Conceptual Design Phase, activities 1-6 (Source from Pourzolfaghar et al., 2011)

<table>
<thead>
<tr>
<th>#</th>
<th>Macmillan Framework Activities</th>
<th>Knowledge From</th>
<th>Architect side</th>
<th>Mechanical side</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specify the business need</td>
<td>Specify kind of building (function)</td>
<td>Specify required technologies: BIPV requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site characteristics</td>
<td>Solar air conditioning requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Owner aspirations</td>
<td>Wind turbine requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exit building problems</td>
<td>Rainwater harvesting system requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mission statement about requirements</td>
<td>Waste management requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Assessing stakeholders requirements</td>
<td>Building modules regarding defined mission</td>
<td>BIPV location, tilt angle and direction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rainwater usage, location and storage tank requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Daylight strategy to catch optimum sky light</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Solar air conditioning area needs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wind turbine location and requirements</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Identify problems with exist solutions</td>
<td>Sunpath movement</td>
<td>Wind direction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Constraints arising from technologies such as wind velocity points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Developing requirements</td>
<td>Space function and requirements</td>
<td>Minimum daylight standard for spaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard modules</td>
<td>Ventilation requirements (such as required space between blocks)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Height of buildings</td>
<td>Pressure variants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Necessity of mechanical ventilation due to stack effect (caused by height of building)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Setting requirements</td>
<td>Specify drawing requirement and diagrams</td>
<td>Solar collector location</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Water catchment location</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PV panels location, tilt angle and location</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Determining project characteristics</td>
<td></td>
<td>Wind turbine location</td>
<td></td>
</tr>
</tbody>
</table>
It needs to be asserted that using this framework results in saving the time for performing the “Identify Knowledge” activities -which were implicit with the conceptual design activities. Like so, this study expects shortening the work duration associated with the project. As stated by Pourzolfaghar et al. (2011), employing this framework during the conceptual design phase of the building projects may facilitate capturing and formalizing the experts’ tacit knowledge. This paper is an explanation on the process of validating the developed tacit knowledge capture technique.

3. Research methodology

This study made use of the SimVision software to address the effects of dealing with the tacit and explicit knowledge through the simulation process. Ibrahim and Nissen (2007) had employed this software earlier as an agent-based tool that allowed evaluating the multiple workflows in a single process. In dealing with the tacit knowledge, the project performance relies on the experts’ experience; the higher the skill of the experts, the more complete knowledge is transferred/retrieved, and vice versa. In the tacit dominant area, completeness of the tacit knowledge movement relies on the skill of the experts involved in the process. Therefore, the work duration will be affected by altering the experts’ skill levels. Contrariwise, the entity of the required knowledge is already specified while dealing with the explicit knowledge. Hence, the experts’ skills will not be able to affect the completeness of the required knowledge to be transferred or retrieved. In other words, a given knowledge in the explicit dominant area has to be transferred or retrieved and the activities, which mostly belong to the tacit dominant area, for specifying the entity of the required knowledge are deducted. In order to fulfill such an objective, both Macmillan’s framework and Pourzolfaghar et al’s

<table>
<thead>
<tr>
<th>#</th>
<th>Macmillan Step</th>
<th>Knowledge From Architect side</th>
<th>Knowledge From Mechanical side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Entity of Knowledge</td>
<td>Entity of Knowledge</td>
</tr>
<tr>
<td>7</td>
<td>Generating initial concepts</td>
<td></td>
<td>Specify effect of courtyard for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Better distribution of daylight</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Use of building shade</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Specify PV panel location base on need to cool</td>
</tr>
<tr>
<td>8</td>
<td>Transformation / Combination of concepts</td>
<td>Design alternatives for building modules</td>
<td>Specify width and length of buildings</td>
</tr>
<tr>
<td>9</td>
<td>Selecting suitable combinations</td>
<td>Specify size of blocks of buildings</td>
<td>Specify space between buildings</td>
</tr>
<tr>
<td>10</td>
<td>Firming up into concept proposals</td>
<td>Alternative forms of design</td>
<td>Finalize PV location</td>
</tr>
<tr>
<td>11</td>
<td>Evaluating and choosing proposal</td>
<td>Specify chosen alternative</td>
<td>Rainwater catchment diagram</td>
</tr>
<tr>
<td>12</td>
<td>Improving detail and costing proposal</td>
<td>Estimating storage tank base on roof area</td>
<td>Specify location of pump and water tank</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Estimation of needed air condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cooling capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Estimation of needed space needed for solar requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Life cycle cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Estimation operating cost saving</td>
</tr>
</tbody>
</table>
knowledge-based framework were tested and compared as two cases for the simulation. This study compares the results obtained from the simulation of these two frameworks. In practice, the study compares the work cost, the work duration, the PRI (Project Risk Index), and the FRI (Functional Risk Index) for both models. After simulating Pourzolfaghar’s knowledge-based framework (2013), this study uses the FRI and PRI values for the subsequent reasons:

- To compare the FRI and PRI values for the existing framework and the proposed framework of this study and to inspect the effects of adding the required knowledge to Macmillan’s framework.
- To ensure that the mentioned values are acceptable (FRI<0.5; PRI<0.5). In other words, the current study attempts to ascertain that adding the required knowledge to the existing work flow does not exert negative effects on the results.

3.1 The Model Simulation

We employed SimVision, the educational version 4.2.0, which was developed by Vite Corporation with a license from ePM. Ibrahim (2005) states that there are three items which are of significance while studying the knowledge flow in any organizations, namely the process under study, the organization, and their connections. Since the flow of knowledge is engaged with the passage of time as the process progresses, SimVision links the process to its organization. For the first time, Nissen and Levitt (2002) attempted to simulate the knowledge flow in the design of the organization by using a computational method (Simvision). In line with this, they used a theory for multidimensional conceptualization of the knowledge-flow phenomenon to develop the dynamic models of the knowledge flow dynamics. They illustrated their research approach and the modeling environment through formal representation and simulation of several knowledge-flow processes by means of SimVision. Moreover, Ibrahim and Nissen (2007) extended the organization theory by integrating it with the knowledge-flow theory, while making use of the computational methods and tools to recognize how discontinuous membership would affect the organizational performance. Likewise, we utilize the computational modeling to inspect the effects of adding knowledge to the workflow of the conceptual design phase since this study is mainly concerned with the knowledge flow during the conceptual design process.

It needs to be reminded that Macmillan’s (2001) framework forms the basis of the current study for the conceptual design phase. Using this software, we attempted to create the conceptual design workflow adopting Macmillan’s (2001) framework for this stage. Although Macmillan’s (2001) conceptual design framework entails 12 main activities, there are some implicit activities which function to determine the required knowledge as well as exchanging the required knowledge. Therefore, we added two activities following each activity proposed by Macmillan’s framework. In conclusion, the process of the conceptual design entails 36 activities which stem from Macmillan’s model along with 24 more additional activities for identifying and exchanging the required knowledge for each activity.

The current study was an effort to implement Macmillan’s framework as the base case. As it is exhibited in Figure 1, Macmillan’s main activities are presented in lighter colors. Moreover, it is discerned that the activities are ordered in columns. For instance, the first activity is “specifying the business needs”. The next activity in the first column is “identifying the required knowledge”. The following activity is for “exchanging the required knowledge”. Other activities are ordered accordingly. In SimVision, we have to assign the activities to the project team members. Many experts such as the project manager, architect, and the mechanical/electrical engineers are involved in the conceptual design phase; therefore, each activity is assigned to all of these experts. Like this, we can examine the effects of these experts’ skills on the project performance.
According to the Nissen’s (2006) multidimensional model, the knowledge moves from the individuals to the group through sharing the experience. At this instant, if the experts’ skills match the required experience for the related task, the person in charge will know the accurate and complete knowledge which has to be transferred. As a result, completeness and accuracy of the knowledge obtained by the receiver would depend on the senders’ skill. In a tacit dominant area such as the conceptual design phase, the performance of the successor’s task relies on the received knowledge which has been sent by a provider. Therefore, all the team members’ skills can affect the knowledge exchanging process between the experts and the project performance as well. It needs to be highlighted that these experts’ skills (experts’ tacit knowledge) would exert an undeniable effect on the performance of the project (Table 3).

According to this table, the required skills for the team member consist of the Medium level for Project Manager (PM), the High level for the Architect (AR), and the High level for the Mechanical/Electrical engineer (ME). Because these experts possess the required skills, they are able to provide the required knowledge at the right time. If an expert such as an architect does not possess the required skill level, other team member’s task will suffer from his/her incomplete knowledge transfer. Having considered all the above mentioned notions, this study establishes the following hypotheses:

**H1**: A building project team member who has sufficient knowledge required for the other team members’ tasks can improve the performance of the receiver’s task. The study expects the FRI and PRI to be less than 0.5.

**H2**: A building project team member who does not have sufficient knowledge to be considered by the other team members to do their task can increase the risk involved in the receiver’s task by transferring incomplete knowledge. The study expects the FRI and PRI to be less than 0.5.

To prove the abovementioned hypotheses, a comparison and contrast on the results would be established when a team member—such as the architect—possesses the required skill which matches the required experience to participate in a project with the situation in which the same person does not have it.
Table 3: The team members’ awareness about the required knowledge

<table>
<thead>
<tr>
<th>Awareness</th>
<th>PM</th>
<th>AR</th>
<th>ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficient</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Insufficient</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

In such a situation, the project manager’s skill (PM) as the leader of the design team has a great impact on the knowledge exchange process. If the project manager knows that some knowledge is required to be exchanged at a certain time, he will facilitate this process, accordingly. Hence, explication of the entity of the knowledge required to be considered during the conceptual design phase can affect the project performance. In other words, when the entity of the required knowledge has been specified, we can avoid spending time on identifying it. In such a situation, the team members deal with the explicit knowledge which does not depend on the skill of the experts involved. For that reason, the current study establishes another hypothesis regarding the Nissen’s theory (2006):

**H3**: By specifying the entity of the required knowledge during the conceptual design phase, performance of the building project improves due to the explicitness of the knowledge entity. The study expects the FRI and PRI to be less than 0.5.

For instance, when an architect knows the entity of the required mechanical/electrical knowledge which has to be considered through each step of the conceptual design, the time needed to determine the required knowledge will be accordingly reduced.

**Test case 1: the Base Case (Sufficient Awareness)**

Following Ibrahim and Nissen’s (2007) example, this study proposed a situation where in a small number of task volumes in the base case exists, the behavior parameters we reset are higher than the normal in the construction industry to amplify the effects of the knowledge flow on the outcome. According to SimVision, a project represents a work process when it must be performed by the project team members to achieve an outcome. Each project is composed of tasks, positions, milestones, meetings, as well as links between the components. We set the parameters for the project, positions, and tasks as follows: a medium level for the team experience, a low level for centralization, a medium level for formalization, a medium level for the matrix strength, 0.7 for communication probability, and finally 0.15 for the noise problem, project error probabilities as well as for the functional error probability. As mentioned before, the values of the above said parameters were set in accordance with the normal construction industry values. The position parameters for experts (including the project manager, the architect, and the mechanical/electrical engineers) are tabulated in Table 4. The micro-behaviors included the fulltime-equivalent (FTE), the role, the application experience (App. Exp.), and the salary.

<table>
<thead>
<tr>
<th>#</th>
<th>Position</th>
<th>FTE</th>
<th>Role</th>
<th>Application Experience</th>
<th>salary</th>
<th>Knowledge Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project Manager</td>
<td>0.3</td>
<td>PM</td>
<td>Medium</td>
<td>100</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>Architect</td>
<td>1</td>
<td>SL</td>
<td>High</td>
<td>80</td>
<td>High</td>
</tr>
<tr>
<td>3</td>
<td>Mechanical/Electrical</td>
<td>2</td>
<td>ST</td>
<td>High</td>
<td>70</td>
<td>High</td>
</tr>
</tbody>
</table>

In the base case, all the team members’ skills satisfy the required skill for carrying out the job. For instance, the required skill for the architect and the mechanical/electrical engineers is high. In the case base, these experts’ skills satisfy the required skill, meaning that the architects and mechanical/electrical experts are fully aware of the knowledge which needs to be exchanged between the experts.

**Test case 2: the Proposed Case (Insufficient Awareness)**

The second case test is about insufficient awareness of the experts. All the project, positions, and tasks parameters resemble the ones in the case test. To represent the effect of the experts’ insufficient awareness on the performance, we changed their skill. Accordingly, the skill of the architect changed from High to Medium in order to gauge the effects of the experts’ skill on the project performance (Table 5). As it is shown, the skill of the architect has not
fulfilled the application experience requirements, indicating that the architect does not have the sufficient knowledge to accomplish his/her own task.

**Table 5. The Changed parameters for the architect skill**

<table>
<thead>
<tr>
<th>#</th>
<th>Position</th>
<th>FTE</th>
<th>Role</th>
<th>Application Experience</th>
<th>Salary</th>
<th>Knowledge Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project Manager</td>
<td>0.3</td>
<td>PM</td>
<td>Medium</td>
<td>100</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>Architect</td>
<td>1</td>
<td>SL</td>
<td>High</td>
<td>80</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>Mechanical/Electrical Engineer</td>
<td>2</td>
<td>ST</td>
<td>High</td>
<td>70</td>
<td>High</td>
</tr>
</tbody>
</table>

4. Results and Analyses

We made 3 simulations for the base case, changing the experts’ skills as well as setting the “Identify Knowledge” activities’ duration to 0. By setting the trials to 50, we ran 150 trials. Different simulations were made because these experts had different roles while the current study needed to examine the effects associated with changing each condition. The first simulation was for the base model in which the experts’ skills met the application experience requirements. The next simulation was for changing the architect skill from High to Medium. The last simulation was for setting the duration of the “Identifying Knowledge” activities to 0 which stemmed from explicating the required knowledge. It was finally observed that all the simulations yielded similar results for changing micro-behavior parameters.

In the stated hypotheses, we claimed that changing the experts’ skills in the tacit dominant area would affect the project performance. Consequently, we examined the difference between the parameters’ values before and after changing the architect’s skill levels. As such, we intended to demonstrate the occasion when an experts’ skill level can affect some parameters such as rework, coordination, etc. According to the results obtained from changing the architect’s experience level from High to Medium rework (12.8 days to 18.23 days), there would be a rise in the coordination (22.63 to 30.43) and decision wait (14.70 to 22). Statistics also showed that by changing the architect’s skill level from High to low, the duration would increase from 11 days to 13.5 days and the total work cost would rise from 98941 to 120324 (Table 6). The right-side column in Table 4 illustrates the amount of the increase in the percentage resulting from changing the architect’s skill. Indeed, Table 4 refers to hypotheses 1 and 2 that are related to the skill level of the team members. A considerable effect related with changing the architect’s skill level on the parameters of the project performance was also established after comparing the project parameters with one another.

**Table 6: The Effects of changing the architect’s skill level on the project performance parameters**

<table>
<thead>
<tr>
<th>Affected Item</th>
<th>Parameters’ Value Base on Architect Skill Level</th>
<th>Difference %-Arising from Changing Level of Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Work Duration</td>
<td>11</td>
<td>13.5</td>
</tr>
<tr>
<td>Total work cost</td>
<td>98941</td>
<td>120324</td>
</tr>
<tr>
<td>Rework</td>
<td>12.8</td>
<td>18.23</td>
</tr>
<tr>
<td>Coordination</td>
<td>22.63</td>
<td>30.43</td>
</tr>
<tr>
<td>Decision wait</td>
<td>14.70</td>
<td>22</td>
</tr>
</tbody>
</table>

It should be admitted that the abovementioned results are related to the first and second hypotheses of this study which pertain to the characteristics of the tacit dominant area. We claimed that changing the skill of the experts involved in the project could affect the performance of the team members while dealing with the tacit knowledge. The diagram of the differences resulting from changing the architect’s skill is displayed in Figure 2, revealing that there is a relation between the level of the architect’s skill and the project parameters. By changing the skill level from High to Medium, there will be an increase in the values of the parameters i.e. the work duration, the rework, the coordination as well as the decision wait. In other words, the completeness of the sent/received knowledge by the architect depends on his/her skill. The architect’s awareness of the knowledge required to be sent or received would considerably decrease the parameters of the project.
As mentioned earlier, the last simulation was conducted for setting the duration of the “identifying knowledge” activities to 0 which stemmed from explicating the entity of the required knowledge. Indeed, this simulation was related to the third hypothesis. In practice, we made three more simulations in connection with the properties of the explicit dominant area. According to the third hypothesis, adding knowledge to Macmillan’s (2001) framework for the conceptual design phase will eliminate the need for identifying the required knowledge. The obtained results from this simulation a represented in Table 7, in which the “Base Case” column contains the simulation values for Macmillan’s conceptual design framework. The next right-side column is for changing the “Identify Knowledge” activities to 0. Comparing these two columns reveals that the work duration and the total work cost have considerably decreased. Referring to the results, it becomes apparent that adding the knowledge flow to the work flow in Macmillan’s model reduces the work duration (by 33.6%), the total work cost (by 33.3%) and also the FRI (by 3.3%). For instance, the work duration of the base case decreases from 11 days (SD=0.5) to 7.3 days (SD=0.3). Although the functional risk has increased by 3.3%, its value is still under 0.5 (Based on SimVision FRI<0.5 is an acceptable range for this parameter). More discussions on the results will be presented in the next section.

Table 7: The effects of removing the “Identify Knowledge” activities due to adding the knowledge flow to Macmillan’s (2001) conceptual design process

<table>
<thead>
<tr>
<th>Affected Item</th>
<th>Base Case</th>
<th>“0” Duration for “Identify Knowledge” Activities</th>
<th>Difference %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Value</td>
<td>Value</td>
<td>Difference</td>
</tr>
<tr>
<td>SD</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work duration</td>
<td>11 days</td>
<td>7.3 days</td>
<td>-33.6%</td>
</tr>
<tr>
<td>Total work cost</td>
<td>$98941</td>
<td>$65967</td>
<td>-33.3%</td>
</tr>
<tr>
<td>Process quality risk</td>
<td>0.28</td>
<td>0.29</td>
<td>+3.6%</td>
</tr>
<tr>
<td>Product quality risk</td>
<td>0.15</td>
<td>0.15</td>
<td>0</td>
</tr>
<tr>
<td>Functional risk index</td>
<td>0.30</td>
<td>0.29</td>
<td>-3.3%</td>
</tr>
</tbody>
</table>

Indeed, Table 7 contains the values to prove hypothesis 3 whereby we claimed that explicating the required knowledge during the conceptual design phase can improve the project performance. As demonstrated, the work duration and the total work cost have considerably reduced.

5. Discussions

As mentioned earlier, Macmillan’s (2001) framework contains 12 explicit and 24 implicit activities. The implicit activities correspond to the explicit ones to identify and exchange the required knowledge required to be considered through the activities. For instance, the sun path movement is one of the basic mechanical requirements which needs to be considered to orient the building. In this respect, a novice architect needs to interact with the mechanical/electrical engineers to identify the required considerations. Then, he would also need to obtain the identified knowledge at the proper time. In such a situation, explicating the entity of the required knowledge can reduce the
required time for the implicit activity for identifying the required knowledge. Moreover, explication of the required knowledge reduces the probability of the incomplete knowledge flow.

To prove this study's claim, we used computational organization tool (SimVision) to simulate Macmillan's (2001) framework as the base model and knowledge-based framework by Pourzolfaghar et al. (2011). The results of changing the level of the architect's skill indicate lower organizational performance in terms of the parameters of the project, namely the work duration and the rework. By changing the level of the architect's skill from High to Medium, the work duration increases from 11 days to 13.5 days. This result is equivalent with the rework, where the Medium level skill of the architect has more rework than the High level skill. The estimated rework with a High skill architect is 12 day, while with a Medium level skill it rises to 18 days. The work duration also concurs with the coordination, where the Medium level of the architect needs further coordination than the High level skill for an architect (22 days are needed for coordination in comparison with 30 days). Finally, the work duration concurs with the decision wait, where the Medium level of the architect' skill causes more decision wait than the High level skill (14.5 days is required for the decision wait in comparison with 22 days).

According to the simulation results, after changing the architect’ skill level ,the work duration, the total work cost, the rework, as well as coordination and decision wait parameters were all affected in a negative way. Indeed, by decreasing the architect’ skill level all the above mentioned parameters increased considerably. The obtained results revealed that there is a negative relationship between these parameters and the experts’ skill. In conclusion, this study finds out that the level of the architect’s experience during the concept design has a conspicuous effect on the project performance, implying that the time needed to identify and obtain these results from the mechanical/electrical engineers will be saved when an architect has sufficient knowledge about the technology requirements such as the positioning of the building blocks with respect to the existing structures—for example a solar bowl. As a result, the saved time reduces the entire work duration of the project. In brief, these results support hypotheses 1 and 2.

Nissen (2006) has claimed that the explicit knowledge contributes to a shorter flow time. Thus, we attempted to simulate an ideal condition in which the duration of the "Identify Knowledge" activities was set to 0 through adding the knowledge flow to the existing work flow for Macmillan’s (2001) model for the conceptual design phase. As mentioned earlier, setting “Identify Knowledge” activities to ‘0’ pointed to the time saving which stemmed from explicating the entity of the knowledge in Pourzolfaghar et al.’s (2011) framework. In conclusion, based on the obtained results, there was a considerable reduction in the work duration and the total work cost for the conceptual design phase. Finally, the results together with the comparison made between similar parameters for the base case and simulated cases revealed that explicating the required professionals’ tacit knowledge results in the improvement of the performance of the project.

6. Conclusions

In this study, we attempted to substantiate the knowledge-based framework proposed by Pourzolfaghar et al. (2011) for the conceptual design phase of the building project using SimVision. To do so, we developed three hypotheses arising from the tacitness and explicitness of the knowledge. Then, this study compared the results coming from the simulations of these two frameworks suggesting that in the tacit dominated area the experts’ levels of skill affect the performance of the project considerably. Therefore, the conceptual design phase of the building projects as a tacit dominated area is subjected to the skills of the experts involved. In other words, the completeness of the exchanged knowledge is dependent on the experts’ skill level. By counting on their experiences, the experienced experts may know the required considerations in different professions whereas the novice team members may not possess the sufficient knowledge on these considerations. The insufficient knowledge of the novice team members may result in the failure in considering the requirements which result in the rework. However, by specifying the entity of the required knowledge, there is no need to identify what knowledge is required through each activity. Therefore, a great deal of time is saved through eliminating the “identify knowledge activities”. The results from the simulations are used to corroborate this statement. Like so, this study attempted to inspect the impact of adding the knowledge flow to the conceptual design workflow (Macmillan framework, 2001). To fulfill this, the results of the simulating knowledge-based framework by Pourzolfaghar et al. (2011) and Macmillan’s framework for conceptual design phase were compared. Simulations revealed that by adopting the knowledge-based framework (Pourzolfaghar et al., 2011) which embraced the entity of the required mechanical/electrical knowledge during the concept design phase, the cost and duration of the project would certainly decrease. According to the results obtained in the current study, it can be
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concluded that by employing the knowledge-based framework, the knowledge flow can be improved which accordingly reduces the overrunning of the time and cost.

References


Web 2.0 Use and Knowledge Transfer: How Social Media Technologies Can Lead to Organizational Innovation

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Abstract: The concept of Web 2.0 has gained widespread prominence in recent years. The use of Web 2.0 applications on an individual level is currently extensive, and such applications have begun to be implemented by organizations in hopes of boosting collaboration and driving innovation. Despite this growing trend, only a small number of theoretical perspectives are available in the literature that discuss how such applications could be utilized to assist in innovation. In this paper, we propose a theoretical model explicating this phenomenon. We argue that organizational Web 2.0 use fosters the emergence and enhancement of informal networks, weak ties, boundary spanners, organizational absorptive capacity, which are reflected in three dimensions of social capital, structural, relational, and cognitive. The generation of social capital enables organizational knowledge transfer, which in turn leads to organizational innovation. Based on this model, suggestions for organizations to facilitate this process are also provided, and theoretical implications are discussed.

Keywords: innovation, knowledge transfer, social capital, web 2.0

1. Introduction

Over the last several years, Web 2.0 has rapidly become a significant presence in the public sphere. A variety of Web 2.0 applications have been widely adopted on an individual level, and recently such applications have received interest from organizations looking to increase their creativity, knowledge sharing, and collaboration to better innovate in their field (O’Reilly, 2005; Tredinnick, 2006). For example, Blog World Expo, the world’s largest Weblog conference, hosts a track called “Business of Blogging.” Some highly referred management journals also have published a series of “Enterprise 2.0” articles to guide organizational adoption of Web 2.0 applications (e.g., Brynjolfsson and McAfee, 2007; McAfee, 2006). Due to the increasing use of Web 2.0 applications in organizations and their role in the learning process, some scholars have also advocated for the implementation of Web 2.0 in corporate training programs (e.g., Martínez-Aceituno et al, 2010).

In the era of knowledge economy, knowledge is regarded as an important strategic asset to drive organizational innovation and sustain competitive advantages (Cohen and Levinthal, 1990; Nonaka, 1994; Nonaka and Takeuchi, 1995; Wasko and Faraj, 2000). As pointed out by Reagans and McEvily (2003), the higher an organization’s capacity to transfer knowledge, the greater the competitive advantage potential that organization will have over its competitors. This naturally encourages organizations to always be on the lookout for ways to better facilitate their knowledge transfer processes. Regarded as social software, Web 2.0 applications enable the formation of virtual groups that connect users with different backgrounds beyond formal and physical boundaries (Shirky, 2003; Swisher, 2004). In the organizational context, the use of Web 2.0 applications can expedite knowledge transfer. Their utilization is expected to lead to the emergence of informal networks among organizational units. The emergent informal networks involve the enactment of boundary spanners who maintain weak ties and facilitate the enhancement of organizational absorptive capacity. In this study, we argue that these emergent and facilitated characteristics through Web 2.0 use comprise the dimensions of organizational social capital. Interactions through these social capital dimensions are then expected to facilitate knowledge transfer across organizational units. When knowledge is freely transferred within an organization, it is more likely to drive organizational innovations.
The objective of this paper is to detail the phenomenon of Web 2.0 use as a catalyst for organizational innovation. We will first discuss enablers of knowledge transfer (i.e., information networks, boundary spanners, weak ties, absorptive capacity, and social capital). A theoretical model depicting organizations’ use of Web 2.0 leading to these knowledge transfer enablers, ultimately driving innovation, will then be presented. We will conclude with suggestions on how organizations can best implement Web 2.0 to expedite organizational innovation, as well as proposed directions for future research.

2. Enablers of knowledge transfer

Resource theory posits that in order to sustain a competitive advantage, organizations are required to be in control of resources that are valuable, rare, imperfectly imitable, and of low substitutability (Barney, 1991; Grant, 1996; Penrose, 1959). Recognizing that knowledge is a resource demonstrating these characteristics, organizations seek to “know more” and differentiate their knowledge from their competitors in order to make correct decisions, provide better services, and innovate to sustain a competitive advantage (Davenport and Prusak, 1998). To achieve this goal, organizations need to acquire the ability to efficiently and effectively manage organizational knowledge (Alavi and Leidner, 2001). Managing efficient knowledge transfer has been a critical issue in the study of knowledge management (Alavi and Leidner, 2001; Ko et al., 2005). In this section, studies on enablers of knowledge transfer will be discussed, specifically on the existence of informal networks, weak ties, boundary spanners, absorptive capacity, and social capital.

2.1 Informal networks

Informal networks are defined as “networks where individuals are connected based on their social or personal relationships rather than work or task related relationships” (Awazu, 2004: 63). Informal networks play a crucial role in organizations; as Cross and Prusak (2002: 105) pointed out, “the real work in most companies is done informally, through personal contacts.” Informal social relationships supplement formal networks by exposing the participants in the relationship to individuals with different knowledge than themselves (whereas in a work- or task-based relationship, all members have the similar type of specialized knowledge). Desouza (2003) found that informal networks foster the exchange of tacit knowledge – knowledge that is highly practical and personalized, difficult to codify and plays a critical role in organizational innovation (Alavi and Leidner, 2001; Grant, 1996; Nonaka, 1994; Polanyi 1967). This informal transmission “accelerate[s] and broaden[s]...knowledge sharing” (Davenport et al., 1998: 45).

Informal networks can also contribute to knowledge transfer by making this process easier. Focusing on the relationships between the structure of informal networks and knowledge transfer, Reagans and McEvily (2003) suggested that the informal network range (i.e. the extent to which an informal network crosses different communities) is positively associated with the ease of knowledge transfer and found that the more diverse the knowledge and one’s informal network span, the easier it was for them to interpret transferred knowledge. In such an environment, one is more likely to acquire useful knowledge when needed, and knowledge transfer becomes more efficient (Tushman and Scanlan, 1981).

2.2 Boundary spanners

Boundary spanners are members of a community who connect to an external environment (Awazu, 2004; Cross and Prusak, 2002; Tushman and Scanlan, 1981). Within a boundary, members share similar characteristics in terms of culture, language, norms, values, and knowledge. This differentiates them from other communities, but also limits their ability to transfer knowledge between their community and the external environment, as well as their ability to adapt to environmental changes (Aldrich and Herker, 1977; Tushman and Scanlan, 1981). In the organizational context, this issue is exacerbated by the fact that the competitive environment faced by most organizations is, by its very nature, prone to rapid changes over a short span of time. An organization that cannot acquire knowledge from outside its community, and capitalize on that knowledge to stay abreast of current trends in its field, runs the risk of falling behind its competitors. Through boundary spanners, knowledge outside the community can be identified, collected, filtered, and disseminated to the members (Aldrich and Herker, 1977). Cross and Prusak (2002: 109) put it simply and effectively: boundary spanners “serve as the group’s eyes and ears in the wider world.” Boundary spanners thus contribute to “viable organizations” (Aldrich and Herker, 1977: 218), which are characterized by “an increase in the ability to learn and to perform according to changing contingencies in the environment” (Terryberry, 1968: 660).
2.3 Weak ties

The concepts of strong and weak ties were proposed by Granovetter (1973). Strong tie relationships connect those who communicate frequently, express higher emotional intensity and mutual confidence, and share a norm of reciprocity. Strong ties are normally found in intimate relationships, such as those between family members, close friends, and co-workers on the same project. Weak ties, on the other hand, are maintained by those who communicate less frequently, with low emotional intensity and mutual confidence, and do not share the norm of reciprocity. While strong ties are good at providing social and emotional support and solving conflict (Hansen, 1999), the benefit of weak ties to organizations lies in their ability to facilitate information transfer (Granovetter, 1973).

Weak ties are often found between different communities within an organization (Granovetter, 1973). When these communities are connected in such a way, any information transferred between them will be more diverse, useful, and less redundant, due to the variety of specialized knowledge across the different task-based groups that tend to comprise organizational communities (Hansen, 1999). Burt (1992) came to similar conclusions, asserting that social networks characterized by weak ties are particularly effective at increasing the efficiency of information diffusion by minimizing redundancy. Wellman (1992) also indicated that weak ties are more instrumental than strong ties in terms of providing useful information. With weak ties, socially distant ideas, influences, or information become more reachable, and those who maintain weak ties will be more likely to acquire new information (Granovetter 1973).

2.4 Absorptive capacity

As already mentioned above, the diverse knowledge residing outside of a community has been considered critical for generating new ideas (March and Simon, 1958; von Hippel, 1988). However, the mere existence of informal networks, boundary spanners, and weak-tie connections does not guarantee successful knowledge transfer. Tsai (2001) argued that even if external knowledge is accessible, a community may not have the capacity to absorb it. It is only when the value of external knowledge is both recognized and able to be commuted between connected peers that it will be transferred and acquired by the community. This idea of an organization’s capability to identify and communicate external knowledge is part of the theory of “absorptive capacity” (Cohen and Levinthal, 1990; Zahra and George, 2002). Cohen and Levinthal (1990: 128) argued that absorptive capacity, “the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends,” is critical to organizational innovation.

The key to organizational absorptive capacity, as emphasized by Cohen and Levinthal (1990), is diverse, prior knowledge. Tsai (2001) argues that organizational units that possess relevant prior knowledge are more likely to have a better understanding of external knowledge. Szulanski (1996) also shows that the lack of prior knowledge impedes the inter-unit knowledge transfer. Without absorptive capacity, an organization will fail to transfer knowledge from one unit to another and will not learn. With prior knowledge, individuals are more likely to identify the value of external knowledge when needed and are able to communicate with knowledge sources using shared knowledge-specific language.

3. Social capital

When people start to interact with each other, social capital is developed and increased among them (Nahapiet and Ghoshal, 1998). Bourdieu (1985: 248) defines social capital as “the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition.” To Nahapiet and Ghoshal (1998: 243), social capital is “the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit.” By treating knowledge as a strategic organizational resource, Nahapiet and Ghoshal (1998) claimed that with social capital embedded in social networks within an organization, knowledge creation is facilitated through the transfer and integration process. They identify three dimensions of social capital, structural, relational, and cognitive, that are conducive to the creation of organizational intellectual capital: “the knowledge and knowing capability of a social collectivity” (Nahapiet and Goshal, 1998: 245). Chiu et al. (2006), by developing a theoretical model based on Nahapiet and Goshal’s (1998) work, demonstrated that certain facets of social capital increase the quality and quantity of knowledge transfer. They identified these facets as social interaction ties, trust, norm of reciprocity, identification, shared language, and shared vision. Inkpken and Tsang (2005), also drawing from Nahapiet and Goshal’s (1998) work, argued that in an organization, the benefits of social capital can include privileged access to knowledge and information. Through constant interaction, social capital can be acquired and enhanced among members of social networks, and knowledge embedded in these social networks will become readily available with increasing quality and quantity.
When it comes to the issue of knowledge transfer, these five concepts (i.e., informal networks, boundary spanners, weak ties, absorptive capacity, and social capital) are highly interrelated. Nahapiet and Goshal’s (1998) three dimensions of social capital and the ways they are reflected in the above enablers of knowledge transfer shed light on the convergence among these concepts. The structural dimension of social capital concerns the existence and patterns of social connections among social actors. This idea can be seen in the existence of boundary spanners, which form social connections between communities through informal networks. The relational dimension, which concerns the quality of social connections (i.e., the trust, norms, or identity present in a connection), is found in the presence of the weak-tie relationships that tend to characterize such connections across separate organizational units. The cognitive dimension concerns the “shared representations, interpretations, and systems of meaning among parties” (Nahapiet and Ghoshal, 1998: 244), manifested as shared mental models, language, narratives, and vision (Chiu et al., 2006). This can be seen in the accumulation of absorptive capabilities, which result in the increased common language and knowledge overlapping across multiple communities.

When an informal network is formed connecting different communities, when weak tie relationships are established, when boundary spanners emerge and expose a diverse knowledge base, and absorptive capacities are enhanced, the entire social network is brought to a state that facilitates knowledge transfer. These features constitute dimensions of social capital. Through social interaction among network members, social capital is gradually expanded, increased, and embedded, which supports and increases the transfer of quality, diverse knowledge. Organizations encouraging and supporting this environment become “innovation ready” (Fichman and Kemerer, 1997), meaning they will ultimately be more likely to engage in innovative practices.

In the next section, a theoretical model depicting how organizational use of Web 2.0 has the potential to drive innovation will be proposed. It is argued that organizational use of Web 2.0 applications will foster and support the aforementioned “innovation ready” environment. By facilitating the emergence of cross-boundary informal networks, weak ties, boundary spanners, and absorptive capacity, which in turn facilitate the emergence of social capital through interaction, organizational use of Web 2.0 applications will foster knowledge transfer among organizational units and lead to the readiness of innovation.

4. Web 2.0 use and organizational innovation

Web 2.0, operating on principles such as “the web as platform”, “harnessing collective intelligence”, and “rich user experiences” (O’Reilly, 2005), is by nature a primarily social concept. Tredinnick (2006) indicates that Web 2.0 is a “process of ceding control over applications to users, enabling users to extract information and data and reuse that information and data in a flexible way.” Alexander (2007: 33) points out “the label ‘Web 2.0’ is far less important than the concepts, projects, and practices included in the scope.” Web 2.0 therefore is not just an application type or a collection of tools, but also a concept, a perspective, a paradigm, or an attitude (Davis, 2005). Generally speaking, Web 2.0 can be thought of as virtual communities that facilitate the sharing of information and knowledge with the web as a platform, and with users creating the majority of the content.

Applications commonly associated with Web 2.0 include blogs (a subject-oriented or personal web page characterized by continuous, dated publishing), social tagging or bookmarking applications (sites that allow users to apply personalized tags to content), and social networking sites (applications that foster the creation and maintenance of social networks and relationships) (Levy, 2007). The unique features of these applications play a crucial role in the ability of Web 2.0 to foster knowledge transfer. For example, Farell et al. (as cited in Treem and Leonardi, 2012), found that the ability of users to leave comments on blogs could engender conversations between employees that spanned organizational boundaries, and John and Seligman (as cited in Treem and Leonardi, 2012) showed that social tagging could be used to identify experts within organizations, as tags were presumed to be indicative of a user’s interests and areas of expertise. In addition, Thom-Santelli et al. (2011) suggested that due to their informal nature and frequent content updates, internal social networking sites could be effective in building social capital within an organization.

Organizational Web 2.0 use is quickly becoming widespread. In Levine (2008), it was reported that 32% of companies surveyed said they are currently using Web 2.0 applications, or that they will be using them within the next 12 months, and a later survey conducted by Bughin et al. (2011) shows a steady increase in organizational use of four web 2.0 technologies (social networking sites, blogs, video sharing sites, and microblogging) from 2008 to 2011. In this paper, we argue that organizational use of Web 2.0 applications increases diverse knowledge transfer among social networks spanning multiple organizational units. Concepts such as weak ties and social capital enabled through Web
2.0 use are also highlighted. By identifying these key benefits of the organizational use of Web 2.0 from the literature, a theoretical model depicting organizational use of Web 2.0 driving innovation is proposed (see Figure 1).

Figure 1: Innovation through Organizational Use of Web 2.0

The model illustrates that Web 2.0 applications as a platform facilitate the building of informal networks among organizational units, the maintenance of weak tie relationships, the enactment of boundary spanning roles, and the enhancement of organizational absorptive capacity. Together, these features comprise dimensions of social capital as an organizational configuration that facilitates knowledge transfer. Such a configuration leads organizations to an innovation-ready state, which ultimately drives organizational innovation. In the following sections, we also describe each concept in the model to explicate how Web 2.0 use contributes to organizational innovation through them.

4.1 Web 2.0 Use Fosters Informal Network Building

As social software aims to connect people informally, Web 2.0 applications make it possible for users to not only connect to those belonging to their own community, but also to communities outside their immediate network, exposing them to different perspectives and knowledge (Chatti et al., 2007). Web 2.0 applications transcend bureaucratic hierarchies and create informal communities to foster communications among employees from different organizational units. This further helps individuals access knowledge sources and identify experts, thus fostering knowledge transfer.

Jackson et al. (2007) conducted a study on corporate blog use in a large scale IT company, analyzing corporate blog users’ usage patterns. They found that informal social networks are formed among these users, and that a corporate blog facilitates communication and knowledge transfer among employees from diverse organizational units, including marketing, sales, and engineering. Jarrahi and Sawyer (2013: 118) found that employees use Web 2.0 applications such as email, forums, and social networking sites (SNS) to acquire expert knowledge from individuals outside their immediate work environment, and stated that “[b]y supporting the mechanisms underlying the social practices of expert locating, social technologies serve as a platform for supporting informal networks within and across enterprises.” Damianos et al. (2007) studied a high-tech organization’s deployment of a social bookmarking system (i.e., Onomi). They showed that employees found it useful for discovering new resources, forming and supporting social networks, and locating relevant experts. Another study conducted by Millen et al. (2006) on Dogear, a social bookmarking system adopted by IBM, found similar results, highlighting that communities created with this system facilitated finding and sharing of information, organizational resources, and the discovery of expert knowledge.

4.2 Web 2.0 Use Enacts Boundary Spanning Roles

Employees use Web 2.0 applications to locate knowledge sources and identify experts outside their local communities in order to acquire different perspectives and solve project problems. In addition, such applications can extend an employee’s network of connections and contacts within their organization’s industry, as well allow them to stay informed on developments in the wider marketplace (Jarrahi and Sawyer, 2013). This is identical to the role of the boundary spanner as defined earlier in this article. As a result, users of Web 2.0 applications will enact boundary
spanning roles to monitor the outside world and ensure that “the required knowledge is able to flow across the boundaries” (Gopal and Gosain, 2009: 5), which leads to what Aldrich and Herker (1977: 218) mentioned as a “viable organization.”

4.3 Web 2.0 Use Fosters Weak Tie Building

When Web 2.0 applications connect employees of different units, weak tie relationships emerge. Compared to coworkers of the same unit, employees from different units connected through Web 2.0 applications are less likely to have frequent, emotional intensive, confident communications. It is also more difficult for them to construct the norm of reciprocity, although it can be improved through increasing social capital by constant interactions.

Jackson et al. (2007) showed that weak tie relationships can be formed within organizations through corporate blog use. Ellison et al. (2010) found that Facebook enables its users to maintain a greater number of weak ties, and that the addition of these weak ties into the user’s social network makes it more likely that that user will have access to a diverse knowledge base and potential resources for new information. Skeels and Grudin (2009: 102) studied employees’ use of SNS, such as Facebook and LinkedIn, at Microsoft and concluded that the main benefit of employees’ using SNS is the “creation, maintenance, and strengthening of weak ties among colleagues.” Similar findings on the benefits of corporate SNS are also mentioned by DiMicco et al. (2008). In their study of IBM’s adoption of SNS, they found that the main motivation of users who used internal SNS was to “build stronger bonds with their weak ties and to reach out to employees they do not know” (DiMicco et al., 2008: 711). Therefore, with Web 2.0 use, weak ties as relationships spanning across organizational units are maintained, aiding in expediting the flow and reach of diverse knowledge (Hansen, 1999; Kavanaugh et al., 2005).

4.4 Web 2.0 Use Enhances Organizational/Individual Absorptive Capacity

Through the use of Web 2.0 applications, informal connections across organizational units are created. Employees of an organizational unit take the role of boundary spanners and can interact not only with those in their unit, but with employees in other units as well, employees with diverse backgrounds and expertise that differs from their own. This increases Web 2.0 users’ exposure to various knowledge sources. It also enables these users to have access to various knowledgeable experts when needed. Furthermore, through continuous interaction across units, shared language can be gradually built up, thereby easing the cost of communicating knowledge. When Web 2.0 users are exposed to diverse knowledge and are aware of “who knows what,” and when the overlap of these remote users’ knowledge increases, the absorptive capacity of an organization increases. This is the case when an organization creates and exposes broad ranges of “receptors” to the environment (Cohen and Levinthal, 1990). Such capability of acquiring external knowledge provides firms with the strategic flexibility in adapting to a changing environment (Zahra and George, 2002).

4.5 Web 2.0 Use Fosters Social Capital Building

When employees start to use Web 2.0 applications to build up social networks, interaction opportunities characterized by informal connections and weak ties are created among different organizational units. Through constant interactions between employee users as boundary spanners of different units, organizational absorptive capacity is enhanced. These knowledge transfer enablers create organizational structural social capital – informal networks and boundary spanners, relational social capital – weak tie connections, and cognitive social capital – absorptive capacity.

Steinfield et al (2009: 246) in their study on Beehive, a SNS used by IBM employees, found that the more heavily employees used, the SNS the higher their social capital levels were, and stated that “social capital is embedded in the informal networks among workers.” Kostova and Roth (2003) found that the relationships boundary spanners form not only create social capital, but are important for its maintenance over time. Kavanaugh et al. (2005) found that “the Internet, by providing additional channels for communication among social network members and among the organizations to which they belong, facilitates and supports the formation of social capital in the community.” In addition, Blanchard and Horan (1998) mentioned that dispersed social networks are more likely to attract members because it is easier to locate useful information and resources through dispersed weak ties, which would have a positive effect on social capital in virtual communities. Finally, Xiong and Bharadwaj (2011) found that absorptive capacity enhances the social capital benefits of relationships between firms, as well as mitigating any negative effects that might arise. We have seen that Web 2.0 use fosters informal networks, boundary spanners, weak tie relationships, and absorptive capacity. Consequently, by engendering these enablers of knowledge transfer, Web 2.0 use will enhance the building and growth of social capital as well.
4.6 Web 2.0 use fosters knowledge transfer

Informal networks, weak ties, boundary spanners, absorptive capacity, and social capital are catalysts of knowledge transfer, and their effects reach the highest when one’s network spans multiple communities with diverse knowledge bases. Web 2.0 applications provide the platform for the creation of these knowledge transfer catalysts. It is the interplay and inter-augmenting of these catalysts which fosters organizational knowledge transfer.

A study on the blog use of IBM (Huh et al., 2007) found that blog use makes it easier to access experts, and to transfer tacit knowledge and resources across communities. The National Aeronautics and Space Administration (NASA) recommended in 2009 that Web 2.0 be utilized to facilitate intra-agency and inter-agency communication for this exact reason, stating that “[i]nternal deployments of these tools help the government’s best assets -- its people -- interact with one another, exchange information, and transfer knowledge more rapidly and effectively than ever before.” They later assert that “Tools which enable the development and maintenance of social networks among employees helps [sic] not only to catalog and identify expertise, but can also enable the transfer and capture of critical information and knowledge. Support for social networks allows employees to work together, across organizational boundaries, allowing relationships to flourish that may otherwise have never been discovered. It also enables organizations to more easily search for and align existing talent with strategic goals.”

4.7 From Utilizing Web 2.0 to Innovation

Web 2.0 applications facilitate communication channels among organizational units characterized by informal networks, weak ties, and boundary spanners with enhanced absorptive capacity. Knowledge transfer is fostered through these enhanced dimensions of social capital. Fichman and Kemerer (1997) argued that when employees have access to greater, diverse knowledge, the innovation knowledge barrier should be lower. This idea is also mentioned in Leonard and Sensiper (1998). They believe it is more likely that new ideas will be generated and identified out of interactions among diverse knowledge – the so-called “creative abrasion” process.

There is ample evidence supporting the link between social capital and innovation. Cohen and Levinthal (1990) pointed out that the exposure of boundary spanners to diverse knowledge and experts increases organizations’ absorptive capacity to make novel linkages and associations among this knowledge, leading to the generation of new ideas. Hauser et al., (2007) found that social capital developed through weak ties had a strong influence on patenting activity among businesses, which they defined as a type of innovation. Jamali et al. (2011: 388), in their study on innovation in business partnerships, found that “[t]he more innovative partnerships seem to have created and successfully exploited different dimensions of social capital, which has increased in turn the efficiency of information diffusion...and facilitated the absorption of knowledge.” And finally, Carrasco-Hernandez and Jimenez-Jimenez (2013), in a study of 282 family-run firms, found that social capital has a positive relationship with product innovation.

We have shown that social capital can be produced through the use of Web 2.0 applications, and that the development of social capital among organizations leads to innovation. Organizational use of Web 2.0 applications will thus drive organizational innovation through constant transfer of diverse knowledge facilitated by the interplay of informal networks, weak ties, boundary spanners, absorptive capacity, and social capital. To quote Hemsley and Mason (2013: 157): “Social media enables workers to be immersed in the organization’s culture, even during “non-work” periods, simultaneously with cultures and behavioral norms of multiple other networks. Although some companies seek to retain control over the knowledge (a resource view) by attempting attempt [sic] to block sites such as Facebook, Twitter, and YouTube (Barzilai-Nahon and Mason 2010), we believe these attempts are likely to inhibit innovation, knowledge seeking, and serendipitous connection that SM make possible.”

As we can see from the second half of Hemsley and Mason’s quote, there is some uncertainty on the part of executives regarding the merits of Web 2.0. Chief concerns include fears that employees may behave inappropriately on social media, that Web 2.0 technology may not provide a good monetary return on the company’s investment, and that information disseminated via such technology may prove to be of low quality (McAfee, 2009). Other executives have blocked blogs and instant messaging due to concerns about a lack of focus on work (Barzilai-Nahon and Mason, 2010). However, McAfee (2009) asserts that in many cases, executive fears of the dangers of Web 2.0 are unfounded, and not necessarily reflective of reality.

We are already seeing organizations begin to use Web 2.0 applications to innovate. The MITRE Corporation, an American nonprofit, has developed an open idea management platform called Idea Market to manage submissions during their annual proposal contest. The platform has been successful in not only optimizing their submission and...
review process, but due to the transparency of the platform, in facilitating collaboration between staff and providing wider access to fresh ideas as well (Holtzblatt and Tierney, 2011). The implementation of a wiki by Ingenta, a technology firm, consolidated all collected information into one place and provided a helpful reference guide for newcomers during a period of multiple acquisitions, as well as improving interdepartmental communication (Grace, 2009). And the adoption of a wiki by German investment bank, Dresdner Kleinwort Wasserstein, made collaboration between departments easier; due to all parties being able to work on a particular presentation on the wiki, as opposed to being forced to email drafts back and forth and coordinate several in-person meetings, time spent on the presentation was cut from multiple days to three or four hours (Socialtext, 2006).

5. Implications and conclusions

In this article, a model is proposed in order to provide insights of how organizational use of Web 2.0 applications drives organizational innovation. Facilitators of knowledge transfer – informal networks, weak ties, boundary spanners, absorptive capacity, and social capital, are identified as keys to this process. It is through Web 2.0 use that the quality and quantity of diverse knowledge transferred within organizations is enhanced, which in turn stimulates the generation of new ideas and ultimately drives organizational innovation. This model offers organizational managers an impetus to adopt Web 2.0 applications. However, Web 2.0 is not a panacea to drive organizational success; different considerations need to be taken before what this model envisions can be achieved.

5.1 Practical Implications

Managers need to understand that not all Web 2.0 applications are suitable for every organization. Organizations should consider which Web 2.0 applications best fit their strategic requirements. Categorization of Web 2.0 applications by type (communicative, collaborative, documentative, generative or interactive (McGee and Diaz, 2007)) can be a good foundation to make the right choice. Future studies matching business strategies with different Web 2.0 application choices and analyzing the outcomes should also be considered. In addition, managers should understand that the adoption of Web 2.0 applications will not necessarily lead to employee use (Ardichvili et al., 2003; Wasko and Faraj, 2000). Organizations need to support the culture of democratic knowledge sharing via Web 2.0 use, and encourage employee contributions on Web 2.0 applications through external rewards (Davenport et al., 1998), shared organizational vision (Chiu et al., 2006) and promotion of the idea that knowledge is a shared good (Ardichvili et al., 2003). Only when employees begin to use Web 2.0 applications in their daily practices can benefits of Web 2.0 use given by this model be achieved.

5.2 Theoretical Implications

This model provides a way to explore how Web 2.0 use affects organizational communicative structure, and how that then leads to innovation. However, organizational innovation does not only happen behind a wall, it also happens with the involvement of customers or organizational allies (Chesbrough, 2003). For future study, we should not only conduct research to understand how Web 2.0 users’ practices create informal networks, maintain weak ties, enact boundary spanners, enhance absorptive capacity, and generate social capital, but also to discover whether this innovation-driving model still holds true with the involvement of customers and other organizations through Web 2.0 use.

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References


The Role of Intellectual Capital in Creating and Adding Value to Organizational Performance: A Conceptual Analysis

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Abstract: The rapid growth of knowledge economy in the last two decades has changed management styles. Organization’s knowledge strategy should be driven from business strategy to ensure development of knowledge culture. Such a culture ensures knowledge activities, namely acquiring, sharing, creating, transforming and its utilization. The knowledge environment will encourage and promote innovative processes. The feedback from external environment and experience from previous projects will help in research and development. The amalgamation of new and known knowledge will help devise ways and means of transformation for effective and efficient performance. A conceptual model is developed to study the moderating role of intellectual capital competencies in knowledge strategy-organizational performance relationship. The research study’s how intellectual capital competencies moderate the knowledge strategy-organizational performance relationship. The novelty of this research is studying relationship of Knowledge Strategy-Organizational performance through moderating role of process innovation, research and development integration of past projects and market intelligence. It will educate and create awareness in managers for nurturing organizational intellectual capital and managing their daily affairs effectively. It will guide in devising better strategies, processes and methods to manage intellectual capital. This will help create value through innovations and improved performance.

Keywords: Knowledge strategy, intellectual capital, value creation, process innovation, research and development, market intelligence, performance

1. Introduction

Wealth cannot be created until profits are generated from innovations. Innovations that create wealth are the expected outcome of managing knowledge. Value creation through innovation describes the process through which intellectual capital resources are recognized, groomed and utilized. In the rapidly changing environment, management must update and utilize knowledge (internal and external) effectively to stay competitive. Knowledge is the base of intellectual capital (IC) and consequently of organizational capabilities (Amiri, Jandghi, Alvani, Hosnavi and Ramazan, 2010).

Wiig, (1997) ‘the purpose of knowledge management is to maximize the enterprise’s knowledge-related effectiveness and returns from its knowledge assets and renew them constantly. Knowledge management is ‘hands on’ to understand, focus on and manage systematic, explicit and deliberate knowledge building, renewal and application i.e. to manage effective knowledge processes.’ Organizations through processes, training, learning and a sharing culture convert these capabilities into core competencies. These competencies can be nurtured into critical success factors to achieve competitive advantage and contribute towards wealth enhancement of organization (Prahaled and Hamel, 1990). All organizations contain three important resources namely; tangible, intangible and financial, and even though intellectual capital (IC) is intangible but it is an excellent source of generating wealth (Edvinsson and Sullivan, 1996).

Drucker (1993) has reasons that IC is a significant resource, and not just another resource along with the traditional factors. The importance of traditional factors has given way to knowledge intensive ones and they have gained preference in quest of achieving competitive advantage (Firer and Williams, 2003; Gallego and Rodriguez, 2005; Boedker et al., 2005; Ticha, 2008). Chen and Lin (2004) write “the value-added created by human capital has prevailed over that created by tangible assets, such as machines” (p. 116). Lev (2001) has concluded that tangible and financial factors are no more main drivers of growing service sector, but have become mere commodities. This conclusion is later affirmed by research (Lev and Daum, 2004) that composition of assets has changed. Wealth has evolved into outcome of knowledge and has become the most crucial factor of production (Stewart, 1997). These arguments are valid to a certain degree but this research agrees with Lev, (2001) and Upton, (2001) that the concept of IC is not new and it has been around since the first relationship developed between customer and supplier, than it was named goodwill.
Knowledge predicts Drucker, (1995) to emerge as a crucial economic resource and an important source of competitive advantage. Knowledge management has attracted attention of researchers and there are two research streams on it namely, a) Resource-based stream and b) Process-based stream (Yang, 2011). The resource based stream focuses primarily on increasing the knowledge stock and the reuse of those knowledge repositories (Barney, 1991; Kamara et al., 2002). In this stream knowledge is viewed as the probable creation (Teece, 1998). It deals with the developing structure of techniques, tools, methods, and values through which firms can ‘acquire, develop, measure, distribute’ and provide a rent on their IC (Snowden, 1999). The process-based focuses on processes, organizational structure, strategy and people are key elements in management of knowledge (Teece, 2000). This research stream defines KM as a ‘transformation process going from tacit knowledge into explicit knowledge in order to facilitate flows of organizational knowledge’ (Lubit, 2001; Schulz and Jobe, 2001). In this stream, organization, strategy, and people have become central issues in knowledge management.

This research views knowledge management from perspective of process-based stream on organizational level. Failure to drive knowledge strategy from business strategy is obstacle to effective implementation of knowledge management (Minonne and Turner, 2009, 2010). Therefore to survive in knowledge economy firms need to clearly identify their knowledge strategy. The inclusion of Knowledge Strategy in the research model is a novelty.

It is investigating the existing management skills sets to determine their fit with the skills required for the management of IC. How they are contributing to the respective firms? How the firms are managing their IC? This research will be looking at what firms are doing in the way of managing IC - and take a number of different firms of approximately the same size to identify whether the firms are managing their IC, if so, how, if not why. It examines the relationship of IC components through their constructs, Process innovation, Research and Degree in integration of Knowledge from past Projects, Market intelligence and business performance through strategic alignment of knowledge strategy.

The novelty of this research is studying the relationship of knowledge strategy - organizational performance through moderating role of process innovation, research and development integration of past projects and market intelligence.

2. Literature Review

The expression "Structure follows strategy" (Chandler, 1990) is believed to be various forms of IC flow to and in connection with the strategy. Each strategy presents some unique challenges likely to affect the management of IC. Different strategies are preferred by organizations to manage organizational knowledge. The choice of strategy depends upon their capability and priority. In the context of knowledge management, strategy refers to the intention and environment of organization to create knowledge (Nonaka & Takeuchi, 1995). Knowledge management strategy focuses on the acquisition, application, and communication of mission specific professional expertise that is largely tacit in nature to organizational participants and contents in a manner that is focused (King, 2001).

Managing IC

The management of the IC is about recognizing that they offer new opportunity for the organization to create value for them (Stewart, 1997). The success of a business strategy is closely linked to the level of IC connected. It is important that management of IC is designed to provide a framework for maximizing the leverage of intangible assets (chatzkel, 2000). Organizations employ people for a certain period (Stewart, 1997). It is through the process of renewal, and transformation of knowledge assets, that the organization defines its future and the ability to create value through its intellectual assets.

The three recognized types of IC are:

i) Human capital (HC)

It consists of all attributes related to human of the organization, i.e, his exposure, experience, and skills, his innovative and creative capabilities. It contains all intangible information and knowledge in the human mind of the organization (Bontis et al, 2002; Stewart, 1997). It is critical base of organization’s innovative and strategic sustainability (Bontis, 2002; Bontis et al., 2000). A superior human capital is connected with organization’s superior output and improved compensation or earning (Wilson and Larson, 2002). Therefore HR managers must strive to recruit and groom the best possible team in order to achieve competitive advantage for their organization (Bontis et al., 2002). The effectiveness
of knowledge strategy implementation relies on the facilitation of innovation and value creation by organizational employees. This can be achieved only through a process innovation (Santosus and Surmacz, 2002).

ii) Structural capital (SC)

It includes organization’s learning and sharing that is utilized in its daily practices. This is organization’s knowledge storage after an employee leaves (Ross and Ross, 1997). It is the sustaining infrastructure for an organization’s human capital. All the different physical storage facilities in the organization, namely, its culture, processes, database, operating procedures, and its intellectual assets, they not only create value but also add to the financial worth of the organization (Ordoñez, 2004; Bontis et al., 2000).

iii) Relational capital (RC)

It consists of organization’s relations with its external stakeholders and how they perceive organization’s product and or services (Grass Nick and low, 2004; Fletcher et al, 2003; Bontis, 1998). This is very important for any organization because it creates perception and value in the minds of stakeholder through organization’s HC and SC (Ordoñez, 2004).

Process Innovation refers to the extent an organization develops and performs its activities through imaginative means. The strategy of an organization depends upon creative flexibility of the human mind. The knowledge environment highly values creativity and innovative competence and rewards it accordingly. Employees should be encouraged to share ideas and information freely and bring out their creative abilities and innovate. Process innovation interacts with knowledge strategy and knowledge management methods to achieve fundamental and continues development. Kamara et al., (2002) affirm that successful organizations are creative and innovative to capacity when they implement knowledge strategy. Innovation transforms competencies to bring products, process and service improvements that help organization to achieve competitive advantage (Danneels, 2002).

R&D integration with previous projects is an organization’s capability to improve on its past project experiences incorporating their results in R & D. In an ever-changing economic environment, organizations need to decide how effectively they can use their intellectual capital to not only create value but achieve competitive advantage too (Armbrecht et al, 2001). The integration of knowledge obtained through R&D is based upon tacit knowledge flow. The main focus of the integration process must be on successfully utilizing innovative ideas for value creation. An organization mainly creates internal knowledge through R&D. The quicker an organization creates knowledge, the more potential it has to add value to its growth.

An organization expands its creative potential through integration of knowledge via R&D. According to (Armbrecht et al, 2001) facilitating flow of knowledge and its creation is an activity with high returns; this improves an organization’s bottom-line. The integration of past projects knowledge in R&D provides a strong support to knowledge management, which significantly reduces the cycle time of new product development, improved processes and service (Shermann et. al, 2000; Danneels, 2002)

Market Intelligence refers to the degree to which information is available about the external environment of an industry. Market intelligence gathers information about consumers, competitors and market. This information is processed into knowledge to achieve a better fit of strategy for the organization. It is described as one of three forms of competitive intelligence (Deschamps and Nayak, 1995). It is critical for understanding consumer needs, preferences, market opportunities and treats. Organizations needs to effectively use market information and integrate it with knowledge creation process, to achieve a strong market intelligence solution. Jaworski and Kohli, (1993) identify market intelligence generation and its dissemination as two important factors in achieving improved performance. It helps in implementation of knowledge strategy in achieving higher performance. The information from market environment plays important role in success of new product, and staying ahead of competition (Adams et. al, 1998; Wren et. al, 2000).

The above three types of intellectual capital are interdependent. The collective utility, interactivity, aligning of three types of IC and balancing knowledge flow between them ensures best possible value creation for an organization’s product or service (Kong, 2007). There is a need for companies to continually review what to leave with the aim of better things to do has been done, the operations are no longer relevant, and replace them with new ones (Rastogi,
2003). Commitment is involved in the management of IC. This begins with an understanding of the purpose and direction of the organization and the knowledge that IC as a strategic asset is linked with organization’s performance (Mitchell, 2010). Knowledge is proven to be valuable to individual and sharing it in organization is a symbol of unity and trust (Brown and Woodland, 1999). The knowledge sharing process can be fostered in organizations through incentives. The best way of effective creation and sharing of knowledge is through establishment of a knowledge culture within the organization.

3. Competence and Capability

Strategy of the organization is a determinant of the capabilities and competencies, which showed such progress that by the end of 1980’s and early 1990’s, several authors (Teece et al., 1999; Chandler, 1990; Prahalad and Hamel, 1990) presented proposals on organizational ability to adapt to a rapidly changing environment. Bhatti, Khan, Hussain, Ahmed, & Rehman (2011); Hayashi, (2004) the essential manner for organizations to become competitive is through creating, updating and effectively using knowledge. In order to achieve success organizations need to gather and blend specific knowledge from different sources to overcome its technical and operational hurdles. Without bringing in updated knowledge and blending it with existing knowledge organizations cannot achieve success (Henderson and Cockburn, 1994). Updating of knowledge represents shifting from external to internal base. While integrating internal knowledge shows internal transfer. It was found that organizations with higher knowledge shifting mechanisms within the organizational departments and with external sources produced better performance (Henderson and Cockburn, 1994).

Such acquisition, integration and availability of expertise, influences the outcome of organization’s success (Leonard-Barton, 1992; Teece et al., 1997). It is important that employees with different capabilities share their expertise with one another and enable them to work towards common organizational goals from varying perspectives. This will create synergy among employee performance by sharing through individual expertise by interacting and sharing feedback (Leonard-Barton, 1995). This interaction among employees will create transformed knowledge and through effective sharing organizations will achieve their pre-determined goals. An environment should be provided in organization for a complete and comfortable transfer of knowledge among individuals. Organization will benefit from this individual exchange of knowledge, when it will be used in developing capabilities reducing internal barriers to share and learn. These capabilities will develop into processes and structure for smooth flow and utilization of knowledge in an organization.

4. Conceptual Model (An IC Management Model ‘MIC’)

A study conducted on IC by Organization of Economic Cooperation and Development, (2008) identified several benefits of IC which contribute to any organization that include, hiring retaining, increasing, motivation of employees, developing customer loyalty, nurturing competitiveness and utilizing resources efficiently and effectively for a better outcome. Keeping in view the results of this aforementioned study, managers need to carefully highlight the intangible resources that are important and required for value creation and sustaining competitive advantage for their organization. Managers can also gain knowledge of intangible resources by learning from experiences of others organizations.

Strategy identifies the activities to be undertaken to achieve the corporate vision (Teece, 1998; Thompson, 2001). The models of Carnerio, (2000), Harrison and Sullivan, (2000), Klaila and Hall, (2000), Firestone and McElory (2003), and Wenger, (2004), all include strategy. To achieve organization’s vision and to provide input for the development of its strategy, the components of IC to be managed, are human capital, structural capital, and relational capital. Innovations that create wealth are the expected outcomes of IC management. Therefore, through the management of IC, an environment should be developed that encourages free flow of knowledge through sharing and transformation, and allow innovations to emerge (Bhatt, 2002; Kantar, 1996; OECD, 1996; Priess, 1999).

Prokopeak, (2008) claims that, “more and more businesses are realizing the role that the knowledge residing in their IC plays in creating economic power and value.” Edvinsson and Sullivan, (1996) state that, “today successful knowledge organizations recognize that IC is a major source of value and leverage”. To compete effectively in a market place that is becoming increasingly competitive it is essential to have in place a program of continuous improvement of employee competencies. An organization’s structure impacts on how effectively it will operate. How systems and processes are managed determines its efficiency and effectiveness.
From the IC perspective, the process of mapping knowledge (Davidson and Voss, 2002; Heng, 2001; Stewart, 1997) is essential for finding knowledge of potential value for the organization. Knowledge is critical to the operational activities of an organization. Discussion reveals that there is considerable reliance on the skills and competencies of employees that link to the successful operation of the business unit. Managing the process of facilitating knowledge sharing is important for both performance improvement and for encouraging knowledge creation. Knowledge creation emerges from the sharing of knowledge, and in turn can lead to ideas and innovation. IC determines the capability of the organization and it is crucial for the managers making decisions to have access to all available knowledge, and to take a holistic view of organization's IC (Rastogi, 2003; Hussi, 2004).

The empirical studies investigating perceptions of management regarding contribution and importance of IC are not enough (Steenkamp and Kashyap, 2010). There is need to research this in a different environment of a growing service industry to find out whether management is aware of the importance and contribution IC makes to business. In the era of knowledge, organizations need to clearly state their knowledge strategy. The need to identify knowledge strategy is needed for success of knowledge management in organizations as suggested by (Turner and Minonne, 2010 and Minonne and Turner, 2009). It has not received as much attention and importance as required in this changing period (Yang, 2010, Alammary and Fung, 2008). In the research model knowledge strategy is added to fill the research gap and clearly state knowledge objectives of the organization.

From an extensive study of recent academic literature, based upon their recommendations and findings, a conceptual model is developed by this study. This model is an attempt to bring together an approach for effective management of IC. The effective management of IC will help create and add value hence impacting organizational performance. Failure to drive knowledge strategy from business strategy is obstacle to effective implementation of knowledge management (Minonne and Turner, 2009, 2010). Therefore to survive in knowledge economy organizations need to clearly identify their knowledge strategy. Knowledge strategy has received little attention in academic research (AlAmmary and Fung, 2008); its inclusion in the research model is a novelty. Mitchell, (2010) suggest studying the existing management skills sets to determine their fit with the skills required for the management of IC. Shih et al., (2010) and Bhatti (2011) recommend research on variables like scale of organization, its revenue and capital and their influence on IC. The study also suggests research on relationship between IC and organizations performance.

Based upon research gaps identified from above mentioned studies, this study theoretically contributes by conceptualizing a model, which highlights the knowledge strategy role in effective management of organizational intellectual capital. The model highlights the intellectual capital antecedents namely, process innovation, R&D integration from past projects and market intelligence in light of knowledge strategy. The second contribution is studying intellectual capital antecedents and organizational performance relationship.

This research model (figure no 1) will study the management of IC through identification of knowledge strategy and how that affects organization's performance. The identification of skills and their mutual fit will help managers and researchers to devise better management tools and techniques to improve internal environment, processes, training methods and relations with external stakeholders. The IC management model illustrates a holistic perspective. It starts with the organization's vision, identifies the need for a corporate strategy and links strategy to the management of IC. Within the IC management framework are the areas, human structural and relational capital. These areas require to be managed effectively. They provide a comprehensive view of the IC available and develop directions of the corporate strategy that will lead to the vision of wealth generation.

Figure 1: An IC Management Model
5. Discussion

In order to sustain long-term success, organizations must regularly update and use the knowledge they acquire and increase their innovative capacity (Liedtka, 1999). The process of learning effectively in organizations through sharing among individuals and transformation of environmental knowledge helps not only in better understanding of environment knowledge but its precise usage as well (Jones et al., 2003). The individual exposure, experience, knowledge will influence how the new learned or shared knowledge is transformed. This process ensures after interpretation if the acquired knowledge is of any use and value to the organization (Seng et al., 2002; Davenport and Prusak, 2000).

Therefore, after knowledge is shared and learned, the utility and usage of transformed knowledge may be different. The absorption capacity of an individual must be considered (Loermans, 2002; Hwang, 2003). Sharing of knowledge allows individual to learn through the organization’s processes. As organization gives its employees opportunity to share individual experiences and learn from others, this process will promote learning within organization. The individual’s beliefs, his absorptive capacity will ensure the utility and value of gained knowledge after transformation (Davenport and Prusak, 2000; Seng et al., 2002).

Knowledge Effectiveness

The process of knowing consists of three factors, namely, sharing, learning and thinking. These three factors are mutually dependent. The effective process allows individuals to ponder over what is shared with them and learn from it. This would help increase their capabilities (Petras, 1996; Gupta and Govindarajan, 2000). Through this process new transformed knowledge is created which is not essentially organization’s knowledge. This knowledge may lose its worth or importance if it is not updated or utilized properly, on the other hand its proper use can increase learning outcome (Yang, 2007). The effective knowledge sharing and learning in organization helps improve performance, by creating innovation and boosting its competitiveness. This improves the profitability of the organization through effective operations.

Value Creation through IC

Value creation describes the process through which IC resources are recognized, groomed and utilized. Its how these resources contribute in changing the organization from being an ordinary business to becoming a top manufacturer of products in its field (Peppard and Rylander, 2001). The effective utilization of those resources enables an organization to grow to an industrial leader status. Experience and success in professional life teaches a lot. This teaches managers how business success is reached, through methodology they have saved in their minds. The conceptualized model of this research can guide them, in situations when they have to react immediately and take action; they do so based on their experience. Every individual has varying and different experience, exposure and uses his knowledge and competency accordingly (Peppard and Rylander, 2001). The purpose of value creation process is to uncover the manager’s mental model. Through the organizational learning process a model is developed which can facilitate in meeting organization’s strategic objectives. By developing such a model, the management describe how they intent to create value. They will identify, which resources to use, why to use them, how to use them and a mutual understanding about their relevance with one another (Peppard and Rylander, 2001). The knowledge transformation that takes place through this value creation process will help reach the desired objectives.

This research will educate and create awareness in managers for nurturing organization’s intellectual capital and effectively managing their daily affairs. They will be able to devise better strategies, processes and methods to manage intellectual capital. The future researchers can empirically test the conceptualized model and study the relationship of IC with organizational performance. How the organizations are managing their IC. How they are contributing to the respective organizations. The financial and Non-financial performance of organizations can be studied for a better understanding of the concept.

References


Knowledge Management for Public Administrations: Technical Realizations of an Enterprise Attention Management System

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Abstract: The improvement of governments’ efficiency has gained great importance and validity especially in the current times of economic downturn. E-Government constitutes the most contemporary techno-managerial proposition in the track of possible interventions. The paper addresses, more specifically, empowerments necessitated by Public Administration (PA) organizations. Anchored on the needs of three real-life cases, the paper describes the conception and the realization of an IT artefact together with its methodological appeals aiming at improving information access and delivery and thus PAs’ decision making capacity. Our proposition constitutes a novel approach for managing users’ attention in knowledge intensive organizations which goes beyond informing a user about changes in relevant information towards proactively supporting the user to react on changes. The approach is based on an expressive attention model, which is realized by combining ECA (Event-Condition-Action) rules with ontologies. The technical realizations described in the paper constitute the underlying infrastructure of an Enterprise Attention Management System.

Keywords: Attention management, proactive information delivery, public administrations, semantic infrastructures, intervention methodology

1. Introduction

The advent of the e-governance era inevitably poses new challenges for public administrations effectuating continuous monitoring and adaptation to changing legislative and political environment, predicting citizens’ and business needs accurately, and making right decisions. The public sector is therefore by far one of the most knowledge-based and intensive organizations, thus making it ideal for KM interventions.

KM has a clear mandate for e-government to enable and promote the requisite information and human mechanisms for the advancement and sustainability of competence-driven service delivery (Ping, 2008). Still any attempt to manage knowledge would suffer from two seemingly competing requirements: managing humans’ cognitive capacity vs. organizational knowledge abundance. To avoid such deadlocks, we capitalize on a KM approach that is based on a model of information delivery, which utilizes human attention capacity as a means to tackle “proactively” any information requests of knowledge workers.

This knowledge perspective recognizes workers as a source of knowledge in their respective roles (Devdoss and Pan Shan, 2002). Any intervention in this respect should make allowances for the support of the human factor and in particular its on-the-job requirements and significations. Our claim goes beyond existing empowerments for the structuring, searching and discovery of knowledge, concentrating on the importance of making information more readily and meaningfully available to its seekers and therefore any reaction on it more (pro)active. The realization of this approach necessitates the understanding of the functioning of human attention in order to capture and model the requirements for proactive information delivery.

Our ideas for proactive information delivery were realized in the SAKE project and subsequently in the produced system and methodology. In this paper we demonstrate the origins but also the products of our KM approach, which is based on the idea of proactive information delivery by technically enabling attention management. Our paper is split in 3 main cores. The first core accounts for the knowledge environment of public administration organizations along with the specification of three real life (3) application scenarios. The second core is dedicated to the technical design and implementation of the proposed solution and last we present the basic conceptual strands of our methodological framework.

2. The knowledge landscape in Public Administrations

Public Administrations (PA) represent the backbone of any political system. Involved at all stages of the policy-making process, PAs also play the role of the interface between citizens and the political system, thus acting as an efficient catalyst for the process of transferring political measures towards society. Nowadays, contemporary societal developments impose the modernization of PAs in order to achieve higher levels of efficiency in the delivery of public...
service. In this realm, KM introduces new options, capabilities, and practices that can impact and assist public administration to great advantage (Wiig, 2000). For Public Administrations, the management of their knowledge landscape comprises a new responsibility and certainly leads to the heart of administrative work where decisions are taken.

The knowledge landscape in public administrations consists of knowledge relevant for problem solving and decision making. This knowledge is represented in explicit forms of content like documents and database records enabling its effective retrieval. However, knowledge is not static; it evolves as it is being used by its consumers. This perspective of knowledge differs significantly from the one ascribed by traditional and static information management views (Balatsoukas, 2005).

The “changeability” of knowledge is usually reflected on metadata, like creation date, last modification, how often a document has been changed, etc. However, metadata alone are not sufficient to capture the dynamic nature of knowledge and specifically any changes related to its purpose and scope of application. Factors that apparently influence knowledge changeability are the form of representation of knowledge, the context of application and individual preferences. Knowledge is no longer manifested by static and re-active information structures such as usage stamps (time, person, purpose, etc.) and cataloguing rules (clustering, etc.) but could be continuously redefined based on its role in the organizational landscape. In its new structure, knowledge codification is enhanced with information elements acquired during its lifespan rather than any human ex-post attributions. Failing to capture knowledge changeability might result in both knowledge stickiness and leakiness (Brown and Duguid, 2001).

In knowledge-based environments like PAs, where knowledge is endless and chaotic and human mediation is overwhelming, KM needs to facilitate efficient access to information and knowledge by enabling information seekers’ attention with appropriate IT-based mechanisms. Managing people’s attention will result in more relevant and important information and knowledge to reach its seekers. Our approach for KM is built on this premise.

3. Application Scenarios for KM: The case of 3 public administrations

Our proposition does not stem only from conceptual inquiries but is also grounded in the requirements of three actual PA organizations from Hungary, Poland, and Slovakia. Due to their recent endorsement by the European Union (EU), these countries are still struggling to meet the quality criteria of EU in several areas of public services. This task becomes harder considering the PAs’ heterogeneity within the boundaries of a single country, let alone at the pan-European level. This heterogeneity is increased due to the complexity of activities of the PAs, the continuous political changes as well as their scope (regional, national, international). Amidst these conditions, these PAs participated in the formulation of a KM solution that could eventually support them in their knowledge-intensive tasks. Below are the areas of the envisaged support for each PA:

- **LATA (Mestska cast Kosice – Sidlisko Tahanovce):** involvement of the public into the process of making local legal regulations by annotation of the city ward general binding regulation.
- **MEC (Ministry of Education and Culture):** higher education portfolio alignment with world of labour needs.
- **UMC (Urząd Miasta Czestochowy):** management of education institutions’ material resources.

All three cases concern processes in PA environments that target citizens, businesses, or PA-internal groups. Several aspects demonstrate the knowledge- and information-intensive nature of their environment:

- They depend on a number of applicable laws, regulations, court decisions, etc.
- They typically process a huge amount of information and documents from different sources.
- They require continuous monitoring of the content of the employed knowledge resources as they frequently become subject of change.
- The application and interpretation of law and regulation is often not trivial, ambiguous, such that it requires experience in the field but also constantly updated knowledge.
- Content items logically belong together (e.g. a regulation interprets a law in a more or less binding manner, while example cases illustrate the borders of applicability) and are only valid in a certain, complex application context (which region, which timing of events, which kind of citizen or decision, ...)

User requirements were collected through workshops between PA stakeholders and the project’s intervention team (partners acting as consultants). Our on-site inquiry led to the inception of a technical and management intervention constituted by empowerments on the content and collaboration functions of the Pas i.e. monitoring changes in laws, capturing purpose-oriented interactions and communications, etc.
Our requirements analysis also included detailed mapping of the knowledge landscape of the three PAs as constituted by processes, knowledge assets and knowledge agents. Specifically our inquiry focused on eliciting detailed description of the targeted processes in terms of knowledge inputs/outputs, communication modes and knowledge agents, the detailed description of knowledge assets (as the main input for the ontology population), and the detailed description of knowledge agents.

Finding a purpose for KMOur analysis led to the identification of pertinent to the public administrators empowerments that are dominated by the need to control information in its context of usage. Consequently, we adopted the notion of changeability to address the breadth of possible situations that an information resource can be found in during its lifespan. Given information lives within a social context, it would be a mistake from our behalf to leave the human factor unaddressed (Brown and Duguid, 2000). People comprise the basic sense-giving instrument for information. We perceive sense as a blend of value and meaning that is enacted by humans during the utilization of information in work. The maximization of these two aspects will inevitably lead to better decision making and problem solving.

Apparently, access to information is not the problem. Accessing information that is relevant, meaningful and valuable for our work is. Given humans’ bounded capacity to process information, proactive delivery of knowledge and information becomes an imminently important priority. Our treatment for this matter comes through managing the attention of knowledge workers. In our approach, there are three main requirements for modeling attention (to be further discussed later):

- Modeling information sources that should be accessed, in order to enable focusing on relevant ones
- Modeling context in which information should be received, in order to define the business context in which information will be consumed
- Modeling preferences of users, in order to express individual "context" in which information will be used

Based on requirements from three public administration organizations and also our technical aspirations for a KM solution, we endeavored to implement a technical solution that provides:

- an integrated knowledge space (instead of a set of isolated and heterogeneous knowledge resources) that will unify different perspectives and interpretations of knowledge resources and will enable their treatment on a far more fine grained level: now any bit of information or any knowledge object could be given identity (so called virtual content) and assigned attributes (metadata) allowing for more sophisticated applications and services in e-government;
- a collaborative working environment (instead of a single person decision making process) that will bring every public servant to the same level of effectiveness and productivity and will ensure more efficient knowledge sharing by guaranteeing at the same the time the reliability and the consistency of the decision making process;
- a change management system (instead of ad-hoc management of changes) that will ensure harmonisation of requests for changes, resolution of changes in a systematic way and their consistent and unified propagation to the collaborative and knowledge space, in order to ensure the high quality of the decision-making process;
- a platform for proactive delivery of knowledge (instead of an one-way knowledge access) that enables creation of an adaptable knowledge sharing environment through learning from the collaboration between public servants and their interaction with the knowledge repository and supporting in that way full empowerment of public servants.

4. Underpinnings of Attention Management

4.1 Related Work

Our claims for proactive information delivery using the notion of attention management are not new. Next we present the most representative initiatives.

Researchers from IBM and MIT designed and developed the Simple User Interest Tracker or SUITOR (Maglio et al., 2001) which is a framework for developing attentive information systems that track computer users through multiple channels to determine interests and to try to satisfy information needs. SUITOR implements four main modules: a) watching user’s actions to infer user’s current mental state and needs, b) storing user’s actions to create and maintain...
user’s model, c) searching information from the digital world and scanning user’s local hard disk and d) ranking and suggesting relevant information sources through peripheral display. Having enough input information from these modules, SUITOR can infer user’s current interests and propose relevant information sources from local and remote databases that have previously gathered and stored.

The Attentional User Interface project (Horvitz et al., 2003) developed methods for inferring attention from multiple streams of information, and for leveraging these inferences in decision-making under uncertainty. These methods have been used in illustrative applications of the use of attentional models. Applications focus on the design of new interfaces that take into account visual attention, gestures and ambient sounds as clues about a user’s attention. These clues can be detected through cameras, accelerometers and microphones or other perceptual sensors and, along with the user’s calendar, current software interaction and data about the history of user’s interests, they provide valuable information about the status of a user’s attention. The same project built Bayesian models aiming at dealing with uncertainty and reasoning about current or future user’s attention taking as input all of the above clues. Moreover, it introduced the economic model of attention and information. The model computes the expected cost of disruption user’s current activities and infers whether and how to alert the user and display incoming messages.

A significant stream of related work deals with the design of attentive user interfaces (e.g. see Vertegaal, 2003; Vertegaal et al., 2006). Shell et al. (2003) identify five key properties of attentive user interfaces: sensing attention, reasoning about attention, communication of attention, gradual negotiations of turns, and augmentation of focus. Wood et al. (2006) make the distinction between visual and auditory attention and discuss five themes that concern the nature and measurement of visual attention.

In order to analyse the issues related to the design of attention aware systems, Roda and Thomas (2006) have identified three aspects of attention management: (1) Detection of current user’s attentional state. The system needs to establish what are the user’s goals and current tasks, where is the user’s attention focussed, and what is happening in the environment, (2) Detection and evaluation of possible alternative attentional state. The system establishes whether alternative foci are available, how important they may be for the user, and the cost effectiveness of possible focus switches, (3) Strategies for presentation of alternative states to the user (or maintenance of current focus). The system defines the strategies best suited to present the user with alternative foci.

In comparison to attention aware systems, our approach does not include sensor-based mechanisms for detecting the user’s environment. We argue that for enterprise attention management, non-sensory based mechanisms provide a wealth of attentional cues such as users’ scheduled activities (e.g. using online calendars), users’ working context (e.g. by querying workflow or enterprise systems) and user’s communication and collaboration patterns (e.g. using groupware and other communication tools). However, our system is tailored to support enterprise attention management by taking into account the business context and working preferences.

4.2 Proactive Information Delivery: A Role for Ontologies

Information and Communication Technologies (ICTs) have been used in several purposeful manners in order to support and facilitate KM activities (Alavi and Leidner, 2001). The basic usages of ICTs refer to supporting creation, storage/retrieval, transfer, and application of knowledge in organizations. Typical examples of ICTs used for the aforementioned purposes comprise communication and collaboration tools, brainstorming tools, knowledge mapping and mining tools, workflow and content and document management systems, Intranets, and many more which were named KM tools following the concept’s hype in the last decade (Ngai and Chan, 2005). Lately, a new technological concept, called ontologies, lends its capacity on encapsulating shared and common understandings as a means to support knowledge sharing and reuse. Ontologies are increasingly seen as a key technology for enabling semantics-driven knowledge processing (Maedche et al., 2003). Our technical proposition also draws on ontologies’ capabilities to model possible transformations of information inside an artefact i.e. interaction among components, changing of content and metadata, etc.

Ontologies have been primarily and largely used for enabling the sharing of common understanding of the structure of information among people and software agents as well as enabling reuse of domain knowledge and making domain assumptions explicit to name just few of the reasons for their necessity (Noy and McGuinness, 2001). The problem that we are trying to tackle in our domain of interest lies in the effective delivery of information to its seekers, the resolution of which requires grasping and modelling the transformations of the information while being used. Given its existence in a shared context (e.g. PAs) the ontological treatment of information as resource (enclosing both
content and action) deems appropriate and necessary. Ontologies are sufficient in capturing both the concepts and the relations about information resources as well as the changes affecting them. Modelling information in that way allows mapping and switching between different contexts i.e. context of resource creation, (individual) context of resource application, (business) context of living.

4.3 Modeling attention

The main challenge for modeling a KM system in e-Government nowadays is modeling (efficiently) the attention of public administrators. Indeed, (human) attention capacity is the only resource which cannot be increased by improvements in the technology, as illustrated in Figure 1.

Figure 1. The importance of managing attention efficiently

On the other side, the amount of (relevant) information around public administrators is increasing dramatically, leading to the well known information overload problem. Therefore, managing access to relevant knowledge includes managing attention of knowledge workers.

Figure 2 presents our proposal for a framework for Attention Management. It is developed along 3 axes, corresponding to the aforementioned requirements:
Information represents all relevant chunks of knowledge that can be found in the available information repositories and sources. In the business environment of an organization, sources of information can be both internal and external to the organization. Moreover, information can be represented either formally (e.g. using information structuring languages such as XML) or informally. Finally, information may be stored in structured repositories such as databases that can be queried using formal languages or in unstructured repositories such as discussion forums. We use a set of ontologies for representing information (and sources).

Context defines the relevance of information for a knowledge worker. Detection of context is related to the detection of the user’s attentional state which involves collecting information about users’ current focus of attention, their current goals, and some relevant aspects of users’ current environment. The mechanisms for detection of user attention that have been most often employed are based on the observation of sensory cues of users’ current activity and of the environment; however others, non-sensory based mechanisms also need to be employed to form a complete picture of the user’s attentional state (Roda and Thomas, 2006).

Preferences enable filtering of relevant information according to its importance/relevance to the given user’s context. In other words, the changeability of resources is proactively broadcasted to the users who can be interested in them, in order to keep them up to date with new information. Users may have different preferences about both the means they want to be notified and also about the relevance about certain types of information in certain contexts. User preferences can be defined with formal rules or more informally by means e.g. of adding keywords to user profiles. Moreover, even when employing mechanisms capable of formalizing the users’ preferences, a certain level of uncertainty about users’ preferences will always remain. For this reason, dealing with uncertainty is an important aspect of attention management systems. Equally important is the way preferences can be derived: by explicitly specifying them or by learning techniques.

5. A methodological approach for semantic realizations in PA’s

The implementation of semantic-enabled knowledge-based e-government requires an appropriate methodological approach to cater for both the technical and organizational proceedings of the underlying endeavor.

The functions required of a knowledge management system cannot be known completely upfront. Thus, the design and deployment of any knowledge-based system should ideally follow an incremental approach, i.e. developers implement a part of the system and increment it rapidly, as new requirements emerge. A pilot implementation of the knowledge management system on a small scale can lead to insights that might prove to be invaluable before the full-
blown system is implemented at an organisation-wide level. Thus, potential problematic aspects can be tackled with and reworked without major expense in order to comply with the actual needs of the end users and suit their preferences.

Taking the aforementioned into account, our methodological drive adopts the main principles of the Information Packaging methodology (IPM) primarily because of the iteration cycles of the latter throughout the design and development of a KM system lifecycle. In addition to that, the presented approach can be generally used by public administrations when taking-up semantic knowledge management initiatives. Consequently, it also takes into account a number of approaches and methodologies created in the frame of several EU-funded research efforts in the field of Knowledge Management. In specific, the proposed methodology takes into consideration the Know-Net method that has been designed as a supporting tool to help the design, development, and deployment of a holistic Knowledge Management Infrastructure, the CommonKADS leading methodology that supports structured knowledge engineering, and the DECOR Business Knowledge Method that constitutes a business process-oriented knowledge management method consisting of a structured archive around the notion of the company’s business processes which are equipped with active, context-sensitive knowledge delivery, to promote a better exploitation of knowledge sources.

A diagrammatic overview of the methodological approach deployed in the public administration at hand is provided in the Figure 3.

![Figure 3: A methodology for semantically enabled technological interventions](image-url)

The figure depicts an infinite loop between the methodology’s steps as well as a respective feedback at the end of each one and before the start of the next one. The benefits of this approach are obvious; namely easier and more effective incorporation of iterative and incremental improvements to the knowledge management system under development. The smallest subset for running an iteration is defined on a per case basis. In majority, it comprises a business process in a PA but, in some cases, it can even be one complex task of the business process. In any case, the issue boils down to defining a meaningful set of functionalities to be implemented in the iteration system prototype, that can be used for testing and supplying feedback to the next iteration cycle.

The current methodological proposal comprises 4 steps/phases, namely:

- **Step 1: Application Domain Selection**, where the selection of the most promising area to focus is performed (e.g. a knowledge-intensive business process),
- **Step 2: Design and Analysis**, where a detailed analysis of the selected application domain is performed as well as the development of the system’s semantic extensions,
- **Step 3: Technology Implementation**, where the implementation of the prototype takes place and then the prototype is tested (components independently at first and then together) in a small part of the
organisation. At this step a preliminary user feedback is collected that assists in order to scale up and test the prototype at the organisational level.

- **Step 4: Deployment and Evaluation**, where the prototype is being deployed in the organisation, potentially integrating with legacy applications. Users are trained in order to be able to use adequately the system and the system evaluation takes place. The results from the evaluation process serve as feedback to Step 1 in order to perform another iteration of the methodology either with the same or another application domain.

In the execution of the methodology the following roles participate:

- **External consultant**: A consultant that is not a member of the pilot public administration organisation,
- **Ontology engineer**: Anyone with profound knowledge and experience on the development of ontologies,
- **Domain expert**: An expert on a specific domain of interest,
- **Public administrator**: Any civil servant working in the public administration organisation,
- **Manager**: Anyone belonging to the higher management of the public administration organisation,
- **IT expert**: Anyone expert in Information Technology.

The added value of the current methodological undertaking in successful uptakes of KM initiatives is manifold. It is not constrained into driving simply the technological implementation of a semantically-enriched KM infrastructure but can reach to the point of restructuring the way the knowledge worker (a public administrator) performs his knowledge-intensive / decision making tasks.

For the purpose of this paper we focus on the way the methodology facilitates the modeling of attention of the knowledge worker, namely on steps 1 and 2 of the methodology. As aforementioned, modeling attention basically drills down to:

- Modeling information sources that should be accessed, in order to enable focusing on relevant ones,
- Modeling context in which information should be received, in order to define the business context in which information will be consumed,
- Modeling preferences of users, in order to express individual “context” in which information will be used.

All three requirements link to analyzing and modeling the knowledge landscape, namely the AS-IS situation of the organization but also, as a supplement to that, what can be deducted by looking at the present state and bearing in mind the future semantically-enhanced knowledge infrastructure of the targeted organization. A methodological approach spans the entire organizational context and knowledge environment in order to identify knowledge related problems and opportunities. More specifically it assists by providing the means for systematically:

- Identifying and capturing the knowledge assets that exist in the PA and the respective agents (key people) that posses but also use them, as well as changes that these knowledge assets are subject to. Those changes constitute obviously candidate reasons for triggering the attention of the public administrators.
- Defining simple as well as complex preferences with regard to users needs for specific information in a particular individual context via the detailed analysis of the knowledge assets, their changes and the involved agents, to the level of a single task in the business process of the PA.
- Extending/ enhancing the pre-existing ontologies (e.g. information ontology) as well as developing the per case domain ontology(-ies) taking into consideration the aforementioned modeling of knowledge and context in which this knowledge is used and consumed. These ontologies provide the backbone for the semantic-enriched knowledge infrastructure effectively empowering the public administrator and drawing his/her attention only to information pertinent to a particular business context or explicitly defined with a personal preference rule.

### 6. A prototype of an Enterprise Attention Management System (EAMS)

#### 6.1 The Logical architecture

The vision of proactive information delivery based on attention management has been technically realized in an Enterprise Attention Management System (EAMS). The overall objective of the EAMS was to support knowledge
workers always keep their attention focused on their current tasks by pre-selecting and feeding them with the most relevant information resources to complete their tasks in a way that will not disturb them more than they prefer.

Figure 4 depicts the logical architecture of the EAMS system that complies with the general Attention Management framework presented in Figure 2.

**Figure 4. Logical Architecture of the Enterprise Attention Management System**

The produced system incorporated public administrations’ requirements for more effective, efficient and meaningful management of their knowledge landscape. To succeed in this, the Enterprise Attention Management System utilized the power of semantic technologies to cope with the information, the context and preference dimensions of PAs’ requirements. The above axes were instantiated in three components of the EAMS, namely the Content Management System (CMS), the GroupWare System (GWS) and the Change Notification System (CNS).

The **content management system (CMS)** enables storage and provision of content by:
- supporting the annotation of content with metadata as well as relations between different content items;
- semi-automatic population of metadata using text mining methods; and
- realizing semantics-based search that retrieves content based on both full-text and metadata.

The **groupware system (GWS)** supports information sharing and creation by:
- supporting the annotation of the interactions between users;
- enabling identification of communities of practice from mining their interactions and their specific vocabularies by social tagging; and
- searching for experts based on their profiles as these are created explicitly and implicitly during their interaction with the system.

The **Change Notification System (CNS)** is a server-based change detection and notification system that monitors changes in the environment which is external to the system. It can be configured to monitor web pages, RSS feeds and contents of file servers. Users and the administrator can create new notification queries for finding and displaying interesting changes. When creating a query, users can define if they want to monitor a web page for any change or specific changes in links, words or a selected section specified by a regular expression. Moreover, users can select a topic of interest from a list. If new web page content is added that is related to the topic or an RSS feed update contains information related to the topic, then the user is notified.
To conclude, the produced Enterprise Attention Management System comprises an engineering effort to transform the aforementioned attention management framework in technically and organizationally meaningful IT functions.

6.2 The Technical architecture

The EAMS prototype is based on J2EE and Java Portlets following a three-tiered architecture (Figure 5). The presentation tier contains Portlets, JavaServer Pages (JSPs) and an auxiliary Servlet. Portlets call business methods on the Enterprise Java Beans (EJBs), pre-process the results and pass them to the JSP pages. The JSPs contain Hypertext Markup Language (HTML) fragments as well as placeholders for dynamic content (such as the results passed from the Portlets). The auxiliary Servlet is used for initializing the connection to the KAON2 ontology management system part of the integration tier.

The business tier consists mostly of EJBs, which provide the business logic and communicate with the components of the integration tier that comprise a third-party CMS component (Daisy) and GWS component (Coefficient) as well the Preference Framework. The interface to these components is represented using EJBs which all use the Kaon2DAO in order to access the ontologies: the CMSBean and GWSBean enhance the CMS and GWS with semantic meta-data, the AMSBean manages the preference rules. KAON2 stores the semantic meta-data for these entities with ontologies and provides the facilities for querying them using SPARQL. The KAON2 reasoner is used for evaluating the user’s preference rules. The integration tier contains also a MySQL relational database, which stores CMS- and GWS-related content, such as forums, discussions, documents etc.

Figure 5. EAMS Technical Architecture

From a conceptual point of view, we have ensured that all components are based on a common ontological model for representing information resources and changes as well as context, roles and preferences. From the technical point of view we ensured standards-based interoperability by using state-of-the-art Semantic Web technologies, such as SWRL and SPARQL.

7. Conclusion

In this paper we presented a novel approach for managing attention in an enterprise context by realising the idea of having a reactive system that does not only alert users that something has changed, but also supports the user to react properly on that change. In a nutshell, the corresponding system is an ontology-based platform that captures
changes in internal and external information sources, observes user context and evaluates user attentional preferences represented in the form of ECA rules.

Future work will be towards further refinement of ECA rules for preference description and automatic learning of preferences from usage data using machine learning techniques. Considering the existence of hierarchical relations that exist in the Log Ontology which models interactions (events) that occur in the system, we can further utilize Generalized Association Rules in order to mine and discover interesting patterns in the system’s usage. The use of taxonomy by the Generalized Association Rules comprises a major improvement compared to standard association rules.

Finally, a strong focus towards refining and enhancing the methodology will be given, bearing in mind the imperative need of providing a clear methodology in one comprehensive document – for example as a handbook – in order to help potential users identify main problems and opportunities in the process of implementation.

References


Abstract: Knowledge Management (KM) has come to be regarded as an important activity in today’s organizations. Technology plays a crucial role in KM of facilitating knowledge flow through the knowledge life cycle. This role is mostly realized by the implementation of a Knowledge Management System. However, the development of these systems is still haphazard, as organizations implement systems that are not guaranteed to enhance knowledge processing activities, and which may not be knowledge management systems at all. Most of these systems are groups of technologies brought together, with no theoretic and/or conceptual framework to justify the way in which they are integrated. The various forms of knowledge are not handled appropriately, as there is no distinction between the processes involved in managing these knowledge forms in the systems. Hence knowledge distribution and use is not done consistently, efficiently, and effectively. There is therefore a need for a reference point from a technical perspective, emanating from a theoretic and conceptual framework that will guide in developing these systems. This reference point is best provided in the form of a generic knowledge management system architecture, which will guide all technological implementations for KM. This paper seeks to outline the need for a generic knowledge management system and what is to be taken into consideration in terms of technical as well as organizational objectives when developing it. The paper also presents some of the quality attributes to be considered in developing the architecture, and the technologies that can be incorporated.

Keywords: Knowledge management systems, generic architectures, system models, technology models

1. Introduction

Knowledge Management (KM), a discipline viewed by many academics as cross-functional and multi-faceted (Lee H, Choi B, 2003), has come to be regarded as the driving force behind some of the world’s largest and most successful organizations. Although it is still a young field (Kumar S, Gupta S, 2012) (G, Kebede, 2010), it is increasingly becoming important to corporate competitiveness (Sucahyo R, Eriyatno, Suroso I A, Affandi M. J, 2013). All these disciplines that make up KM can be classified under the four pillars of KM, namely Leadership, Organization, Learning and Technology (Stankosky M.A., 2005). KM is expected to lead to fundamentally new and never before possible ways of knowledge processing through the Knowledge Life Cycle (KLC) and leveraging knowledge about people and the organization (Galandere-Zile I, Vinogradova V, 2005) while having the ability to move knowledge in all directions throughout an organization (Bixler H. C, 2005). The adoption of KM has been necessitated by drivers that include (Bixler H. C, 2005):

- technological advances which have improved knowledge processing and storage,
- clients’ increased expectations for quality products,
- the need for continuous innovation due to increased competition for market share.

Organizational elements such as strategy, culture, processes and measurement are regarded as important for a successful implementation of a KM solution (CEN, 2004). Technology, which is equally important as the other stated factors, makes up a part of a KM initiative (Kumar S, Gupta S, 2012). Technology is primarily viewed as an enabler in KM solutions (Stankosky M. A, 2005), it enables knowledge sharing, integration, and collaboration (Mickey R. V., 2005) through the implementation of an organization-wide knowledge management system (KMS). Combined with organizational processes, it can bring people together for knowledge creation (Lindvall M, Rus I, Sinha S S, 2002). A KMS is an IT system that supports processes and activities encompassed in the knowledge life cycle; these processes are basically dependent on the assistance of IT (Tseng S, 2008). Since they are IT systems, KMSs are thus key enablers for a KM initiative (Huang C, Lin T), which support the codification approach, personalization approach, or a hybrid of the two. The development of these systems has evolved from the initial codification-intensive approach, to including more technologies to support knowledge personalization (Matayong S, Mahmood A K, 2013). Codification approach deals mainly with explicit knowledge and how it can be stored and transferred. The personalization approach is largely concerned with tacit knowledge and enhancing interactions between humans for tacit knowledge transfer. Effective use of a KMS could lead to achieving enhanced effectiveness, facilitate innovation and improve efficiency and competence, as the system will provide a pipeline for the flow of knowledge across the organization (Heejun, P, 2005).
In like manner, these systems create the bridge between the social structures of an organization and the IT, allowing for a synergistic relationship (Kumar S, Gupta S, 2012). More so, KMSs create an access channel that facilitates human interactions and assists in locating experts for direct transfer of tacit knowledge (CEN, 2004) (Kumar S, Gupta S, 2012) for knowledge production, effective decision making and problem solving (Kebede G, 2010).

Defining a KMS is made difficult by the different interpretations in various scientific communities (Lindner F, Wald A, 2011). A KMS is defined in numerous ways, including but not limited to:

- It as an integrated multifunctional system that can support all main knowledge management and knowledge processing activities found under the knowledge life cycle (Sultan A. O, 2003).
- It can be thought of as a network of contextual data and documents linked to directories of people and skills and providing intelligence to analyze these documents, links, employees’ interests and behavior, as well as advanced functions for knowledge sharing and collaboration (Galandere-Zile, Vinogradova V, 2005).

These definitions show that KMSs are interpreted differently from one academic to another, with practitioners also adding in their own voices into the debate. But fundamentally, whatever the definition and/or structure of a specific KMS, they are all responsible for the processing, production and integration of knowledge throughout the knowledge life cycle (Firestone J, 2001). In this regard, a poorly developed KMS leads to poor knowledge processing activities, which inadvertently lead to poor performance by the organization at large. To counter the development of inappropriate KMSs, the study of KMS’ architectures has to be undertaken since the latter is the foundation of any software system (Clements P, Kazman R, Klein M, 2001) and this architecture will form the basis upon which most, if not all, KMSs will be developed.

Clements et. al, (Clements P, Bachmann F, et. al, 2011) define software architecture as a “set of structures needed to reason about the system, which comprises of software elements, relations among them, and properties of both”. A software architecture is the most abstract depiction of a system (Clements P, Kazman R, Klein M, 2001), which provides the structural foundation of the system, to ascertain that it meets system requirements and has the quality attributes desired to meet organizational goals (Kazman R, Klein M, Clements P, 1999). There are various types of software architectures being implemented today, with the commonly used ones being, among others: Software Oriented Architecture (SOA), client-server, and web services. These modern architectures can be considered in the development of knowledge management system architectures, to increase interoperability of the knowledge management systems with modern systems. In essence, a software architecture is the blue print of the system. KMSs need this blueprint. They have been developed without a main point of reference and the various definitions and lack of theoretic foundation of what a KMS should be like has made it difficult to come up with this reference point. This shows the need for coming up with a reference architecture for KMS, from a technological perspective, to aid both academics and practitioners alike in developing and working with KMSs.

Questions have been raised over the effectiveness of Information Technology (IT) in increasing knowledge transfer between individuals and/or groups (Maryam A, Leidner D E, 2001). It is the opinion of the authors that IT provides a technical foundation that facilities the implementation of KMS. It provides a means by which a strong theoretical foundation for KM can be implemented, as it participates in all stages of the knowledge life cycle. The study and development of a generic KMS architecture can lead to the creation of a tried and tested basis on which information technology can be confidently used for KM.

2. Components of a KMS Architecture

Developing an effective KMS for a comprehensive approach to knowledge processing requires the integration of many technologies (Galandere-Zile I, Vinogradova V, 2005), since no single technology can do it alone. This means that those tasked with developing these systems have a good understanding of how these technologies work together, and appreciate that developing the system is not an easy undertaking (Galandere-Zile I, Vinogradova V, 2005). The dynamics of the market for knowledge management make a classification of KMS preliminary and difficult (Galandere-Zile I, Vinogradova V, 2005), but knowledge management technologies can be described under three levels (Gallupe B, 2001):

- Level 1 is the knowledge management tools, which provide the fundamental building blocks for a knowledge management system.
- Level 2 are knowledge management system generators that can be used to build the KMS’ subsystems.
- Level 3 are the specific knowledge management systems that have been built.
The technologies that were found in literature studies that are used in coming up with a KMS include (Bixler H. C, 2005) (Kevin O, 2005):

- enterprise collaboration system,
- knowledge database,
- business development knowledge and information systems,
- the internet, intranet and extranet,
- data warehousing,
- document/content management,
- decision-support systems,
- knowledge agents (people, computers),
- electronic performance support systems,
- artificial intelligence,
- electronic meeting systems,
- groupware to support enterprise collaboration,
- Knowledge-based computer-aided design tools for developing new products.

Knowledge Management Applications (KMAs) can also be developed and used, whose intention would solely be for knowledge processing, with attributes that are tailor made to suit their operating environment, but having a common back-end interface with other KMAs (Personnel, United States Office of, 2011) for easy maintenance as well as for inter-operability of the various KMAs of the KMS.

It is also important to use and experiment with the latest multimedia technologies to capture knowledge, especially tacit knowledge (Schubert D, Romberg O, Kurowski S, Gurtuna , Prévoit A), as such technologies have the capabilities of handling knowledge in many forms from various media, which eliminates the need for knowledge conversions. However, it should be noted that a KMS should not be developed on the basis of having the best leading-edge technologies and information systems because this does not guarantee use and effectiveness (Bixler H. C, 2005). Instead, the technologies that are used for a KM initiative should be supported by a KM framework that governs the whole KM initiative in the organization (Bixler H. C, 2005).

The technological tools used for KM are meant to support the interaction and collaboration of knowledge workers (Heejun P, 2005) and to achieve this they should provide a good conceptual basis, go through practical testing and should be well-adapted for the various business environments they operate in (Agreement, CEN Workshop, 2004). Their integration into a KMS should provide value to the organization (Bixler H. C, 2005):

- Through knowledge distribution to those who need it for improved performance and problem solving.
- By enhancing innovation through the improvement of knowledge creation processes and product development support.
- Through continuous improvement of products and processes.
- By protecting knowledge from loss through worker turnover and/or attrition (Heavin C, Frederic A, 2012).

It is difficult to draw the line between information systems’ technology and tools for KM as the boundary is fuzzy (Lindvall M, Rus I, Sinha S S, 2002). Information management tools are a subset of knowledge management tools (Kebede G, 2010), as knowledge builds on top of information. However, there is still need to differentiate between knowledge management tools and information management tools, as some of the technologies classified as KM technologies are not necessarily such. For instance, vendors tend to describe search and retrieval functions of their systems as knowledge capabilities, creating the deception of knowledge management, use and retrieval (Firestone J, McElroy M W, 2005). Knowledge management tools are capable of handling the context and richness of the information and not just the information itself (Gallupe B, 2001). If a technology merely handles information without having some form of meta-claim to help in contextualizing it, is incapable of differentiating between information and knowledge and/or does not enhance knowledge sharing, then it is an information management tool (Firestone J, McElroy M W, 2005).
Kebede (Kebede G, 2010) gives a detailed analysis of the knowledge hierarchy, which is a continuum from data to information to knowledge, following each other in that order. Through literature research, Kebede shows the differences among data, information and knowledge as follows (Kebede G, 2010):

- The relationship between the three is hierarchical, with data being elementary and/or crude facts, information being data that has meaning attached to it, and knowledge being information coupled with experiences, insights, beliefs and expertise.
- The manifestations of the three is logically incremental with data becoming information, and information becoming knowledge. The higher level manifestation is also inclusive of the one below it, hence knowledge is inclusive of both data and information.
- Data and information require knowledge for their interpretation and understanding.
- It has to be noted that information and data management are important pillars for KM.

This analysis helps in breaking down the differences and natures of the three elements (data, information, knowledge) that make up the knowledge hierarchy.

3. Managing Different Forms of Knowledge

The content to be managed by a KMS is very important (Galandere-Zile I, Vinogradova V, 2005) and should be taken into consideration when developing such a system. Knowledge, the content of a KMS, is categorized into three types: explicit, tacit, embedded [14]. Explicit knowledge is that which can be codified and stored in databases to become organizational knowledge; tacit knowledge is that knowledge that cannot be stored in repositories, but exists in the brains of knowledge workers (Lindner F, Wald A, 2011) and embedded knowledge is that which is locked in processes, products and structures and is difficult to understand and modify. One can argue that embedded knowledge is simply a subset of tacit knowledge, hence setting tacit and explicit knowledge as the main categories of knowledge. While explicit knowledge has been the main focus of information systems in organizations, KMSs seek to give equal affordance to all types of knowledge. However, a bias towards tacit knowledge management should exist to allow for the creation of a balance in the methods and technologies used in managing the different forms of knowledge.

Many authors view IT’s role in KM as being largely related with knowledge combination (Lee H, Choi B, 2003), that is, the conversion of knowledge from explicit to explicit. However, with the advancement in information technology and data processing technologies (Tseng S, 2008), IT can now be involved in the socialization, externalization as well as internalization stages of the SECI model as given by Nonaka and Takeuchi (Haslinda A, Sarinah A, 2009) (Kebede G, 2010). Figure 1 shows a few examples of technologies that can be used for KM at each stage of knowledge transformation in the SECI model, illustrating how technology has gone beyond merely facilitating knowledge combination, to encompassing the whole SECI model. This means that the use of technology for KM can now cut across many forms of communication and knowledge distribution that were once difficult to use and implement from a technological perspective. IT is also an integral part of knowledge codification as it provides fast feedback for explicit knowledge and it is not limited to transfer of explicit knowledge only, but is also integral in knowledge creation (Lee H, Choi B, 2003).

To give a practical view to the management of knowledge, the knowledge should be viewed from its nature, which includes dimensions such as (Supyuenyong V, Islam N, 2006):

- Characteristics - that is, explicit or tacit
- Location – is it individual or collective knowledge
- Source – is it internal or external
- Knowledge Transfer – Whether it can be easily moved from one device or location to another.

Managing tacit knowledge is becoming more and more important because of the following reasons, among others (Nabeth T, Angehrn A, Roda C, 2003):

- Organizations are continuously changing and time for knowledge codification is becoming scant. More so, explicit knowledge is becoming obsolete too rapidly to justify the need for knowledge codification.
- Some of the knowledge is difficult to codify, especially that involving intangible factors such as insights, beliefs, perspectives and emotions.
- Knowledge codification may face resistance from the people themselves, who may consider their knowledge as their asset to guarantee their position in the organization.
- Tacit knowledge is important for the learning organization since it is part of a spiral-type interaction between tacit and codified knowledge.
Due to various barriers in the transfer of tacit knowledge, such as lack of time and resistance from workers to share knowledge (Schubert D, Romberg O, Kurowski S, Gurtuna, Prévot A), there is need to embed the components that make up the KMS directly into the day-to-day activities of the knowledge workers. It has to be noted that some information loss occurs as a result of conversion of tacit knowledge into explicit knowledge in IT systems (Agreement, CEN Workshop, 2004). This is inevitable as some tacit elements of knowledge cannot be made explicit (that is, codified) and conversely.

The differences between information and knowledge have to be well articulated to avoid having KM initiatives that are just but information management solutions. The distinction between the two cannot be obtained by using a purely formal (scientific) approach, as is the case in computer science (Ulrich F, 2001). However, the complete exclusion of information in KM is not possible, as information adds value to knowledge and conversely, therefore a KMS should support the integration of knowledge with information (Ulrich F, 2001). A KMS should also provide various perspectives on the knowledge it stores, with different levels of details and also using corresponding languages and abstractions. This enables it to support different users and tasks (Ulrich F, 2001).

Choosing the right KM technologies for given business contexts and using them effectively are key factors in getting a higher return on investment, and this can be achieved by reviewing the specific roles of each of the technologies (Heejun P, 2005). However, too much emphasis on technology while overlooking other important areas such as leadership, and organizational structure can lead to a failed KM initiative (Heejun P, 2005). This is because other areas such as social structures of an organization have an impact on technology selection and hence should be considered in setting up a KMS (Heejun P, 2005) because technology should enhance knowledge sharing, capture of explicit knowledge within and outside the organization (Vittal A, 2005) and should provide an environment for continuous process and product improvement (Bixler H. C, 2005). KMSs are more successful if mediated by human behavior.
Embedding KM activities and/or processes into the technologies used by workers to do their jobs is an approach that offers the most potential for creating a knowledge productive environment, as KM will no longer be a separate activity, but one that does not require additional time and motivation, other than that already required to do a particular job (Firestone J, McElroy M W, 2005). This in essence suggests that a KMS should be built upon existing job activities and structure while at the same time highlighting to stakeholders the role of knowledge in the processes they are a part of (CEN, 2004).

Technology should not reduce the richness as well as overshadow the role of and need for personal interactions of knowledge workers, as this is one of the best learning methods (CEN, 2004). Instead, it should rather facilitate such interactions and add ancillary services that knowledge workers can use during these and other related interactions.

5. The Knowledge Life Cycle, Processes and the KMS

The main goal of KM is to enhance knowledge processing in an organization by leveraging knowledge production activities already in place through implementing policies and infrastructure (Firestone J, McElroy M W, 2005), which include the use of technologies via a KMS. Through KM, information technology is viewed as of particular importance in controlling processes of change and development in an organization (Allahawiah S, Al-Mobaideen H, Nawaiseh K, 2013). KMSs, through knowledge processing, can enhance organizational processes and activities (Kumara A, Guptab P C, 2012), leading to a trickle-down effect, which would be seen through changes in worker effectiveness, the bottom line, and knowledge workers’ relationships (Firestone J, McElroy M W, 2005).

Knowledge processing can be broadly divided into two forms – distributive and collaborative, with each having its own set of objectives in supporting various knowledge processes (Heejun P, 2005), which are in turn encompassed under the knowledge life cycle. Technologies for distributive processing mainly focus on information storage and retrieval of explicit knowledge, while those concerned with collaborative processing facilitate human interactions which involve tacit knowledge (Heejun P, 2005). The knowledge activities to be supported by a KMS include planning, scheduling, product and process design, decision making, product and service optimizations, data interpretation, among others (Bixler H.C, 2005).

The knowledge life cycle (KLC) includes the following knowledge flow paths, namely: (Rahman S A, Bhardwaj A, Pathat M, 2011) (Lindvall M, Rus I, Sinha S S, 2002): creation/acquisition, storage/formalization, organization, transfer, use, and creation/acquisition again. A KMS should support knowledge flow through the KLC (Lindvall M, Rus I, Sinha S S, 2002), as the latter embodies activities that govern knowledge processes. Information technology competency has a direct effect on the processes of knowledge management (Hawajreh K M, Sharabati A A, 2012) hence a KMS should support knowledge work processes and not the other way round. This is because KMSs should help in decision making concerning the work activities of its users (Galandere-Zile I, Vinogradova V, 2005), thus ascertaining the role of IT as an enabler, through the use of a KMS. Figure 2 illustrates how technology, through a KMS, facilitates knowledge processing from an entity (human being, computer system, department etc.) and into and out of the knowledge life cycle. The connection between the entity and the knowledge processes is made possible through the use of technology, allowing for knowledge to be processed at any stage in the knowledge life cycle that the entity so desires.
6. Shortcomings of KM Research in Developing KMSs

While most organizations are looking for a well-structured, consistent approach to KM for it to be meaningfully and successfully implemented (Rahman S A, Bhardwaj A, Pathat M, 2011), the discipline still lacks research, study and clarity in some areas, for instance, knowledge creation systems (Gallupe B, 2001), thus hampering the development of effective KMSs that can interact well with the other enablers to produce an effective KM solution for the organization. This highlights the need for a formal approach to KM (Heavin C, Frederic A, 2012). This section outlines some of those areas that are still lagging behind in the study of technologies for KM, how they affect the development of KMSs and how they can be enhanced to assist in coming up with a generic KMS architecture.

The study of generic KMS architectures has been necessitated by a need to come up with a conceptual and theoretical construct for technology’s role in KM (Dwivedimy K, Venkitachalam K, Sharif A M, Al-Karaghouli W, Weerakkody V, 2011), to concretize the findings of anecdotal data, case studies and stories (Mickey R.V., 2005), and to eliminate the structural and conceptual vacuum that exists in the field. Despite a number of studies being done on KMSs, there seems to be lack of a structured approach to the growth of the knowledge body in the area of KMSs and a framework guiding KMS research is non-evident; although frameworks, models and theories are being developed but struggling to gain acceptance (Gallupe B, 2001). There is also a lack of research looking directly at the impact of information technology on KM processes (Allahawiah S, Al-Mobaideen H, Nawaiseh K, 2013). This may be due to a deficiency in studies taking a broader view to include the whole process of KM (Matayong S, Mahmood A K, 2013). A lot of research on KMSs focuses on examining predictable factors that are pre-determined, resulting in scant studies on KM issues concerned with exploring how the factors affect the development of theoretical models for KM (Matayong S, Mahmood A K, 2013). There is therefore a need to look into the theoretic aspects that will create the fundamental basis to justify the use of IT for KM in whatever way deemed fit for the organization, as well as to create a method by which technologies for a KM initiative are chosen. The measurement of knowledge itself is still in its infancy, with an expectation to improve as the discipline of KM matures (Kumar S, Gupta S, 2012).

In addition, the dynamics of the market for knowledge management systems have made it difficult to present a typical architecture of KMSs and/or to provide a comprehensive list of its functions (Galandere-Zile I, Vinogradova V, 2005).
To avoid mediocre and inappropriate systems that may not be KMSs at all the scientific community is tasked with producing a framework by which a KMS can be developed, with evidence that it will perform as expected once implemented. The market will then be guided by the framework, which will form a reference point to justify the structure of the KMS, hence increasing the success rate of the system’s implementation. This therefore creates an environment where science provides the basis upon which the market’s needs in terms of a KMS are met. The generic KMS architecture is meant to be part of this framework, which seeks to eliminate the morass surrounding the suitability and worth of a KMS’ implementation.

More so, very few studies that investigate KMSs use quantitative techniques such as surveys or field experiments as most use case studies or conceptual arguments to make their points (Gallupe B, 2001). This has been as a result of lack of a clear cut definition on what a KMS is, hence conducting such empirical studies from a quantitative perspective has been a challenge. Due to a lack of a reference point on which all studies can be evaluated and compared, quantitative research is still not deterministic of success or failure, but merely shows numbers concerned with a KMS implementation. A generic KMS architecture aims to provide this reference point that will form the basis for any study and or development of such a system. However, this does not undermine the value of qualitative analysis of KMSs, which will continue to play a critical role in the development of KMSs. It has been used extensively in measuring KMS’ effectiveness in the form of soft measures and will continue to be important as KM is an inter-disciplinary field, with various perspectives requiring varying forms of analysis.

There is also no consensus on how a knowledge management system should look like and how they should be classified or categorized, and there is no clear cut direction in which the corresponding research should be directed (Ulrich F, 2001). This lack of a classification criteria for KMSs has resulted in technological tools being taken as universally applicable to any situation and environment (Birkinshaw J, Sheehan T, 2002), making it difficult to develop contextually appropriate systems using the right technological tools. Little research has also been done on tools and technologies that focus on new or unique problems as there is need for KMS to not only identify and work with existing problems but to identify new problems even before they arise (Gallupe B, 2001).

Current knowledge management systems have also been found to be too narrow as they cater for one type of user using one method of knowledge representation, and they require long learning curves, hence difficult to use (Sultan A. O, 2003). This may have been caused by the large amount of research done on KMSs focusing on knowledge codification and storage (Gallupe B, 2001), leaving the other areas of the knowledge life cycle under studied hence poising a great challenge for the analysis of KMSs. This issue can be addressed through multi-perspective modelling, which enables the modelling of particular aspects of knowledge through the use of a number of techniques that model specific aspects most appropriately, as organizational knowledge is quite complex and no single method can model all of it accurately (Abdullah M S, Benest I, Evans A, Kimble C, 2002).

More so, no system operates independent of others and a KMS is no exception. However, integration with other technological systems in the organization is one area which is still being performed poorly (Durant-Law G, 2003). To improve on integration of technologies in forming a KMS, the architecture by which the system is developed has to be carefully developed, and with no basis upon which such an architecture is developed, there exists the chance for a poorly integrated system to be developed. This necessitates the study of the inter-operability of technologies for a KMS, which is best done from an architectural perspective. In essence, this makes the development of a generic KMS architecture a necessity, as it will demonstrate how technologies should be fundamentally integrated to make a KMS.

To address these issues, there is need for collaborative work among researchers, as there are many non-collaborative efforts with regards to KMS in particular (Dwivedimy K, Venkitachalam K, Sharif A M, Al-Karaghouli W, Weerakkody V, 2011). Figure 3 shows how the generic knowledge management architecture fits into the development hierarchy of a KMS. A complete picture of the KM initiative has to be obtained from research, which leads to the development of a theoretical framework on which the generic knowledge management architecture will be built. The generic knowledge management architecture then becomes the reference point from which KMSs are developed and evaluated, hence creating a common point from which to determine the characteristics as well as the effectiveness of a KMS implementation.
7. **Generic Knowledge Management System Architecture (GKMSA)**

The first design artifact that addresses quality attributes of a system is the architecture (Bahsoon R, Emmerich W, 2003). The KMS architecture should exhibit certain qualities that renders it able to deliver its expected objectives. Quality attributes can be in the system realm and/or the software realm and how they will be met has to be well illustrated in the architecture developed. The success of a KMS is partially depended on the extent of use, which itself is tied to the quality of the system, the quality of the information and the usefulness of the system in carrying out knowledge-related activities (Maryam A, Leidner D E, 2001). A system that is of low quality in terms of its construction as well as implementation will not produce optimum performance that can be beneficial to the user. In this case, a set of technical requirements and benchmarks can be produced that will be used in ascertaining the efficiency and effectiveness of the system. By developing a GKMSA, these benchmarks which are the quality attributes and how they are met in a software architecture of a KMS, can then be applied by any organization, in any environment, to aid in implementation of an optimum KMS solution.

8. **Characteristics/Quality Attributes of a KMS**

KMS requirements can only be gathered if we know how a KMS should be and how the initiative will be implemented (Sultan A. O, 2003). There may be need for a customized KMS for an organization if it fears that the use of a standard market solution threatens the sustainability of its core competences (Galandere-Zile I, Vinogradova V, 2005). The following section details the requirements and/or quality attributes of a KMS that have been found from literature studies. They are all not meant to work together in one system but are provided here together since the goal is to come up with a GKMSA.

A successful knowledge management architecture must have the quality attributes of availability, accuracy (in retrieval), effectiveness (useful and correct) and accessibility (knowledge should always be available) (Rahman S A, Bhardwaj A, Pathat M, 2011). Alkadi (Sultan A. O, 2003) lists the characteristics of an effective KMS as follows:

- Scalable: should manage to support a large number of users;
- Extensible: expands per organizational needs;
- Secure: to protect the organization’s intellectual capital;
- Collaborative: should support the interactions of the various organizational units across the organization;
- Complex querying capabilities;
- Flexible: should be able to handle all possible forms of knowledge used and required by the organization, and that include different subjects, structures and media.
- Heuristic: The KMS should learn about its users and the knowledge it possesses as it is used and its abilities to provide users with knowledge should improve (Sultan A. O, 2003).

A KMS should support the dissemination of knowledge by allowing for users to know when information they might be interested in becomes available (Ulrich F, 2001). Lindgren et.al (Lindgren R, Hardless C, Pessi K, Nuldén U, 2002) conducted literature review and a field study research of KMSs and found that KMS evolution is a key quality attribute for a successful KMS implementation and use, and more attention and research should be done into KMS evolution.
Knowledge Management Systems with a deeper understanding of the users through user identity personalization can become virtual companions of users, rather than being mere tools (Nabeth T, Angehrn A, Roda C, 2003). This can be achieved by a system that anticipates user needs, proposes knowledge objects that the user might not be aware of, suggests and provides solutions, advises and creates opportunities for knowledge creation through learning (Nabeth T, Angehrn A, Roda C, 2003).


Acceptance of IT implementations for KM plays an important role in ensuring their use and success (CEN, 2004), as IT is only one aspect of a KM initiative (Kumar S, Gupta S, 2012). IT alone is not adequate for a comprehensive and successful KM initiative (Lindner F, Wald A, 2011) as it has to work with other factors such as culture, motivation, and morale. It is therefore important to involve all stakeholders in the development process of the KMS architecture, to engage them in the design so as to have their buy-in as well as their needs catered for from the beginning (Heejun P, 2005) (Allahawiah S, Al-Mobaideen H, Nawaiseh K, 2013). This can be done through software architecture development methods such as the Architecture Trade-Off Analysis Method (ATAM) (Wood M, 2003). ATAM takes the viewpoints of all stakeholders in the development process of an architecture, taking into consideration their needs and concerns. The stakeholders include business management team, system users, customers, consultants among others, depending on the nature of the organization. This method allows for trade-offs to be made when the requirements of different stakeholders conflict, resulting in a system that satisfies the needs of the stakeholders. Since it is not expected that everyone in the organization will adapt to KM initiatives instantaneously, the KMS can be introduced gradually, concentrating on well-focused groups and manageable groups and/or departments, hence necessitating incremental development of the system (Agreement, CEN Workshop, 2004). At each incremental step of development, an iterative development process should be adopted, going through requirements, architecting and validation repeatedly (Bahsoon R, Emmerich W, 2003). This gradual, incremental development of the system is best aided by the adoption of enterprise architecture techniques, which allow for the analysis of the system to be adopted in relation to the business strategy as well as the currently existing systems in the organization. The TOGAF standard, and similar standards can be used to guide this process, as it gives a high level framework for the development of architectures focusing on business, applications, data, and technology. This avoids dissociating the eventual KMS from the overall organizational strategy and from being incompatible with the rest of the systems in production. With enterprise architectural methods, the essential components of the KMS can be deployed first to aid business goals while at the same time, the KMS’s architecture is maintained to allow for the growth of the KMS in line with the tailored KMS architecture for the organization, which will also be in tandem with the GKMSA.

Implementing a successful KMS may seem difficult, but some experts believe that most of the infrastructure needed for its implementation is already in place in an organization, for instance, the existing technological infrastructure of networks, computers, servers, information systems, etc. (Galandere-Zile I, Vinogradova V, 2005). Hence a realignment of those technologies may be what is required, saving on cost and time taken to implement the KMS (Galandere-Zile I, Vinogradova V, 2005). Hence the GKMSA to be developed will take into consideration the likely environments in which a KMS will be implemented, enabling the realignment of existing technological infrastructure aforementioned.

10. Evaluating the success of a KMS

Feedback and control aspects of KMSs are those processes that ensure the KMS is performing the knowledge management tasks as intended (Gallupe B, 2001). However, there is lack of an effective formal KM analysis technique, which has led to repeated failures in KM technological implementations (Aoyam K, Ugai T, Arima J, 2007). A GKMSA can be used to create the framework that can lead to the development of an analysis technique that can be used on most if not all KMSs. Measurement is one of the control aspects that can be used but it is among the least developed aspect of knowledge management, given the difficulties in coming up with the conceptual and theoretic framework which clearly define what KM is so as to know what and how to measure it (Andone I, 2009). Having standard metrics to evaluate KM initiatives will help in convincing management and users of the value of a KMS’ implementation (Bose R, 2004). To ensure the effectiveness of KMSs, the measurements procedures for KMS requirements should include, among others (Sultan A. O, 2003):

- Precision measurement—retrieval of relevant information.
- Recall measurement – retrieval of all relevant information in response to an inquiry.
- Specificity measurement – express information without limitations.
Heuristic measurement is also important, so as to determine whether the responses from the KMS are improving over time with respect to precision, recall and specificity. The KM impact areas can also be used to provide feedback by measuring the changes that occur to them to have an idea of the KMS' effectiveness. These impact areas include product/service innovation, organizational processes and integration of technologies organization-wide (Bixler H. C, 2005). Defining the quality attributes of the system and how they can be measured and then to apply them onto the generic KMS architecture so as to be applicable is imperative (Owlia S. M, 2010). The definition of these quality attributes can be done according to already set standards, such as the ISO 9126. The ISO 9126 standard creates a baseline on which quality attributes of a system can be determined as it provides an evaluation criteria that includes a focus on Functionality, Reliability, Usability, Efficiency, Maintainability and Portability. The GKMSA can be developed so as to produce KMSs that satisfy these quality attributes. This therefore means that the ISO 9126 standard can be used as a benchmark in the development of the GKMSA which would ensure that whichever KMS that will be developed from this architecture will at the very least provide an acceptable level of service. More so, by adhering to this standard, the KMS would have been developed to cover the aforementioned six quality characteristics that are needed in a well-developed system.

Figure 4 summarizes the factors that have to be taken into consideration when coming up with the proposed GKMSA.

11. Conclusion

In this paper, the need for a generic KMS architecture was outlined. This is as a result of a lack of a theoretic and/or conceptual basis upon which KMSs are built and implemented. Various technologies can be integrated to form a KMS and this integration has to be managed. The various forms of knowledge have to be carefully handled separately while at the same time supporting effective knowledge conversion. The environment in which the systems operate is important, as it affects implementation. The knowledge processing activities affect the development of a generic architecture for KMSs, hence how they are incorporated into the knowledge life cycle is taken note of. The shortcomings in the research field for KMSs were also looked at and how they can be taken care of to provide a solid foundation upon which research into KMSs can be conducted. Finally, a look at the characteristics and/or quality attributes of the generic KMS architecture was taken, together with the possible ways by which the system’s performance can be evaluated. The research into the development of a generic KMS architecture is on-going, and this paper is part of that research.
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