The early warning concept in the system supporting knowledge management in polish machine-building industry enterprises

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PREFACE

It is a delight to be able to chair the inaugural OR Society Knowledge and Information Management Conference, KIM20213, and to be part of the editorial team for these proceedings. The Conference builds on its spiritual predecessor, KMAC, and benefitted by having the previous editor of Knowledge Management Research and Practice (KMRP), Professor John Edwards, chair a panel and discussion as part of the KMRP 10^{th} Anniversary Celebrations.

The Conference is lucky to have attracted three extremely knowledgeable and talented plenary speakers:

- Professor John Edwards, Executive Dean, Aston Business School and Editor of Knowledge Management Research and Practice (KMRP).
- Trevor Howes, Director, BRM Fusion Ltd.
- Dr. Jay Liebowitz, Orkand Endowed Chair in Management and Technology, The Graduate School, University of Maryland University College.

The Conference provides a superb opportunity for people from all industry sectors to meet and exchange views, to build strong relationships and on-going dialogues as well as facilitating interested parties to showcase their work. Knowledge management has become a key process in understanding organisations and their use of resources when considering goods and services, to improve quality. For large organisations, knowledge management may be seen as an intra-organisation activity, but sustaining quality for small-to-medium enterprises may require inter-organisational cooperation. The different quality and knowledge management issues faced by different sectors and differently sized organisations, and how these are addressed in practice and in theory, will help to make this a very interesting conference.

This conference has attracted papers from all over the world, from countries as far as Venezuela, Taiwan, Hong Kong, India, Gambia, Pakistan, Mexico, Russia, Thailand and the European Union. Our team of international experts from academia and industry reviewed the papers and final admissions for the conference proceedings were received on the 12th April 2013. The result is a set of Proceedings that covers a vast range of different areas of knowledge management.

To try to summarise may do injustice to the authors, but the interested reader may like a synopsis of the coverage. This included: Decision Making, KM Frameworks, KM Systems, Knowledge Maps, Knowledge Sharing, Leadership, Organisational Learning, Quality Management and Supply Chain Management.

The Conference and these Proceedings are the result of a lot of hard work on the part of the referees, the co-editor of the Proceedings, Rochelle Sassman, and the Conference Manager, Hilary Wilkes. I thank them heartily for their valuable work.

Dr Brian Lehaney

Quality Assurance Agency for Higher Education

Conference Chair

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A Multiple-Case Study in a Stochastic Demand Industry to Sustain Autopoietic Property of Knowledge Agent

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Abstract

Knowledge agent (KA) is theorised as an autopoietic self-living system that the learning group can self-produce its components with self-referential ability to sustain the learning role in order to enable the organisation learn for better. A multiple-case study in a stochastic demand industry is conducted to examine the sustainability of KA. Three types of learning groups are identified. They are: pseudo-, quasi- and proper KAs. Only the proper KA with complete boundary functions and double neighbourhood relation of the local and universal business unit holds autopoietic property. The findings demonstrate the self-producing characteristics of KA that sustains its cognitive capacity to generate new knowledge for continuously improving quality of operations outputs. The findings also explain why organisations do not learn. This paper illustrates a theoretical explanation of effective organisational learning. In practice, the findings explain how the organisation keeps its learning group generating quality impacts.

Keywords

autopoietic property, group workshops, knowledge agent, organisational learning, ontology, and self-living system.

Introduction

Knowledge in an organisation is defined as a mix of facts, organised or justified skills, experience, value judgments and beliefs with which to deal with collective problems or issues within the organisation. By acquiring knowledge, an organisation can generate the capacity to transform problems to solutions, transmit solutions to other parties, predict the outcomes of processes, make better decisions, and make sense of the signals from its environment (Chan et al, 2012). In order to enable organisations to learn, they need knowledge activists (Ichijo et al 1998, von Krogh et al 2000), namely knowledge agent (KA) which is defined as the simplest unitary entity composed of a group of members that activates knowledge processes. The Knowledge Agent Theory (KAT) conceptualises the ontology of KA as a living system with autopoietic characteristics which possesses self-consciousness of ability to change and self-correction capacity that improvement of operation performances quality can be continuously made (Chan et al 2009). The main feature of a KA entity is to maintain its identity and existence by producing self-components that constitute boundaries. This is an autopoietic system with structural autonomy of its boundary from its environment for future continuation. The boundary functions of being members of KA include: 1. Cognitive abilities to acquire; 2. Willingness to put forth effort on knowledge processes; and 3. Takes action to plan and implement knowledge processes to solve problems (Jonsson & Kalling 2007). To hold the members actually perform the role and carry out knowledge process for organisation, existing of neighbourhood relationship to share common goals and eliminate conflicts is important. In other words, the entity is a living system that self-produces its components in order to maintain an existence. KAT also provides an ontological explanation of self-organising system which supports organisation (Hasan 2008), collaboration in knowledge management and learning capacity with boundary functions (Addleson 2012, Dörfler 2010).

In this paper, we examine the essential feature of boundary and the process of sustaining the autonomy and autopoietic property of KAs in a stochastic demand industry. Consistent with KAT, the case study illustrates how a proper KA constitutes its boundary to sustain its role in carrying out group learning to generate knowledge for an organisation to better the quality of performance and why an improper KA fails to enable an organisation to learn. Practical suggestions to enhance the skills of those involved in knowledge processes are proposed.

Knowledge Agent Theory

A KA entity is a living system which possesses self-consciousness of changes ability and self-correction capacity that its sustainability can be made (Chan 2013). The theory of autopoiesis and its key concepts was developed by Maturana & Varela (1980, 1992). Autopoiesis is the centre of the constitutive dynamics of living systems with self-producing machines. The constitution of the living systems of KA entity is the components which have self-producing mechanism to produce the entity's components and its boundary. The self-producing outputs are simultaneously producer and products. The operation processes of autopoietic systems could also be said that they are circular systems. They are self-contained and self-maintaining dynamic systems of identity. With the self-referential and self-observing nature to support the existence and maintaining the stability of autopoietic operation system, KA entity is always produces and keeps the essential components running the operation systems and forming boundary to distinguish from its environment outside the learning group.

Self-producing

As said, the nature of KA entity is to maintain its living system identity for carrying out knowledge processes by continuously generating its own components. The outputs produced by the entity comprise two types: (i) knowledge which would be implemented to solve collective problems or change organisations for the better, and (ii) memories of experiences in relation to learning processes and applications of new knowledge. The type I outputs eventually become the inputs to operate the organisational business activities. They have positive impacts on organisations to generate quality knowledge for betterment. Type II outputs are the inputs for self-referential processes and circularly act in self-producing activities within the KA operating system after receiving the signal from the self-observing process. Type I outputs are the cognitive resources that make sense to the organisation environment in order to deal with the collective issues in organisations. Type II outputs become the cognitive abilities to support the continuation of the KA entity identity and cognitive evidence to examine the membership for boundary constitution.

In the event that the existing structure of its components may not be sufficient to hold an identity for learning, a signal will be given to the original components for gaining new cognitive resources. Otherwise, the entity will structurally couple with members outside the entity's boundaries to integrate the external members into the KA entity to sustain its role for learning. This circular process enables the KA to self-produce its components and constitute boundaries to hold its learning identity. The circular system gives the entity an important degree of independence or autonomy to act as a learning activist separate from its environment outside its boundaries so that the business functions of various sub-units within the organisation do not disturb the knowledge process of generating type I and type II outputs. Thus, KA recursively uses the learnt knowledge such as learning skills and useful knowledge or solutions to generate new meanings to things, which may include new goals, new learning skills, new applications of knowledge or new solutions, as inputs to forthcoming knowledge processes.

Self-referential

Autopoietic system is sufficient to characterise living system as simplest unity which is self-contained entity. Changes to the structure of components within the system undergoing a particular arrangement may be made in order to maintain its self-producing nature. All interactions within the system are determined on their own, through self-referencing activities. This self-referential behaviour allows the entity to remember its previous interactions in the knowledge process and makes records for justifications for producing components to sustain the KA identity. The purpose of self-referential activities of KA is to examine the conditions for sustaining a living system property being a KA and distinguish it from its environment for other business operations within organisation. The conditions for holding a living system property are basically refer to the maintenance of its boundaries and its self-producing mechanism, that is, its ability to develop components to construct the boundary as a KA. The ability to develop components of KA means that an entity has the capability to examine current cognitive resources and to give signals to the entity for taking forthcoming actions to acquire and implement new knowledge. The purpose of self-referencing behaviour is to hold the distinction of the entity functioning as KA, and avoid any confusion of operations done by KA and other subunits in the organisation.

Cognitive resources are collections of memory of information generated from previous experiences and the inventory of knowledge which are available to be retrieved for self-referential activities. Learning outcomes of what the KA has known before and after new knowledge or information is acquired for bettering business performance are typical cognitive resources. Some of them are the procedural knowledge generated from the memory of experience from the operation processes. The inventory of knowledge may be acquired internally and externally. Internally, they are the outputs of the knowledge process: procedural knowledge for operating cognitive processes by which to enhance and maintain learning capacity and; declarative and conditional knowledge holding a new meaning of the existing knowledge and of things happened or experienced. Externally, new knowledge is brought about by new members who are integrated into the entity after structural coupling. These cognitive resources are acquired after cognitive processes such as transformation, reduction, elaboration, and application for problem solving or decision making. They become the references for the entity to examine its sustainability being a KA. Those cognitive resources are the information from which the entity evaluates the likelihood of its current status maintaining the properties of being a KA.

KA is realised its functions in an organisation through a particular arrangement of components within the boundary to operate knowledge processes. The members of KA, through cognitive operation systems, generate new knowledge and experiences of learning. The former provides solutions to its organisation to cope with change. The latter gives evidence and reference to the agent to recognize, maintain and enhance the cognitive abilities of members in the KA set in order to keep its self-producing property. Self-referencing is therefore defined as a continuous process to distinguish the KA from its environment to avoid identity instability and at the same time, to examine the current components' structure in order to ensure the identity is kept from the triggers of its environment. The self-referencing process is to avoid entity disintegration. If there is any change of its components, this is determined by the entity purposively to retain its identity as a KA, and not as an adaptation of its environment. This self-referential behaviour retains previous interactions as cognitive resources allowing the entity to examine the need to produce new components for sustaining its KA identity. The outputs of self-referencing, therefore, are the inputs for self-observing (Bakken &, Hernes 2003).

Self-observing

The purposes of an autopoietic system are (1) to simplify a living system so that an entity can avoid a complex situation which would interfere with its operation systems, and (2) to stabilise the living system to self-produce its components triggered by the external environment. To ensure the distinction is not lost from its external environment and maintain its self-producing mechanism, the KA entity has a self-observing behaviour. The distinction as a separate entity in an autopoietic system guides the observations of the observed observer. That is, the entity observes itself within its boundary with its self-referential cognitive resources in a recursive manner to develop self-consciousness of its identity. Self-observing is therefore, a nervous system operation to detect any deficiency of the self-producing inputs which barricade the holding of the characteristics of being an autonomous living system to produce the components of the entity. The cognitive resources, which are outputs generated from self-referencing activities for self-observing, are bounded but unlimited. Through recursive interactions, the cognitive resources held in an entity may generate new meanings to the current KA to examine its sustainability to carry out the ability to find solutions for collective issues in the forthcoming knowledge process.

When the entity observes itself lack of sufficient conditions to maintain its identity with its current components, neighbourhood searching and confirmation within a convex region (Maturana & Varela 1980) will allow the commencement of integrating new members which may hold the needed cognitive resources, either from inside or outside the organization. This process is called structural coupling. The change of the structure of the components of KA is to keep the boundary properties for maintaining its identity to learn. As such, self-observing activities give signals to the KA entity for producing the necessary structure of components to maintain boundary properties. It is the only process in an autopoietic system that allows interaction between the members inside and outside the entity. The new meaning of the experiences and outcomes of the knowledge process are recursively applied to its own outputs and become the memory which is reused as input in self-referential activities. The self-referential activities give signals to the KA of the current available cognitive resources for learning. These signals then become the inputs for self-observing to ensure subsequent actions are taken when the current components are evaluated as insufficient to maintain the KA living system. Figure I illustrates the feature of KAT.

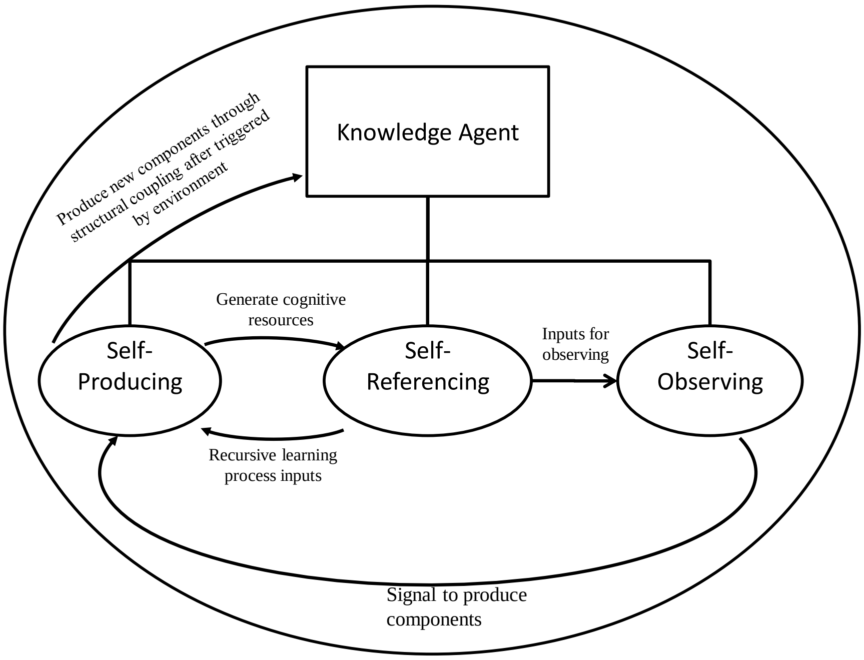

Fig. I Feature of KAT

Methodology

A multiple-case study in a stochastic demand industry, fashion industry, was carried out to examine how KA sustains its identity to generate knowledge for organisations. A new design of field study about group learning called created naturalistic environment with retrospective methods (CNERMs) was adopted (Chan et al 2013) and a random stratified sample of fashion suppliers for global market was acquired.

CNERMs is qualitative research method aims to epistemologically collect data from the research field through foundationalism (Amis & Silk, 2008) which embeds the rigour requirements of validity, reliability, generalizability. A real life field, an action learning project, which embraced an operation management training workshop, focus group discussion and post-workshop consultation meeting, was created to collect observation data of learning group behaviours. A triangulation with multiple-sources of retrospective data collected from individual survey and interviews before and after training workshop was implemented to validate the observed data. Figure II shows the data collection methods.

Four firms were accepted to participate in the study. All of them had conducted knowledge processes for changes in the last twelve months at the time of the field study with the purpose of improving their overall operation processes performance. All of the participants are anonymous. The firms are named as Alpha , Beta, Gamma and Delta. Alpha is an original equipment manufacturer (OEM) that makes fashions for youth casual wear retailers in Europe and the US. Beta is an exporter that serves the high end knitwear fashion market in Japan and Europe. Gamma is a fabric mill with production facilities in Hong Kong. It is a market leader in manufacturing bi-stretch, technical denim and advanced cotton fabrics. Delta is a typical OEM that produces intimate garments for both large and small lingerie retailers in the US. All the firms but Gamma have production facilities in China, Bangladesh and Vietnam. Total over one hundred informants were involved in the study.

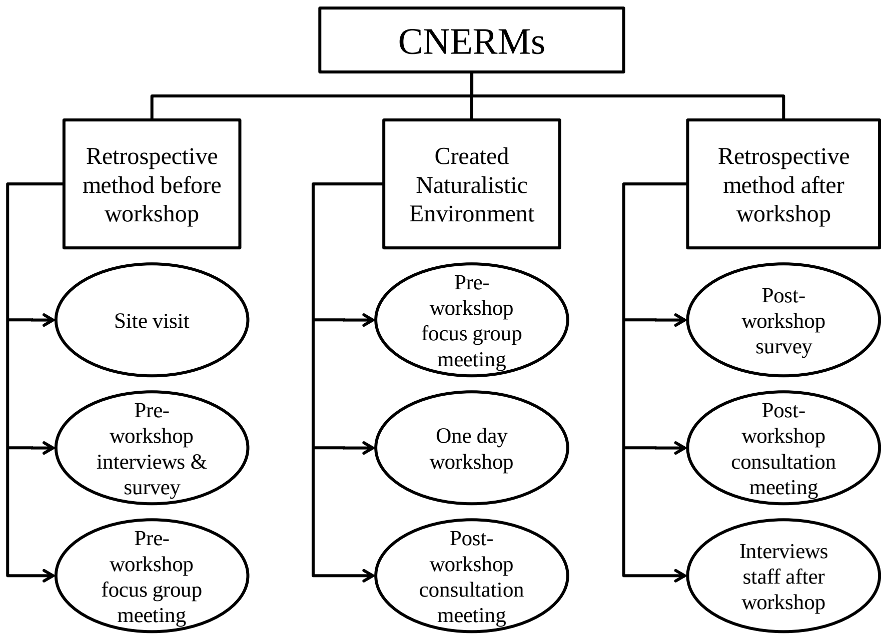

Fig. II Created Naturalistic Environment with Retrospective Methods

Findings

Three types of KAs are identified among the four participated firms. They are: proper, quasi- and pseudo-KAs. Proper KA generates knowledge that comprehensively benefits an organisation to eliminate latent systematic problems and error and minimise negative impacts coursed by external changes. It has the learning behaviour that recursively uses learned knowledge, including learning skills, solutions, and concluded relations between factors, as a reference to acquire, transfer and adopt new knowledge that deal with new collective issues and establish or refine the learning capacities for learning. Learning behaviours of proper KAs are found in both Gamma and Delta. In Gamma, the firm has adopted Nonaka and

Takeuchi's (1995) four modes of knowledge conversion SECI model to reinforce the knowledge learned by the members of learning groups. It also keeps awareness by reviewing its learning group membership in reference to its cognitive resources in order to maintain its identity for learning (self-referring). The firm has also demonstrated that it recursively examined the need to enhance cognitive abilities (self-observing). Delta has used the action inquiry model (Torbert 2004) to identify ways to improve learning process. The KAs in Gamma and Delta hold autopoietic systems that maintain a continuous learning capacity to deal with collective problems for bettering the operation processes quality performance.

Quasi-KA, although generates knowledge to deal with issues at the local level, is unable to learn knowledge for improving overall performance because some conflicts between local and universal of the organisation are not resolved. In Beta, individual members of learning group, similar to Gamma, are having high cognitive ability to learn. Unlike proper KAs, quasi-KAs lack of self-producing ability to generate or integrate new members to maintain the cognitive capacity that carry out knowledge processes for organisation. They could only generate positive impacts to local issues. In Beta, members from the trading unit and manufacturing unit have generated solutions to deal with their local problems: trading unit successfully entered the new market after new knowledge in creating new market was acquired; manufacturing unit developed a special treatment to enhance the softness of finished products. However, they failed to work together even a common goal for improving the total production lead time was set. It was caused by unmerited benefit allocation, ambiguous responsibilities and unfair measure of performance between these two units.

The learning group of Alpha was identified the learning behaviour as pseudo-KA. Pseudo-KA is not really a learning group. It always fails to generate positive benefits neither to local nor to universal after a knowledge process is conducted. Some members of learning group do not have sufficient the cognitive abilities to handle new knowledge. The findings also indicated that the prior knowledge held by the core members in the learning group is not as strong as that of their counterparts from other firms in the sample. Their initiatives in taking action to learn or willingness to put forth effort towards the knowledge process are absent. Conflicts existed between the different departments. Many informants expressed their need to ask other departments to carrying out improvement plan.

Conclusion

KAs are theorized as entities that have autopoietic properties and self-produce components for continuation. The members within KA entities have cognitive capacities and circularity of reflecting their experiences to continuously learn. The outcomes of a self-producing system are: (1) positive impact and usefulness for the organisation to make better decisions, (2) experience gained in the knowledge processes which help the KA entity to review needs in learning and justify recruiting or developing new members within the KA set. To become proper KA, members of the learning group need to have sufficient cognitive ability or resources, willing to put forth effort towards the knowledge process and take action to learn for organisation. Members are also needed to establish common goal at the individual and organisational levels. An analysis of a study based on multiple cases provides evidence that learning groups can become proper KAs to allow organisations to learn. The organisational learning practitioners can adopt the KAT to form proper KAs by i) increasing management awareness of the likelihood that there are pseudo- or quasi-KAs in the organisation and, ii) finding common goal between the members in the learning group and eliminating their conflicts at least to a bearable level in order to implement knowledge processes.

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A Quality Assessment Framework for KMS Software: Reflections on Conducting a Systematic Literature Review

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Abstract

Systematic Literature Review (SLR) aims to synthesise existing research, fairly, rigorously, and openly. It has well defined phases that include planning, conducting and documenting the review. In the first phase of this research, SLR has been used to investigate and establish precisely what attributes define the Knowledge Management System (KMS) software quality features, what methods have been or can be used to measure that quality and ultimately formulate the essential guidelines for assessing quality of the KMS software. There are important factors that should be considered when conducting a SLR. This paper is written based on the reflections on conducting a SLR on a quality assessment framework for a KMS software. The findings reported in this paper will be useful for novices and researchers who wish to successfully complete a SLR as a more effective method in conducting a literature review.

Keywords

systematic literature review (SLR), knowledge management system (KMS), knowledge management system software (KMSS), software quality assessment

Overview of the Research

Knowledge Management System (KMS) is a class of Information System (IS) that manages organizational knowledge: thus it is a system developed in order to support and enhance the processes of knowledge creation, transfer, application, storage and retrieval. KMS provide benefits to organizations in implementing mechanisms for collaboration, organizational learning, workflow management, intellectual property management and document management. KMS Software (KMSS) is a component of a KMS that can be used as a platform for managing various forms of knowledge in organizations. It enables organizations to locate, capture and share information seamlessly with customers, employees and key stakeholders. Other components of a KMS are people, culture, organizational practices and structures. There are many KMSS platforms available in the market as open source software (e.g. Moodle, Claroline, ATutor,) or commercial software (e.g. Microsoft SharePoint, Lotus Notes, Blackboard, WebCT).

The main objective of this research is to find out the various approaches to quality assessment in a KMS with a view to devising a quality assessment framework for a KMS software. The Research Questions (RQs) of this research are:

RQ1: What topics are being investigated by researchers on Knowledge Management Systems (KMS) or e-learning Systems?

RQ2: What is quality in a KMS or e-learning software?

RQ3: What are the quality attributes of a KMS or e-learning software?

RQ4: What are the methods for assessing quality in a KMS or e-learning software?

RQ5: How is learning effectiveness measured in a KMS or e-learning software?

Systematic Literature Review (SLR) has been used in the first phase of the research methodology to investigate and establish precisely what attributes define the quality features of a KMS software, what methods have been or can be used to measure that quality and ultimately formulate the essential guidelines for assessing the quality of a KMS software. This paper is written based on the reflections on conducting a SLR on quality assessment framework for a KMS software.

Systematic Literature Review (SLR)

Systematic literature review is a form of secondary study that uses a well-defined methodology to identify, analyse and interpret all available evidence related to a specific research question in a way that is unbiased and (to a degree) repeatable. A literature review that is not thorough and unbiased is of little scientific value. Systematic reviews aim to synthesise existing research, fairly (without bias), rigorously (according to a defined procedure) and openly (ensuring that the review procedure is visible to other researchers). In the process of literature review, SLR methodology as explained in (Kitchenham and Charters, 2007) has been used to identify related work in a KMS and to investigate how it will apply to this research. There are many reasons for undertaking a SLR. As stated in (Kitchenham and Charters, 2007) the most common reasons are to summarize the existing evidence concerning a treatment or technology (e.g. to summarize the empirical evidence of the benefits and limitations of a specific agile method), to identify any gaps in current research in order to suggest areas for further investigation and to provide a framework/background in order to appropriately position new research activities. Systematic reviews differ from ordinary literature surveys being formally planned and methodically executed. They are intended to be independently replicable and so have a different type of scientific value compared to ordinary literature reviews. In finding, evaluating and summarizing all available evidence on quality assessment of a KMS, a systematic literature review may provide a greater level of validity in its findings than it might be possible in any one of the studies surveyed using ordinary literature review. “In narrative reviews, the results of the studies tend to form the basis for the conclusions. In contrast, the standard used to draw conclusions from the evidence reported in a SLR is the quality of the methods used to conduct the primary studies (i.e., internal validity, including study design, conduct and analyses)” (CRD, 2001). Systematic reviews improve the reliability of conclusions due to limiting the bias with the use of explicit methods (Mulrow, 1994). The objectives of this SLR are to undertake a systematic review of the literature related to Knowledge Management (KM), to select a sub-set of studies related to the KMS and KMSS, to collect and analyse the evidence from these studies in order to assess the need for quality assessment framework for a KMSS, to identify the existing tools and mechanisms for assessing the quality in a KMSS and to identify an appropriate methodology for carrying out the proposed research.

Other Reviews

Other types of literature reviews are systematic mapping study (also referred to as a scoping study) and tertiary study (also called a tertiary review). Mapping study is a broad review of primary studies in a specific topic area that aims to identify what evidence is available on the topic (Kitchenham and Charters, 2007). This allows for the identification of evidence clusters and evidence deserts to direct the focus of future systematic reviews and to identify areas for more primary studies to be conducted. Tertiary study is a review of secondary studies related to the same research question. As explained in (Kitchenham and Charters, 2007) , "In a domain where a number of systematic reviews exist already it may be possible to conduct a tertiary review, which is a systematic review of systematic reviews", in order to answer wider research questions.

SLR Process

There are three main phases that have to be completed in SLR process; planning, conducting and documenting the review findings as shown in Figure 1. The activities in the planning phase are developing and validating the review protocol. In most of the studies research questions are developed at the proposal development stage. If not research questions should also be developed at an early stage of planning the review. It is important to develop clearly understandable research questions which are not vague and some part of one question is repeated in another research question. This step will be tremendously helpful in next stages of the SLR and to reduce the repetitive work. Need for solid research questions after accepting the protocol is emphasised in (Brereton et al., 2007). The research questions should be piloted as those are used for developing search strings and search for publications. In the second phase of the SLR process the relevant research should be identified from the sources. More details on identifying relevant publications, selecting primary studies, quality assessment of publications and extracting required data are given in the following sections. In the third phase, the SLR report is to be documented and validated. This document will be a valuable source for future stages of the research.

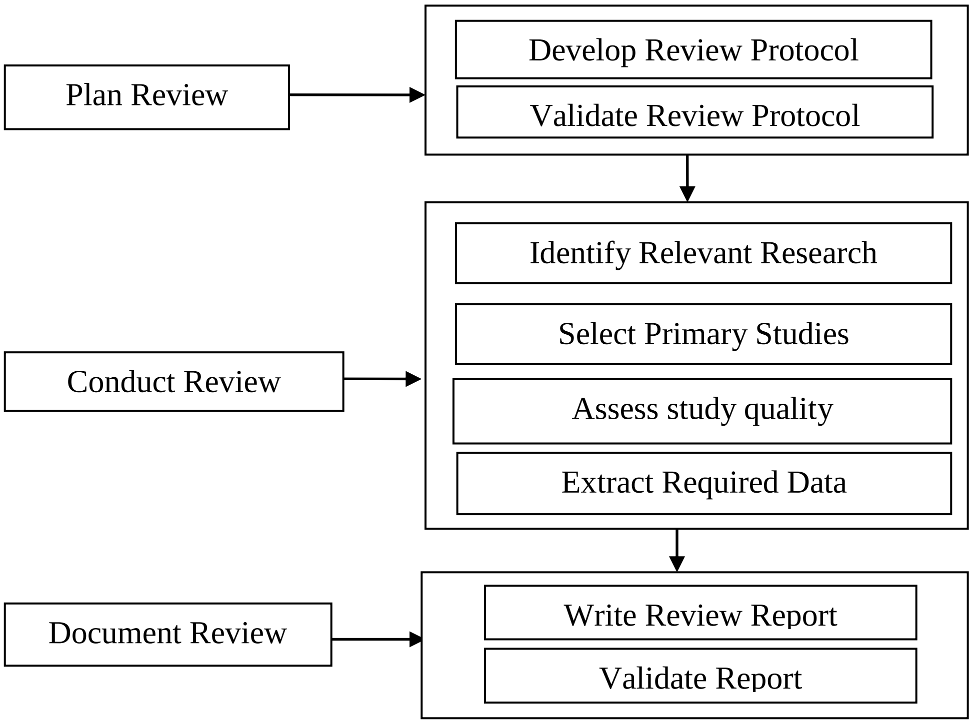

Figure 1.Systematic Literature Review Process

1) The SLR Protocol: The SLR protocol for this research specifies the research questions**,** search strategy, inclusion/exclusion and quality criteria, data extraction and methods of synthesis. It is important to validate the protocol before applying since the protocol is used as a roadmap for next stages of SLR. The initial protocol of this research was reviewed by two supervisors and an external reviewer. Recommendations given by these reviewers were implemented before the protocol was executed.

One of the essential steps in SLR protocol is devising search strings. In this study following steps were taken in devising search strings.

- Keywords, synonyms and other related words for research questions were identified.
- Boolean operators (AND, OR and NOT AND), parenthesis and quotation marks were used to link the relevant words appropriately.
- Search strings were tested on selected digital libraries (e.g. Science Direct, ACM, EBSCOhost and Springer Link) and records on testing of search strings were kept for future reference.

In devising search strings it is important to keep in mind that long search strings cannot be used with some digital libraries due to limited facilities available. Furthermore, when using short forms these might be understood in different ways and will lead retrieving large number of irrelevant publications (e.g. in a search string for this SLR "LMS" was meant as "Learning Management Systems" and "Least Mean Square" and a large number of irrelevant publications were included).

2) Search Publications: The methodology explained for the execution of SLR starts with this stage. The publications should be searched from many different sources as no single source gives all of the related publications. For this research 5 digital libraries used were Science Direct, ESCOhost, ACM, ISI Web of Knowledge and Springer Link. The facilities for extracting relevant articles in digital libraries are different. In Science Direct the strings developed for each research question could be used without any change. In ESCOhost digital library similar facilities are given but the method of linking words is different, therefore search strings had to be rearranged to use Boolean operators and parenthesis appropriately. ACM portal does not support complex logical combination of search strings. Therefore search had to be done based on key words and more manual search had to be done to extract the relevant publications. ISI Web of Knowledge and Springer Link also had difficulties in using search strings directly. Therefore alternative search strategies had to be used according to facilities given in digital libraries. In most of these digital libraries refining of publications could be done using key words, subject areas, type of publication and time period. These can be used to exclude the publications based on the exclusion criteria (e.g. in order to select only conference and journal articles, refining of publications can be done using the type of publication).

After searching the publications most relevant publications for each research question can be selected by reading title, abstract and keywords of publications. The need for reviewing conclusion in addition to the abstract is evident from the statement "The standard of IT and software engineering abstracts is too poor to rely on when selecting primary studies. You should also review the conclusions" in (Brereton et al., 2007). The full papers of the selected publications should be collected and inclusion/ exclusion criteria should be applied on this set of publications.

3) Quality Assessment of Publications: Comprehensively explained quality assessment criterion for different types of research articles used in (Dybå and Dingsøyr, 2008) was selected for extracting publications for this SLR. A summary of the quality assessment criterion used in (Dybå and Dingsøyr, 2008) is presented in Table 1. Results of quality assessment was useful in identifying how many of the studies included had an inadequate recruitment strategy, failed to use a control group, did not collect (or sufficiently analyse) data in a way that addressed the research issue and did not consider the relationship between participants and the researcher. The majority of studies related to this study scored 0 in respect to these criteria are examples of studies that offered a "lessons learned" account and did not report any empirical data. Therefore the overall quality score of most of the papers are low and this leads to low average quality score of the research papers included for quality assessment. In this research there were 81 publications included for quality assessment. All these publications were read fully to fill the quality assessment questionnaire. The reference lists of these articles were also accessed in order to find more related publications. But that did not result in adding any more publications to the collected list of publications since those articles identified as relevant from reference lists have already been included.

Table 1 Summary of Quality Assessment Criterion

1. Is the paper based on research (or is it merely a ''lessons learned" report based on expert opinion)?
2. Is there a clear statement of the aims of the research?
3. Is there an adequate description of the context in which the research was carried out?
4. Was the research design appropriate to address the aims of the research?
5. Was the recruitment strategy appropriate to the aims of the research?
6. Was there a control group with which to compare treatments?
7. Was the data collected in a way that addressed the research issue?
8. Was the data analysis sufficiently rigorous?
9. Has the relationship between researcher and participants been considered to an adequate degree?
10. Is there a clear statement of findings?
11. Is the study of value for research or practice?

All the articles included in the review were based on research or presented a “lessons learned” and clearly stated the aims of the research. Of the 81 publications, 78 publications offered some description of the context in which the research was carried out, while 71 publications were considered to have an appropriate research design. Analysis of these quality assessment results also displays how many of the studies included had no adequate recruitment strategy, failed to use a control group, did not collect (or sufficiently analyse) data in a way that addressed the research issue and did not consider the relationship between participants and the researcher. The majority of studies scored 0 in respect to these criteria are examples of publications that offered a “lessons learned” and did not report any empirical data. Eleven of the studies included in the review were awarded the maximum score of 11. The minimum score for the selection of a publication is 3. The average quality score of the publications included in the review is 8.6. The median score of publications included in the SLR is 11 (with 11 studies awarded this score). In order to test the validity of the quality assessment procedure a second reviewer (PhD supervisor) was given a random sample of 10 papers and was asked to assess their quality based on the same quality assessment criteria outlined. There was no disagreement on the overall quality assessment of these papers. The number of publications which passed the minimum quality threshold is 76. Three publications were not included in to this SLR though the minimum quality criteria are met since those were papers for the same research repeated with minor modifications to the title and were retrieved from different digital libraries. When carrying out the quality assessment care should be taken to keep notes on reasons for rejections and using a proper mechanism for traceability of papers for further analysis at documentation stage of SLR.

4) Documenting the SLR Results: As reported in (Brereton et al., 2007), medical guidelines suggest that the protocol can be used as the basis for the final report. The report should reflect the process that was followed and documented in the SLR protocol development stage. The deviations or changes made to the plan of the SLR process should be explained in this report. It is important to validate the SLR document before publishing. Presenting the findings and experiences in executing a SLR as a conference or journal article is a most suitable method of dissemination. For students a dissertation, report or portfolio can be submitted based on the results of a SLR. For large research projects this can be submitted as a report for the funding organization or the client. The SLR reported in (Brereton et al., 2005) is published as a technical report. For this research the SLR results were initially reviewed by peers and will be published as a conference paper and a journal article for external validation.

Reference Management

In carrying out a SLR large amount of research articles are collected and there should be a proper mechanism for managing references collected. Therefore, it is essential to use a reference management software (e.g. RefWorks, EndNote). For this research publications collected and refined were managed using EndNote software. Most of the digital libraries provide facilities to export references directly to reference management software and to link to the URL of the publications for downloading full papers easily. Since a large collection of publications are accumulated while searching publications, use of a suitable file keeping and configuration management method on retrieved publications is essential. When the searched publications are refined, records on refining methods used at each stage should be kept since it has to be documented when the SLR report is compiled. For an example, initially 23000 publications were retrieved for Research Question 4 (RQ4) in this SLR. Using facilities in digital library (e.g. title, abstract, keyword, subject areas, language and type of publication) it was refined to 842 publications. Using EndNote to select the publications for RQ4 based on key words, removing titles with unrelated research and duplicates it was refined to 230 publications. Manually reading title and abstract refined to 43 publications. Using inclusion and exclusion criteria it was further reduced to 38 publications.

Time Management

SLR is a time consuming process. Good project management tools and techniques will be helpful in managing time and effort in SLR process. If the researcher did not consider using good project management skills, milestones and the project goal cannot be achieved as planned. Preparing an activity schedule (e.g. Gantt chart or work breakdown structure), identifying milestones and percentage completion chart are some of the useful tools to complete the activities on milestones. Evaluating the success and failures of completed tasks and rescheduling by considering any extra effort required if there is any delay in some activities is essential for timely completion of SLR project. The activity schedule prepared for this project at the planning stage is given in Table 2. By using the above mentioned techniques for this research, the researcher could complete the SLR as planned.

Table 2 Activity Schedule for Conducting SLR

Time (Wks)	Activity	Deliverables	Remarks
1-2	Develop SLR protocol	Draft protocol	Experts review
3	Revise SLR protocol	Final version of protocol	Obtain feedback
4-5	Pilot test of protocol	Results of plot pest	Use tested protocol
6-8	Search for publications	List of publications	
9-10	Test/Re-test process	Test results	
11-14	Selection of publications	Tables of data	
15-16	Data extraction	Results of data extraction	
17-18	Data analysis	Results of data analysis	
19-22	Report writing	SLR report	Review by experts
23-25	Revise the report	Revised SLR report	
26-27	Present the results of SLR	Presentation	Feedback

Some of the reasons for time wasting in SLR process arise due to not keeping information about the files saved, repeating the search by changing search strings several times and using some digital libraries that do not give full papers. Other time wasters are not identifying priorities in SLR process and not completing the activities decided to complete for the day/week due to taking too much time on some activities which should have completed with minimum effort and time.

Conclusions

Systematic Literature Review (SLR) is well defined methodology compared to other literature reviews. Based on the reflections on conducting this SLR, the points to be considered at each stage of SLR process can be used in conducting a SLR for any type of research project. As the first phase of SLR process; at the planning stage of SLR, points to be taken in to account are developing research questions and refining those with the guidance of supervisory team, developing and validating a SLR protocol, devising search strings and pilot testing of search strings on selected digital libraries. At the second phase; in conducting the SLR, selecting a set of most suitable electronic databases for your research, using methods to refine the results, quality assessment of selected publications and using a reference management software will be useful for a comprehensive SLR. Using a systematic file keeping method, conducting regular meetings, keeping records on meetings, maintaining activity records and milestones up to date with the schedule will lead to timely completion of SLR. As the third phase; documenting the SLR results as a conference/journal publication or chapter in a dissertation will be useful in disseminating the results of a SLR. According to the experience gained by the author the advice that can be given for a novice or research student on the other important things to be considered in conducting a SLR are; be confident and patient until you reach your final goal in SLR, minimize re-work by getting feedback from supervisors/experts at each stage, be enthusiastic about your topic and read/write as much as possible.

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A Topological Approach to Knowledge Management and Development in a Company

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Abstract:

Most approaches to knowledge or intellectual capital management divide the knowledge of a company into different disjoint categories (e.g. individual knowledge, organizational knowledge, and relational knowledge). However, these categories are mutually codependent. There is no organizational knowledge without individual knowledge. This leads to an understanding of knowledge categories as only different perspectives of the whole body of knowledge in a company. A formal representation of this idea can be based on the mathematical concept of topologies. We introduce a utility topology, which groups knowledge assets according to their combined usefulness in the company. In addition, topologies reflecting the knowledge categories are introduced such as a human capital. The utility topology can be used as a development target for the single category topologies. In other words, by defining useful groups of knowledge assets it leads to topology transformations in the category topologies to have these knowledge groups be reflected there.

Keywords

intellectual capital, utility of knowledge, knowledge topology, knowledge development

Introduction

What is knowledge? The term knowledge is used in a wide area of different contexts and there is no clear understanding of its meaning. Knowledge Management is therefore a rather ample field of research that includes a large variety of different approaches to the systematic application of intangible resources in economic operations (Metaxiotis et al 2005; Meyer and Sugiyama 2007; Maddocks, J. and Beaney, M. 2002). Contributions to the field are made from many disciplines that study intangible resources for their own specific purpose, such as economics, management accounting, organizational theory and strategic management. The terminology of these disciplines is quite diverse. Some talk about knowledge resources or knowledge assets (Grover & Davenport 2001; Bontis 2003), others about intangible assets or intellectual capital (Sveiby 1997, Lev and Zambon 2003). There is no strict distinction between these terms; they are often used interchangeably and ambiguously (OECD 2008; Steenkamp and Kashyap 2010). The importance of knowledge for the economic success of a company can hardly be doubted. It remains unclear, however, how it should be captured to control its influence on business operations.

In order to evaluate the knowledge in a company, Steward (1997) suggests the distinction of three different aspects of intellectual capital: human capital, structural capital and relational capital (see also Edvinsson and Malone 1997 and Steward 2003).

- Human capital covers all aspects of knowledge inherent in the people who belong to a company. This includes competencies, skills and abilities as well as attitudes and motivations.
- Structural capital is everything in a company that supports business operations, for example hierarchies, data collections, communication channels, work routines or factory layouts. Edvinsson and Malone (1997) divide structural capital further into organizational capital, process capital and innovation capital.
- Relational capital consists of all further resources that contribute to a company’s business without being part of it. Many aspects of relational capital concern the customers, for example loyalty, satisfaction, financial power and price sensitivity. They are commonly addressed as customer capital. Other aspects of relational capital may include trademarks, licenses, memberships in industrial organization and supply networks.

The items that are listed in each of the three categories represent different forms of knowledge in a company. They are often assumed to behave like separate resources which can be joined together like elements of a set. Many accounting methods therefore assess the intellectual capital of a company by dividing it into human, structural and relational components and further subcomponents. These components are then evaluated separately and the resulting figures are added together (OECD 2008, Luthy 1998; Sveiby 1997). However, the results of these assessments are often unsatisfactory and confusing: they seem somewhat arbitrary and fail to explain the performance of the company in the market or its stock value (Jurczak, 2008, Roos et al 2005).

Knowledge Categories and their Interdependence

Where do these problems come from? We argue in this paper that the the initial assumption is wrong: the different items listed in the three categories do not behave like separate resources. It only makes sense to distinguish human, structural and relational aspects of knowledge, but not to divide the knowledge itself. There is no organizational knowledge without individual knowledge and vice versa. Relational knowledge without recognition of individual and structural influences does not exist. All the knowledge of a company can therefore be addressed either in terms of the humans who carry and utilize it, in terms of structure, or in terms of the relationships of the company with the outside world.

This leads to a new understanding of the different categories of knowledge. Instead of saying that they form different subsets of the knowledge in a company, we have to say that each of them contains all the knowledge in a company – it is just described in a different way. For the sake of simplicity, we continue to treat knowledge as a set of distinguishable entities. But we claim that the whole set of knowledge entities can be assigned to employees as well as to structural elements of the company or to the external relationships of the company. Our argument is supported by the intuition that a company cannot be a company if it does not involve humans, if it does not have a structure or relations to the outside.

How can this argument be formalized? One possibility is to consider knowledge entities as multi-dimensional objects. Each one of them would then have an extension in the human dimension, one in the structural dimension and one in the relational dimension. At some point, however, it might become necessary to establish further dimensions or to divide a dimension into sub-dimensions. The structural dimension, for example, could be further divided to distinguish organization, process and innovation. With so many dimensions, it would become very challenging to describe knowledge transformations (cf. Ammann 2012).

We will therefore use a less restrictive mathematical construct which allows us to address relationships of different elements in the knowledge space in a very basic way. For the purposes of value creation for the company, single items of knowledge are not necessarily the appropriate level of interest. Instead, often certain sets of knowledge items in their combined application are the drivers for this. They are useful for the company as a combined set of knowledge items. This may be the case, if an employee would bring as well his own individual knowledge as external organizational knowledge into action to perform according to his tasks in the company. As another example, the knowledge of team members must be brought together in run a development project. A formal representation of this idea can be based on the mathematical concept of topologies.

A Topological Definition of Knowledge in a Company

Given a non-empty set **K** and a collection **C** of subsets of **K**, then the pair (**K**, **C**) is called a topological space, if the following criteria are met:

- The empty set **Ø** and **K** are elements of **C**
- The intersection of a finite number of elements of **C** is also an element of **C**
- Every union of elements of **C** is also an element of **C**.

In this case, the set **K** is called the underlying set, **C** is called the topology on the set **K**, and the members of **C** are called open sets. See also (Mendelson 1990) for these definitions and terms. In the topological spaces in this paper, the underlying set **K** will always be the set of all knowledge entities in a company.

Furthermore we define a (topological) transformation $\mathbf{f: (K_1, C_1) \rightarrow (K_2, C_2)}$ from one topological space ($\mathbf{K_1}$, $\mathbf{C_1}$) into another topological space ($\mathbf{K_2}$, $\mathbf{C_2}$) as a function $\mathbf{f}$: $\mathbf{C_1 \rightarrow C_2}$, i.e. a function from the set of open sets $\mathbf{C_1}$ of the topology ($\mathbf{K_1}$, $\mathbf{C_1}$) into the set of open sets $\mathbf{C_2}$ of the topology ($\mathbf{K_2}$, $\mathbf{C_2}$). In this paper we only deal with transformations from (**K**, $\mathbf{C_1}$) into (**K**, $\mathbf{C_2}$) because of our fixed underlying set **K**. Note that such a topological transformation **f** need not be surjective nor injective. That means that there could be open sets in the target topology of the transformation which are not in the range of **f** or which have more than one inverse image under **f,** respectively.

We are now able to formalize our concept of sets of useful knowledge items in the form of a topology. The knowledge utility topology of a company is defined as

$$\mathbf{UT} = \{\, \mathbf{Ø}\, ,\, \mathbf{K_{UT}} \mid \mathbf{K_{UT}} \text{ is a useful subset of } \mathbf{K}\}.$$

Note again that the elements in the open sets $\mathbf{K_{UT}}$ in this topology are useful in a combined sense and not, because single knowledge items in the subsets are useful. The empty set **Ø** is included for consistency reasons, it is of course not useful per se. Most important to note is, that **UT** is indeed a topology. Figure 1 displays the topological space (**K**, **UT**).

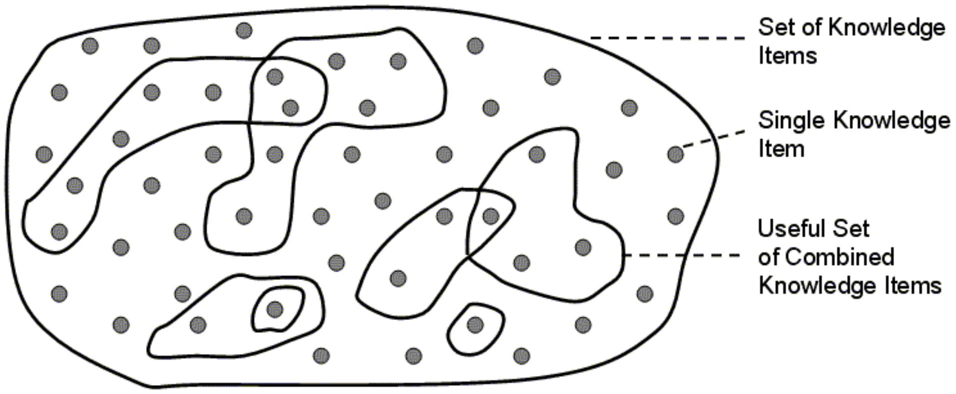

Figure 1: Knowledge Utility Topology

We additionally define three more topologies recognizing the described knowledge categories in the company, namely the human capital topology **HC**, the organizational topology **O** and the relational topology **R**:

$$\mathbf{HC} = \{\, \mathbf{Ø}\, ,\, \mathbf{K_E} \mid \mathbf{E} \text{ is a set of employees}\},$$

where $\mathbf{K_E}$ is considered as the set of knowledge available to the set of employees **E**. We allow **E** to be empty, $\mathbf{K_E}$ can consequently be empty, too.

$$\mathbf{O} = \{\, \mathbf{Ø}\, ,\, \mathbf{K_U} \mid \mathbf{U} \text{ is a organizational unit in the company}\},$$

where $\mathbf{K_U}$ is considered as the set of knowledge applied in the organizational unit **U**. This unit may just be a team, a department or a whole branch of the company.

$$\mathbf{R} = \{ \mathbf{Ø} , \mathbf{K_R} \mid \mathbf{R} \text{ is a set of relationships of the company}\},$$

where $\mathbf{K_R}$ is considered as the set of knowledge available with regard to the set **R**. **R** may consist of sets of customers, suppliers, public institutions or other stakeholders.

Knowledge Management and Development in Topological Terms

What could be gained by these formalizations as topologies? Figure 2 shows the overall knowledge development procedure. The left hand side of Figure 2 indicates the knowledge development process. Through formalization in the form of topologies we can apply topology transformations to the different category topologies of knowledge. These transformations are guided by the knowledge utility topology, which can be seen as a transformation target. Remember that the utility topology formalizes sets of knowledge entities which are useful for the company in a combined sense. That means that the topology transformations should work in direction of (more) useful set of knowledge items in the company. In a final step, the transformed category topologies may then interpreted (or implemented) towards developed knowledge categories.

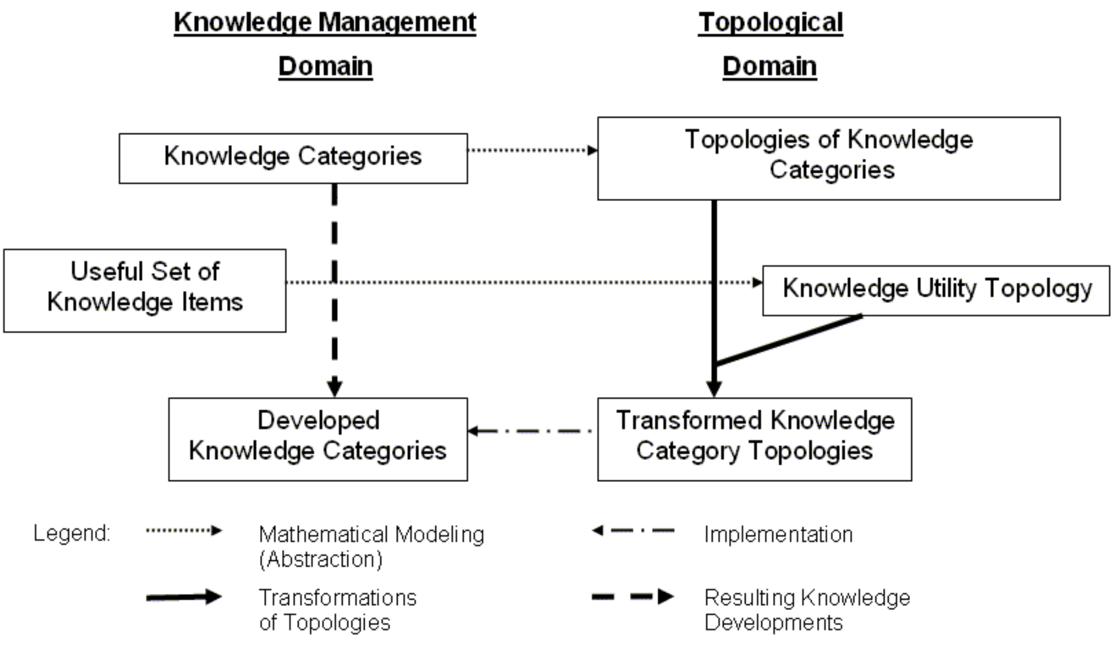

Figure 2: Overall Knowledge Development Procedure

How could the topological transformations in this procedure look like? Note again that all of our topologies (on the right hand side of Figure 2) have the set **K** of all knowledge items in the company as underlying set. An example of a (injective) transformation for the human capital topology **HC** would be that one or more sets of employees would extend their combined set of knowledge items. Another example with a non-surjective transformation for the organizational topology **O** could be observed by establishing a new team as a new organizational unit (for example as the image of the empty set under the transformation and by having no inverse image for the empty set in the transformed topology). The knowledge set of this new team would then establish a new open set in the range of the topological transformation.

Here is an interesting variant of this example about a transformation of the organizational topology **O**. There is the need for a new project in the company, which should propose a product renewal for a product at the end of its life cycle. Because of technological and market changes the original product team for the product does no longer have all the knowledge to do it. From the knowledge utility topology **UT** we can choose the appropriate open set, i.e. a set of knowledge items in the company, which would cover the knowledge needs for the project. Using the human capital topology **HC** helps us to identify the appropriate set of employees, which have the needed knowledge as a team. The operational topology **O** is now transformed by adding a new organizational unit, namely this set of employees as a new team. Hence the team is strengthened by adding new team members and is now able as a team, to perform the project.

Summary and Outlook

Studies of single knowledge items are very popular in management accounting and other disciplines that are concerned with Knowledge Management. However, they have proven to be inefficient in many ways. The topological approach presented in this paper takes a different direction. It discusses knowledge in terms of unions and intersections of open sets. The definition of these sets can be based on many different properties of knowledge in the company, for example the employees that apply it, the organizational unit that uses it or the external partners that are involved in it. In this respect, the topologies show a certain similarity to the categorical distinctions of different intangible resources. It is important to understand that they nevertheless have a different meaning. Each topology can claim to cover the whole company on its own, just as the human beings, organizational structures and external relations each cover all areas of the company on their own.

This approach can help to get a better understanding of knowledge in a company and its behaviour. For example, overlays between the different objects of study are not regarded as a deficiency but an essential characteristic of knowledge. Contradictions between different assessments of knowledge in a company are on this background not surprising. The study of transformation functions between different topologies can help to understand the level of contradiction that has to be expected: if transformations are available in both directions that leave the majority of the topological structures intact, the contradictions should be minimal. If no such transformations exist, more problems will appear.

The topological approach to knowledge management may prove to be particularly interesting in the context of the company development over time: From a knowledge perspective, changes of business processes, acquisitions and mergers will only proceed smoothly if, for example, the knowledge topologies before the merger can be transformed into those after the merger, with respect to the employees as well as the organizational units, the external relations and more. The topological concept of covers can be used to study redundancies of knowledge in a company and the impact of staff fluctuations. If the knowledge sets induced by the single employees provide a minimum cover of the whole space, no further redundancies can be eliminated. If an employee leaves the company, a certain part of his or her knowledge will not be available any more. A comparison to other topologies, e.g. those induced by external relations or business processes will give further insight into the importance of the loss. Applying the full bandwidth of mathematical concepts in the field of topology, many interesting insights into Knowledge Management may still lie ahead of us.

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An Analysis of Localisation Context in Practice-Oriented Knowledge Transfer

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Abstract

Knowledge transfer is viewed as a significant tool for organisational learning, and a powerful mechanism for gaining competitive advantages. However, knowledge transfer is not straightforward as it depends not solely on the nature of knowledge itself but also on the process of acquiring and assimilating it. Additionally, organisations require a method of analysis in order to predict transfer difficulties relating to the absent congruence of the source-recipient context and to assist the organisation's decision to choose a suitable source for the transfer process. In this paper, how organisations can effectively transfer knowledge through practice is discussed and a semiotic model for practice-oriented knowledge transfer is introduced. This is analysed in a localisation context as a semiotic process. This analysis is based on case studies which focused on the transfer of Green ICT practices from a UK university to Thai universities, which were also used to validate this model.

Keywords

knowledge transfer; knowledge model; case studies

Introduction

Knowledge management continues to maintain its importance in organisations because organisational knowledge is a key to supporting the competitive advantage. A movement of knowledge leads to the improvement of existing knowledge and creation of new knowledge. Despite significance of the movement of knowledge, there are still limitations regarding knowledge management and knowledge transfer in particular. To transfer knowledge across organisational boundaries, a major concern is the absence of consideration of context between organisations since each organisation operates its knowledge within a specific context. Prior studies of knowledge transfer view knowledge as an object (Liyanage et al, 2009; Parent et al, 2007) and view a recipient as a passive actor. This perspective ignores the context in which the knowledge transfer occurs and in which the knowledge is used (Inkpen & Dinur, 1998; Parent et al, 2007).

To address this, we introduce a practice-oriented perspective of knowledge transfer based on semiotic analysis. Semiotics provides a means of analysing the process of interpretation of artefacts and concepts. This paper proposes a model for a semiotic approach to practice-oriented knowledge transfer, and its localisation context is analysed as a semiotic process. Case studies are used to inspect the model based on which key findings are reported. Finally, discussions and conclusion are put forward.

Knowledge transfer as semiosis

Nelson & Winter (1982) argue that an organisation applies knowledge through an efficient integration of knowledge leading to a routine use of knowledge. Kostova & Ruth (2002) and Szulanski (1996) discuss how a practice is seen as successful routine in organisations. Accordingly, this research introduces a practice as a vehicle of knowledge to be transferred. This is sometimes referred to as practice transfer, which is considered useful for the replication of existing successful practices that enables organisations to take advantage of their value (Bartlett & Ghoshal, 1989). What is emerging here is the focus on a practice as a key feature of knowledge transfer. To address this, this paper introduces a new perspective of knowledge transfer based on semiotic analysis.

Semiosis

Semiotics is a study of signs in relation to objects and actions. Organisational semiotics is a discipline which aims to study the nature, functions, characteristics and effects of information and communication within organisational context (Liu, 2000). It helps us understand the cooperative workings and interactions among individuals, and between human beings and technology. It defines organisations as systems where signs are created and used for communication and business purposes (Liu, 2000). One of the fundamental concepts in semiotics is semiosis, which is the process of meaning construction from signs that represents an object and shows how an agent uses a sign to understand and interpret something (Liu, 2000).

As illustrated in Figure 1, semiosis assigns the relationship among sign (S), object (O) and interpretant (I) (Liu, 2000). Peirce (1955) defines sign as 'something that stands to somebody for something in some respect or capacity' (p.99). Sign is related to its referent or the object with the assistance of the interpretant which is shown as to mediate the relationship between the sign and the object. When we treat knowledge to be transferred as the object and practice as the sign that represent knowledge, the semiosis model can be applied to analyse the knowledge transfer, as the interactions between the sign, object and interpretant (Chai-Arayalert & Nakata, 2012).

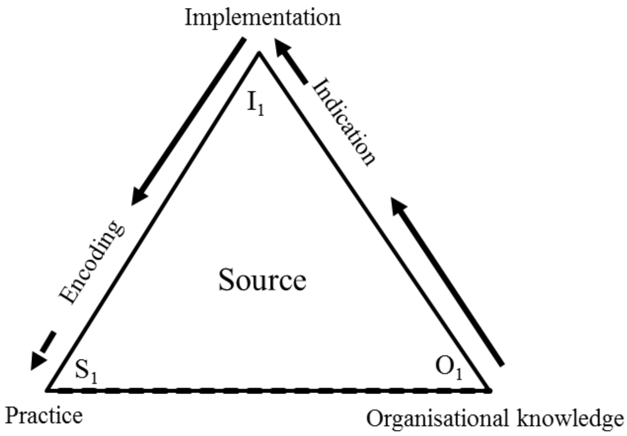

Figure 1 Peirce's triadic model of s source process (Chai-Arayalert & Nakata, 2012)

Based on the semiosis model, problems in practice-oriented knowledge transfer can be identified as 'gaps' (Figure 2). Firstly, the 'representation gap' occurs when the two different signs that refer to the same object are transferred in the process of localisation. Secondly, the 'the interpretation gap' shows the difference of knowledge between the organisations. It leads to a displacement of object when an understanding of the objects differs and can result in a distorted understanding of the intended meaning.

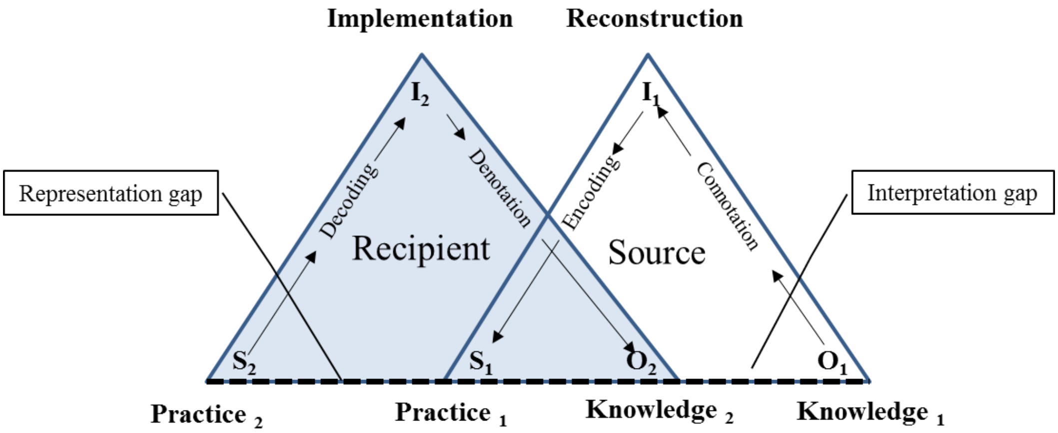

Figure 2: A Semiosis View of Knowledge Transfer (Chai-Arayalert & Nakata, 2012)

Practice-oriented knowledge transfer

The semiosis model shows that practice is a signification of knowledge. It follows that in the source, there is a process that transforms the organisational knowledge which is embedded in the policy into knowledge transfer carriers or practice. As such, the practice is implemented under the policy. Both policy and practice emerge and are produced in an organisation corresponding to the organisational context. Thus, policy and practice cannot be separated from the organisational context. This organisational knowledge may be captured in formal descriptions of the organisation and its activities or in the retained records of organisational activity. We illustrate practice as the representation of 'objectified knowledge' referring to the notion that 'the shared knowledge is collectively accepted and becomes common property of the organisation's members' (Huysman & De Wit, 2002, p. 40).

According to the social constructivist theory, the recipient of knowledge in the proposed model is an active actor and has a dynamic role in knowledge reconstruction. The recipient's reconstruction of knowledge is a process whereby a recipient interprets the adopted practice and constructs knowledge in terms of its policies. To begin with, the adopted practice is interpreted by making knowledge explicit and sharing knowledge at a group level. The interpretation is also associated with the notions of externalisation process of knowledge creation, where individuals are able to translate their intuitive and tacit understandings into explicit knowledge that they can communicate to their group (Nonaka & Takeuchi, 1995). The interpretation is a social activity that creates and refines common language, clarifies images, and creates shared meaning and understanding (Daft & Weick, 1984).

This social constructivist perspective, which argues that knowledge is produced through the shared understandings that emerge through social interactions, emphasises the processes by which people solve problems and construct understanding of concepts, phenomena, and situations. As such, knowledge is context-dependent and it cannot be completely separated from individuals. At the recipient end, the shared knowledge embedded in the adopted practices are externalised by human actions. This knowledge is then constructed by organisational members within a context that influences its outcome. The outcome of knowledge construction, which is a result of human and social activities for accomplishing the organisation's aims, is new organisational knowledge artefact as policies.

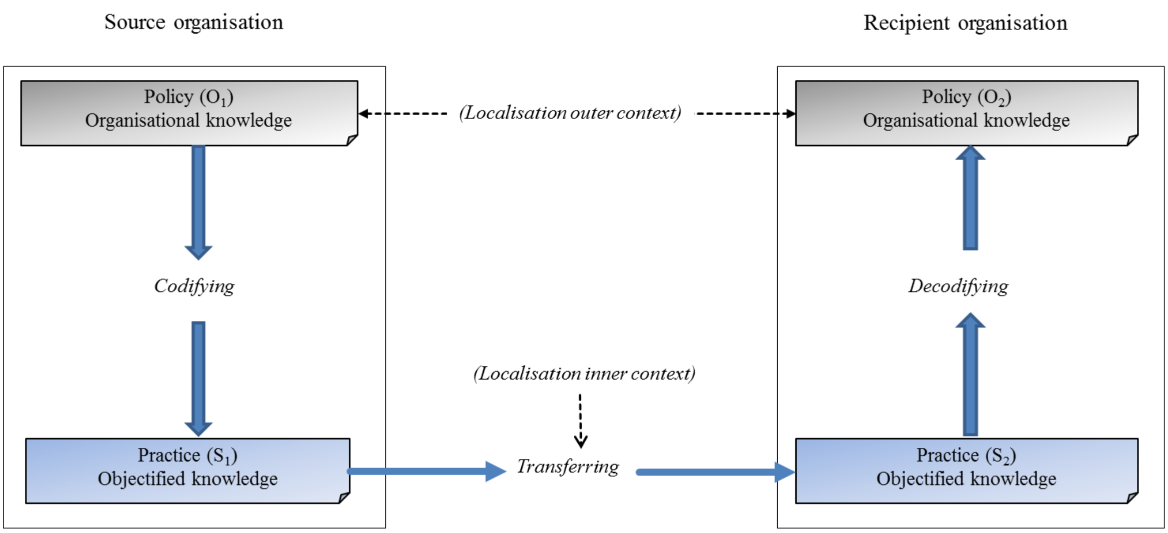

Figure 3 A Practice-Oriented Knowledge Transfer Model (Chai-Arayalert & Nakata, 2012)

As illustrated in Figure 3, this practice is transferred to and adopted by the recipient, after which the adopted practice is interpreted under the influence of the recipient's context. In this manner the interpreted knowledge is constructed into organisational knowledge. Therefore, knowledge construction is an active process that constructs knowledge from external knowledge according to prior experiences and social interaction with others in a particular context. The next section takes into consideration the localisation context of the transfer process.

Taking localisation context into consideration

If the practice is applied in a different environment from which it originates, it tends to make the practice depart from its original (Kostova & Roth, 2002). Thus, it is transformed into a distinct and unique pattern to be adapted appropriately into local environments. We assume that analysing the organisational context helps to better understand the situations that are related to managing knowledge (Kostova & Roth, 2002). The organisational context refers to the environment in which organisation is embedded and includes elements that are relevant and necessary to achieve the organisation's goals (Agostini *et al.*, 1996). If organisations are not able to appropriately analyse their organisational context, it may lead to undermine recipient's capabilities which deal with the knowledge transfer. We propose a semiotic approach for analysing the organisational context between parties which is used to analyse the consistency of context which is hypothesised as a critical factor in the practice transfer.

Firstly, the *inner* organisational context relates to the attributes of the organisation that have been formalised and officially documentations Therefore, this context directly influences on the implementation of organisational practices and it affects the features of the organisational practices. Secondly, the *outer* organisational context influences knowledge re-construction in relation to the translation and transformation of knowledge. When the practices exist within the source's context which differs from the recipient's context, the recipient may face the situation that makes the transfer of practices difficult (Szulanski, 1996). This research identifies the layered context of organisation which follows Stamper *et al.* (2000) who illustrated the working operation between layers in the organisational containment model. It explains that 'Informal norms [*i.e. skills and culture*] are fundamental, because formal norms [*i.e. activity, strategy, resource, regulations*] can only operate by virtue of the informal norms needed to interpret them, while technical norms can play no role…unless embedded within a system of formal norms.' (p. 19). This leads to the idea of multi-layered organisational context of knowledge transfer through the semiotics perspective.

The organisational containment model illustrates a view of organisations is composed of interrelated sub-systems as can be seen in Figure 4 (Liu *et al*, 2002). First, the organisation as a whole is considered as an informal system, where the values, beliefs and behaviour of individuals play important roles (Liu, 2000). This includes culture, systems of belief and politics that govern the perception, expectations, behaviour and values of the individual members of the system. Knowledge is analysed as a part of informal system, as knowledge relates to meanings, is context-specific, depends on the situation, and is created dynamically in social interaction among people (Davenport & Prusak, 1998; Nonaka & Takeuchi, 1995).

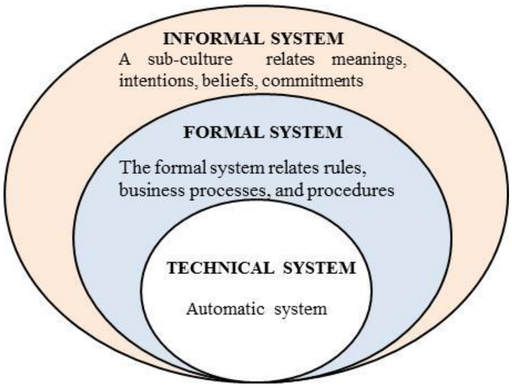

Figure 4 The organisational containment model (Liu *et al*, 2002)

Second, the formal layer is the way individual actions and business processes are carried out according to rules in the organisation (Liu, 2000). The formal layer contains attributes of the system that have been formalised and officially documented in rules, procedures, and other forms of bureaucracy. We view the practice as a part of the formal system, which is in line with Goldkuhl *et al* (2001). Third, the technical system, which is outside the scope of this study, is the part of the formal system that is automated typically through IT systems (Liu, 2000).

Based on the organisational containment model, the organisational context can be analysed in the different system layers as illustrated in Figure 5. Firstly, the inner organisational context is embedded in the formal system layer which is closely relevant to implementing the practice. The context elements relate to the actions and processes which should be carried out according to rules in the organisation. Secondly, the informal layer is the outer organisational context which has an impact on utilise the practices. This context influences the practices during their operations, as well as providing the environment in which practices are developed. This analysis leads to different conditional schema for organisational contexts. If the inner context at the source is similar to the inner context of the recipient, the transfer of practice should be straightforward or transferred with few impediments. Conversely, if inner context of the recipient is different from the source, then the recipient will require changes.

If the outer organisational context at the source is similar to the outer organisational context of the recipient, members can interpret and construct knowledge with minimal effort. Conversely, if the outer context at source is different from the recipient, difficulties arise, which can lead to misinterpretation and misalignment of knowledge. Accordingly, the recipient has to consider the particular context or 'localisation context' in order to adapt recipient organisational context to fit with the source organisational context. The next section presents case studies in Green ICT knowledge transfer which are used to inspect the model based on which key findings are reported.

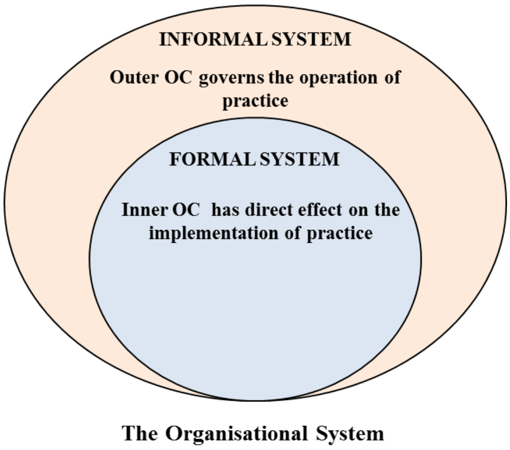

Figure 5 A semiotic view of organisational context

Research Method

A case study approach (Walsham, 1995; Yin, 2003) is employed to validate the analysis of localisation context of the practice-oriented knowledge transfer model. Multiple case studies are used and the domain of analysis is the knowledge transfer of Green ICT practices between universities. As the research topic requires descriptions with emphasis on communications and social relationships among participants, the qualitative data collection technique is preferred (Yin, 2003). This research used multiple data collection methods. Through analysing the Green ICT practices between UK and Thai universities, localisation context of knowledge transfer was analysed.

With the increasing awareness of environmental issues, this research selected Green ICT practices as the carriers of knowledge transfer between UK and Thai universities because Green ICT is still an emerging concept in Thai universities and they are encouraged by social, economic and technological pressures which are studied by Chai-Arayalert & Nakata (2011). Therefore, it benefits Thai universities which recognise the need to implement Green ICT practices. Hence, we studies three cases from Thai universities in which a total of fifteen participants, working in the related IT services and taking direct responsibilities of ICT policy, were observed and interviewed.

Data Collection and Analysis

Data was collected through the direct observation of brainstorming groups, individual interviews, and document analysis. This research used the qualitative content analysis technique which enabled the interpretation of all transcribed interviews, documents and notes of observations, relating each one to the whole in order to gain a holistic picture of the phenomenon. The first stage reviewed the interview transcripts to find key themes and patterns, producing coding for these key themes and phrases, revising the labels to form systematic categories, sorting the interview transcripts into systematic categories, and providing tables of systematic categories with factors from each interview. The second stage of content analysis dealt with cross examination of interview transcripts, and aimed at the integration of all the factors and links from the interviews, in order to validate a model. The next section presents the findings from the three case studies.

Findings

Firstly, the localisation of inner organisational context which influenced a recipient’s ability to adopt the practices to be transferred was identified. As shown in Table 1, we found that the transfer of Green ICT practices was affected by the localisation of inner organisational context. These examples were seen in the cases in which some of the recipients (Thai universities) were not able to adopt some practices from the source of practices (a UK university). The reasons for adopting and rejecting of the Green ICT practices were summarised in Table 1. Data was further analysed and organised to present the localisation of inner organisational of the transfer of Green ICT practices, involving activity, strategic, and regulatory constraints.

Table 1: Summary the inner organisational context for adopting practices

Original practices	**University A**	**University B**	**University C**
Practice 1: Purchasing ICT equipment	Adopted	Adopted	Adopted
	1. Strategic context 2. Regulation context	1. Activity context 2. Strategic context	1. Activity context 2. Strategic context 3. Regulation context
Practice 2: Using Laptops	Rejected	Rejected	Rejected
	1. No policy to support 2. No budget to support	No budget to support	1.No policy to support 2.No budget to support
Practice 3: Using LCD or Flat screens	Rejected	Adopted	Rejected
	1. No policy to support 2. No budget to support	Activity context	No policy to support
Practice 4: Switch off ICT equipment	Adopted	Adopted	Adopted
	1. Activity context 2. Strategic context 3. Regulation context	1. Activity context 2. Strategic context	Regulation context
Practice 5: Printing and photocopying	Adopted	Adopted	Adopted
	Activity context	1. Activity context 2. Strategic context 3. Regulation context	Strategic context
Practice 6: Remote working, teaching and learning	Adopted	Adopted	Adopted
	1. Activity context 2. Strategic context	1. Activity context 2. Strategic context	1. Activity context 2. Strategic context
Practice 7: Managing ICT waste	Adopted	Adopted	Rejected
	1. Activity context 2. Strategic context	Activity context	No regulations to support

Secondly, after adopting the practices, they interpreted these practices and constructed knowledge which is represented in terms of Green ICT policies. Based on the collected data, we found that participants were affected by the particular localisation context which inhibit or support their abilities to interpret practices and construct their own knowledge including the competencies and skills, and the organisational culture. Table 2 shows that participants can understand the objectified knowledge which is encoded in the Green ICT practices, and then reconstruct knowledge depending on the competencies and skills (e.g. the understandings of Green ICT, the prior experience of ICT or Green ICT, Green ICT skills and attitudes etc.) and the organisational culture (e.g. shared formal and informal norms, shared beliefs, etc.).

Table 2: Summary the outer organisational context

Original policies	**University A**	**University B**	**University C**
Policy 1 Encourage energy efficiency by purchasing the ICT equipment based on criteria of Green ICT standards.	Reconstructed	Reconstructed	Reconstructed
	1.Competencies and skills context 2.Culture context	Competencies and skills context	1.Competencies and skills context 2.Culture context
Policy 2 Reduce energy consumption in order to achieve university's targets	Not reconstructed	Reconstructed	Reconstructed
	The gap of Competencies and skills context	1.Competencies and skills context 2.Culture context	1.Competencies and skills context 2.Culture context
Policy 3 Promote sustainable modes of transport, and to reduce transfer needs	Reconstructed	Reconstructed	Not reconstructed
	1.Competencies and skills context 2.Culture context	1.Competencies and skills context 2.Culture context	The gap of competencies and skills context
Policy 4 Minimise the use of natural resources, reducing pollutions, reusing materials, recycling and reducing the ICT equipment waste to landfill	Not reconstructed	Reconstructed	Reconstructed
	1.The gap of competencies and skills context 2.The distance of culture context	1.Competencies and skills context 2.Culture context	1.Competencies and skills context 2.Culture context
Policy 5 Reduce carbon emissions through Carbon Management and Reduction Plan.	Not reconstructed	Not reconstructed	Not reconstructed
	The gap of competencies and skills context	1.The gap of competencies and skills context 2.The distance of culture context	The distance of culture context

Discussion

Findings were summarised into the inner organisational context involving activity, strategy, and regulatory constraints which are seen as the crucial context of establishing practices.

Firstly, we found that the activity context covering the current operations, and procedures in relation to Green ICT, has influence in adopting practices. Secondly, the results show that the strategy context involves ICT-related policy and the executives' support, the budget to support Green ICT , and technology which are available for Green ICT implementation. Thirdly, the regulatory constraints are used to consider when universities adopted the practices. The case studies analysed show that the regulation context are Green ICT or ICT related regulations and informal rules. This shows that inner organisational context refers to the context which directly influences on the formation or implementation of organisational practices and it affects their features. In the transfer of Green ICT practices between the UK University and the Thai universities, the activity, strategy, and regulatory constraints are found as the inner organisational context.

The outer organisational context governs the aspects which consist of the competencies and skills, and the organisational culture which have an influence on achieving the reconstruction of knowledge. This research found that the competencies and skills and the organisational culture indeed affect the organisations to reconstruct knowledge. This context is dynamic because the outer organisational context binds the inner organisational context together with the organisational environment, i.e., the outer organisational context can be adjusted to meet changing circumstances. Besides, the outer organisational context has the capacity and flexibility to recognise new conditions which require new interpretations. According to case studies, the Thai universities can provide the member's learning and training, new working manuals, and set new informal rules for working, etc., in order to support members' abilities of this circumstance.

Conclusion

This paper introduced a semiotic approach to develop the practice-oriented knowledge transfer model. This model focuses on practice as a key feature of knowledge transfer. We applied the semiosis model to explain this process and analysed the localisation context that influences the knowledge transfer. This model is particularly well suited to analysing the organisational systems with multiple stakeholder levels (individual, organisation, and social). It helps us to enhance our understanding of organisational contexts of the transfer process. The model was demonstrated by analysing case studies involved a UK university as the source and three universities in Thailand as the recipients of Green ICT practices. The case studies were based on multiple data collections to identify the localisation factors. This model delineates the role of human, social, and technical contexts in determining the effectiveness of knowledge transfer through the use of practices.

The findings show that there are inner and outer organisational context that influence the transfer of practice. The inner organisational context involves activity, strategy, regulatory constraints that influence the transfer of organisational practices. The outer organisational context involves human competences and organisational culture that influence knowledge interpretation and construction. Based on these concepts, this model helps organisations to analyse knowledge transfer situations and adopt external knowledge in order to fit it into the new organisational context. As such, it assists the recipient's decision to choose the source organisation that fits within the context of transfer process. In the future work, we will validate this model by applying it to further case studies, for example, quality assurance and the design of new university degree programmes.

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Analyzing the Effect of Commitment-based Human Resource Practices, Technology and Competition on Web Knowledge Exchange in SMEs

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Abstract

Internet technologies are increasingly being used within all knowledge management processes, including knowledge acquisition, knowledge exchange and knowledge use. Although technological issues are key drivers for Internet technologies adoption and use, organizational and environmental aspects have been found to be equally important. This paper extends previous studies on the use of Internet technologies and knowledge management by analyzing factors affecting knowledge exchange through Internet technologies within small and medium-sized enterprises (SMEs). More specifically, drawing upon the technology-organization-environment framework, a model to examine how distinct contextual factors influence knowledge exchange through Internet technologies is developed. A data set of 535 SMEs from Spain is used to test the conceptual model and hypotheses. Results suggest that IT expertise and commitment-based human resources practices positively affect knowledge exchange through Internet technologies in SMEs, with the latter being the strongest factor in our proposed model. In contrast, customer power turns out to affect knowledge exchange negatively, while a non-significant relationship was found for factors such as technology integration and supplier power.

Keywords

knowledge exchange, internet, human resource practices, smes, technology adoption.

INTRODUCTION

Much of the organizational transformation during the last decades has been driven by information technologies (ITs). These IT innovations have played an important role in shaping and influencing business processes. IT characteristics of rapid search, access, retrieval and exchange of information make this technology suitable for collaboration and knowledge exchange between organizational members. In essence, IT plays a pivotal role to support organizational knowledge exchange processes (Zhang, Ordóñez de Pablos and Zhou, 2012). Moreover, ITs have been considered fundamental for the development of productivity and knowledge-intensive products and services (Soto-Acosta et al., 2010).

With the advent of Internet and open standards technologies and the associated reduction of communication costs, firms are migrating toward the Internet platform (Zhu et al. 2006) and cloud computing environments (Colomo-Palacios et al., 2012). Effective adoption and use of Internet technologies have become therefore management concerns (Soto-Acosta and Meroño-Cerdan, 2008). Recent studies are starting to analyze the adoption and use of specific digital and electronic technologies within organizations such as electronic signature (e.g. Chang et al. 2007), customer relationship management (Pérez González and Solana González, 2012) and radio frequency identification (Chong and Chan, 2012; Wang et al, 2010) and how these technologies support specific business processes (e.g. Gu et al. 2012). However, much of the existing research is focused on a single aggregate view of the organizational adoption and use of Internet technologies (e.g. Bordonaba-Juste et al., 2012; Gibbs and Kraemer, 2004; Hong and Zhu, 2006; Soto-Acosta and Meroño-Cerdan, 2008; Xu et al, 2004; Zhu et al. 2004; Zhu and Kraemer, 2005). These studies analyze the adoption and use of Internet technologies along the whole value chain activities (or a significant part). Thus, although existing research has expanded our knowledge, little is known about how Internet technologies use affects specific business processes concerning knowledge exchange.

One of the main characteristics of the Internet-based digital platform is that it is founded on the democratization of knowledge, so it facilitates the appearance of natural flows of collaboration and knowledge which, in turn, may favour creativity and innovation (Pérez-López and Alegre, 2012). Thus, it is important to understand the key factors that facilitate and motivate Internet technologies use for knowledge exchange within firms. In this sense, beyond technological and the environmental factors, extant research has recognized the importance of organizational factors in influencing Internet technologies adoption and use

(Gu et al. 2012). Organizational factors may constrain or facilitate the implementation and usage of Internet technologies. In this sense, the literature suggests that organizational human resource (HR) practices that create a commitment-based environment influence the interactions, behaviours and motivation of employees (Collis and Smith, 2006). However, although HR practices may affect the organizational social climate that motivates employees to work together and exchange knowledge, no previous study has analyzed HR practices as organizational enablers of new technologies adoption and use.

Further, small and medium-sized enterprises (SMEs) are of great importance for economic growth, employment and wealth creation. For example, in Europe, SMEs represent around 99% of the total number of firms (European Commission, 2004; Lopez-Nicolas and Soto-Acosta, 2010). However, studies in the literature tend to examine Internet technologies adoption and use in large businesses, with very few and recent studies analyzing Internet technologies adoption and use in SMEs (e.g. Chang et al. 2012; Chong et al. 2009; Dholokia and Kshetri, 2004; Huy et al. 2012). Findings from studies examining large companies are unlikely to be generalizable to SMEs because of various differences between these types of firms (Bhagwat & Sharma, 2007; Lopez-Nicolas and Soto-Acosta, 2010). For instance, smaller firms tend to have centralized structures, with the chief executive officer (CEO) making the most critical decisions, and employ IT generalists rather than specialists (Thong, 1999).

To respond to the above mentioned gaps in the literature, this paper develops a conceptual model, grounded on the technology-organization-environment (TOE) framework, to analyze the key factors that facilitate Internet technologies use for knowledge exchange and employs a large sample of SMEs from different industries for hypothesis testing. The model considers commitment-based HR practices as the organizational enabler, technology integration and IT expertise as technological facilitators as well as customer and supplier power as environmental factors.

The paper consists of six sections and is structured as follows: The next section presents the literature review and hypotheses. Following that, the methodology used for sample selection and data collection is discussed. Then, data analysis and results are examined. Finally, the paper ends with a discussion of research findings, limitations and concluding remarks.

THEORETICAL BACKGROUND AND HYPOTHESES

The review of the literature suggests that the Tornatzky and Fleischer's (1990) technology-organization-environment (TOE) framework is appropriate to study the factors that influence Internet technologies adoption and use. The TOE framework conceptualizes the context of adoption and implementation of technological innovations as consisting of three aspects: technological context, organizational context and environmental context. The technological context refers to the characteristics of the technological innovation, the organizational context describes characteristics of the organizations, and the environmental context implies characteristics of the environment in which the adopting organizations operate (Tornatzky and Fleischer, 1990; Thong, 1999).

The TOE framework has emerged as the main theoretical framework to analyze the different factors which affect the adoption and use of new technologies. As a consequence, very recent studies make use of this theoretical framework to analyze factors affecting Internet technologies adoption and use (e.g. Bordonaba-Juste et al., 2012; Chan et al., 2012; Gu et al., 2012; San Martín et al., 2012). Although specific measures within the three contexts vary across different studies, the TOE framework has been examined in various IT domains including electronic data interchange (e.g. Kuan and Chau, 2001), electronic business (e.g. Bordonaba-Juste et al., 2012, Soto-Acosta and Meroño-Cerdan, 2008, Xu et al. 2004), electronic collaboration (eg. Chan et al., 2012), mobile commerce (e.g. San Martín et al., 2012), Enterprise Resource Planning (e.g. Zhu et al., 2010) and information and open systems (e.g. Chau and Tam, 1997; Thong, 1999). Drawing upon literature analyzing Internet technologies adoption and use, which applies the TOE theory, we propose a comprehensive research model to study the factors that influence Internet technologies use for knowledge exchange. The next subsections discuss the hypotheses of the model.

Technological context

Given the technology-driven nature of knowledge management processes, the extent of Internet technologies use for knowledge exchange would depend on firms' technology competence. Technology competence refers not only to tangible assets, but also intangibles resources, which are more likely to create competitive advantages (Bharadwaj 2000; O'Sullivan and Dooley, 2010; Soto-Acosta and Meroño-Cerdan, 2008). With regard to tangible IT assets, technology integration is a factor, within the TOE framework, that has been found significant in studies focusing on Internet technologies adoption and use (e.g. Zhu et al. 2006, Zhu and Kraemer, 2005). Technology integration is the degree of connectivity of front-end and back-end IT systems and databases. Front-end integration refers to the degree of integration of the Web site functionalities with databases inside the firm, while back-end integration represents the degree of integration of the legacy systems so as to provide data integration among internal databases (Zhu et al. 2004). Front-end and Back-end integration are built on common Internet technologies in use (intranet, website and extranet...) and are important antecedents of Web knowledge exchange since they enable communications and collaboration. Regarding IT intangibles resources, IT expertise has been identified as one of the main factors that influence the level of e-business use (Bordonaba-Juste et al. 2012). Firms that have IT specialists are more likely to adopt IT innovations because they can develop their own website or specific technologies (Lin and Lee, 2005). IT expertise provides the technical skills to develop Internet-based applications. Therefore, IT integration and IT expertise may reflect the extent to which firms are ready to use Internet technologies for knowledge exchange. This discussion leads to the following hypothesis:

> Hypothesis 1: IT integration is positively related to the extent of Internet technologies use for knowledge exchange.
>
> Hypothesis 2: IT expertise is positively related to the extent of Internet technologies use for knowledge exchange.

Organizational context

Knowledge exchange happens when units and members interact, promoting new understanding (Alavi and Leidner, 2001). It is therefore essential for the firm to develop interaction networks that allow individuals not only to access the same information but also to come together and collaborate through the network. This is even more crucial when exchanging tacit knowledge, which requires more interaction between employees (Fox, 2000). However, besides technology enablers, employees need to be willing to collaborate and exchange knowledge. Thus, building a positive social climate may be crucial to motivate employees to work together and exchange knowledge.

Nahapiet and Ghoshal (1998) suggested that cooperation between employees is a key aspect for creating a social climate that drives knowledge exchange within firms. A strong climate for cooperation between knowledge workers positively affect the exchange of valuable and unique knowledge among them (Collis and Smith, 2006). The literature distinguishes between transaction-based HR practices, which focus on individual short-term exchange relationships, and commitment-based HR practices, which emphasize mutual long-term exchange relationships (Tsui et al., 1995). Collins and Smith (2006) found that commitment-based HR practices are significantly related to knowledge exchange among workers. Thus, the following hypothesis incorporates our expectations:

> Hypothesis 3: Commitment-based HR practices are positively related to the extent of Internet technologies use for knowledge exchange.

Environmental context

According to Thong (1999), competition is the business environment in which the business operates. Porter's (1985) five forces refers to horizontal competition (threat of substitute products, the threat of existing rivals, and the threat of new entrants), and vertical competition (the bargaining power of suppliers and the bargaining power of customers).

Early studies on technology diffusion found that competition increases firms' incentives to adopt new technologies so as to remain competitive (Thong, 1999). Competition intensity has been found to be an important driver of Internet technologies adoption (Chong et al., 2009; Wang et al. 2010; Zhu et al. 2003; Zhu et al. 2006). Studies have also found that external pressure from customers and suppliers affect e-business adoption (Del Aguila and Padilla, 2008; Wang and Ahmed, 2009). Therefore, competition intensity is expected to drive organizations to adopt Internet technologies for knowledge exchange. However, research (e.g. Chan et al. 2012; Zhu et al. 2006) has also shown that competition may detract firms from using Internet technologies, challenging the traditional wisdom about competition and innovation diffusion. Zhu et al. (2006) found a positive relationship between competition and e-business adoption, but a negative relationship between competition and the extent of e-business use. Similarly, Chang et al. (2012) found that competition intensity is negatively related to the extent of e-collaboration use in SMEs. Thus, Internet technologies use is less tied to competition intensity than initially thought in both large and small business. Too much competitive pressure lead firms to change rapidly form one technology to another without sufficient time to infuse the technology into the company (Zhu et al., 2006). Thus, although competition encourage technology adoption, it is not necessarily good for technology use.

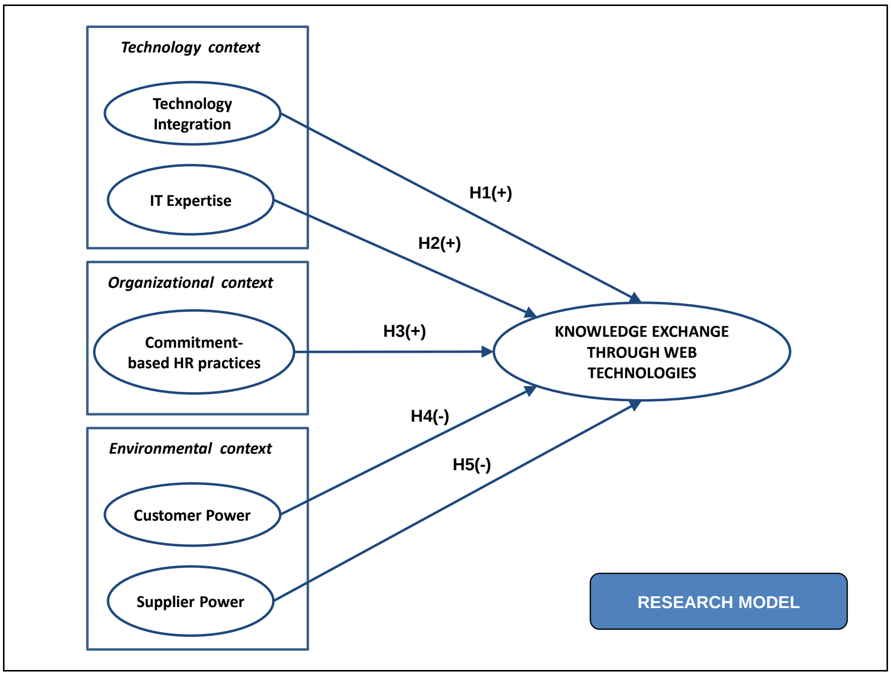
This discussion leads to the following hypothesis regarding vertical competition and Internet technologies use for knowledge exchange:

> Hypothesis 4: Customer power is negatively related to the extent of Internet technologies use for knowledge exchange.

> Hypothesis 5: Supplier power is negatively related to the extent of Internet technologies use for knowledge exchange.

The set of relationships is illustrated in Figure 1.

Figure 1. Research model



RESEARCH METHODOLOGY

Data collection and sample

The organisations selected for this study are SMEs from Spain. Currently, SMEs represent around 99% of the total number of firms in Spain (INE, 2012). Nonetheless, to ensure a minimum firm complexity in which ITs may be relevant, only firms with at least 10 employees were used. Data collection was conducted in two stages: a pilot study and a questionnaire were conducted. Five SMEs were randomly selected from a database to pretest the questionnaires. Based on this responses and subsequent interviews with participants in the pilot study, minor modifications were made to the questionnaire for the next phase of data collection. Responses from these five pilot-study firms were not included in the final sample.

The population considered in this study was the set of all Spanish enterprises, with more than 10 employees, located in the southeast of the country with and which have their primary business activity in one of the following business activities: manufacturing, commercial, services and construction (see Table 1). A total of 2246 were identified and contacted for participation. The survey was administered to the CEO of the companies via personal interview and the unit of analysis for this study was the company. In total, 535 valid questionnaires were obtained, yielding a response rate of 23.8 percent. The dataset was examined for potential bias in terms of non-response by comparing the characteristics of early and late participants in the sample. These comparisons did not reveal significant differences in terms of general characteristic and model variables, suggesting that non-response did not cause any survey bias.

Table 1. Profile of respondents (N= 535)

Profile of respondents	**Percentage**
Industry	
Manufacturing	32.07%
Commercial	29.17%
Services	15.22%
Construction	23.55%
Number of employees	
10-49	74.02%
50-249	25.98%

Measures

The measurement model was developed after successive stages which included theoretical specification, and statistical testing and refinement as indicated by Straub (1989). Measurement items were introduced on the basis of a careful literature review. Confirmatory factor analysis (CFA) was used to test the constructs. Based on the CFA assessment, the measurement models were further refined and then fitted again. Constructs and associated indicators in the measurement model are listed in the Appendix and discussed below. To facilitate cumulative research, operationalizations tested by previous studies were used.

Several constructs are directly operationalized by observed variables. First, *IT expertise* was measured by the number of IT professionals (Bordonaba-Juste et al., 2012; Zhu et al. 2006; Zhu et al., 2004). Second, *Customer and Supplier Power* were measured following two of Porter's (1985) concepts of five competitive forces. Such operationalization has been used in the IT literature (Thong, 1999; Zhu et al., 2004). The survey items assessed the degree of pressure clients and suppliers exert on business regarding purchasing conditions.

Other variables were operationalized as multi-item constructs. First, Technology Integration was measured by the extent to which the website is connected with back-end information systems and databases, and the extent to which company databases are linked to business partners' systems and databases (Zhu et al. 2006). Second, *Commitment-based HR practices* were operationalized from previous research (Collins and Smith, 2006; Delery and Doty, 1996; Youndt et al. 1996) work. Overall, 8 items were adapted to measure Commitment-based HR practices. *Knowledge exchange through Internet technologies* represents the extent of use of common Internet technologies (Intranet, website and extranet/Internet) to exchange knowledge with different stakeholders: employees, customers, suppliers, competitors... (Soto-Acosta & Meroño-Cerdan, 2006; Meroño et al. 2008).

Instrument validation

This study conducted a CFA to assess the unidimensionality of each construct. In this sense, construct reliability, convergent and discriminant validity were assessed. The measurement model presented a good fit to the data ($\chi^2(3)= 6.701$; CFI = 0.99; IFI = 0.99; GFI = 0.99; RMSEA = 0.048). All traditionally reported fit indexes were within the acceptable range.

Construct reliability assess the degree to which items are free from random error and, therefore, yield consistent results. This study calculated reliability of measures using Bagozzi and Yi's (1998) composite reliability index and Fornell and Larcker's (1981) average variance extracted index. For all the measures both indices were higher than the evaluation criteria, namely 0.6 for composite reliability and 0.5 for the average variance extracted. Convergent validity assesses the consistency across multiple constructs. As shown in table 2, after dropping insignificant items, all estimated standard loadings are significant ($p<0.01$) and of acceptable magnitude, suggesting good convergent validity (Sethi and King, 1994).

Table 2. Measurement model: confirmatory analysis and scale reliability

Construct	Indicators	S. Loadings	t-value	Reliability
Technology integration	TI1	0.767	--	CR = 0.78 AVE = 0.64
	TI2	0.834	4.20	
IT professionals	ITP	*na*	*na*	*na*
Training support and employees' interest	HR1	0.742	--	CR = 0.75 AVE = 0.61
	HR2	0.814	6.59	
Carreer plans and evaluation reporting	HR5	0.43	--	CR = 0.80 AVE = 0.57
	HR7	0.78	6.52	
	HR8	0.94	6.33	
Customer power	CP	*na*	*na*	*na*
Supplier power	CP	*na*	*na*	*na*
Knowledge Exchange through Web technologies	KE1	0.677	--	CR = 0.78 AVE = 0.56
	KE2	0.606	4.23	
	KE3	0.597	4.24	

Fit statistics for measurement model: $\chi 2(3)$= 6.701; CFI = 0.99; IFI = 0.99; GFI = 0.99; RMSEA = 0.048.
Insignificant factors are dropped (HR3, HR4, and HR6); (--): Fixed items; CR: Composite reliability
AVE: Average variance extracted; na. Loadings, CR and AVE are not applicable to single-item constructs.

To assess the discriminant validity – the extent to which different constructs diverge from one another – Forell and Larcker's (1981) criterion, that the square root of average variance extracted for each construct (diagonal elements of the correlation matrix in Table 3) should be greater than the absolute value of interconstruct correlations (off-diagonal elements), was used. All constructs met this criterion, suggesting that the items share more variance with their respective constructs than with other constructs. Table 3 also provides an overview of the means, standard deviations and correlations of the constructs.

Table 3. Descriptives statisticts and discriminant validity

Constructs	Mean	Standard deviation	Correlation matrix (1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Technology integration	2.67	1.22	**0.80**						
2. IT expertise	0.73	2.79	0.11**	*na*					
3. Training support and employees' interest	3.88	0.90	0.09**	0.02	**0.78**				
4. Career plans and evaluation reporting	3.18	0.91	0.33***	0.04	0.33***	**0.76**			
5. Customer power	3.61	1.09	-0.06***	-0.04	0.04	-0.01	*na*		
6. Supplier power	3.03	1.08	0.08	-0.01	-0.02	0.06	0.22***	*na*	
7. Knowledge Exchange through Web technologies	2.62	0.99	0.05**	0.10**	0.29***	0.26***	-0.13**	0.06	**0.75**

*Significance levels: $p<0.05$**; $p<0.01$***;* na. Variance extracted is not applicable to the single-item constructs.
Diagonal values in bold represent the square root of the AVE

This study measures commitment-based HR practices as a single construct made up of two dimensions: Training support and employees interest and career plans and evaluation reporting. A second-order factor analysis demonstrated that the two dimensions reflect a higher-order construct (see table 4)

Table 4. Second-order confirmatory factor analysis of HR commitment practices

First-order construct	**Fist-order** Indicator	Loading	t-value	**Second-order** Loading	t-value
Training support and employees' interest	HR1	0.674	--	0.910	9.626
	HR2	0.858	7.23		
Carreer plans and evaluation reporting	HR5	0.456	--	0.466	6.546
	HR7	0.784	9.80		
	HR8	0.875	9.50		

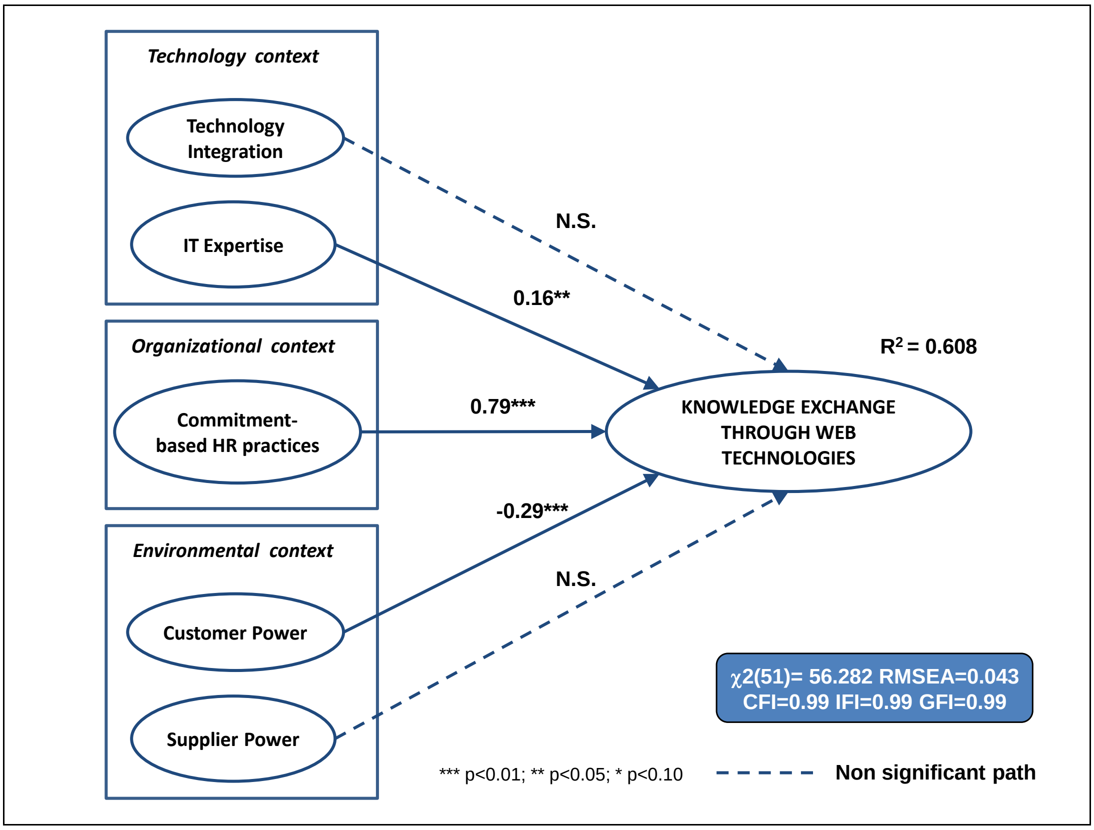
Fit statistics: $\chi2(3)$= 6.701; CFI = 0.99; IFI = 0.99; GFI = 0.99; RMSEA = 0.04; (--): Fixed items

RESULTS

This paper performs structural equation modelling (SEM) to test the hypotheses, using maximum likelihood estimation techniques to test the model. The fit of the model is satisfactory ($\chi^2(51)$= 56.282; RMSEA=0.043; CFI=0.99 IFI=0.99 GFI=0.99), suggesting that the nomological network of relationships fits the data and the validity of the measurement scales (Churchill, 1979). The model explained substantial variance of knowledge exchange through Internet technologies (see figure 2).

Figure 2 shows the standardized path coefficients with their respective significant levels. Hypothesis 1 did not found support, indicating that technology integration is not related to knowledge exchange through Internet technologies in SMEs. Hypothesis 2 was confirmed (0.16, $p<0.05$), this result show that hiring specialized IT personnel in the firm is an important factor for knowledge exchange through Internet technologies. Hypothesis 3 was confirmed (0.79, $p<0.01$), being commitment-based HR practices the strongest factor in the proposed model. This indicates that the presence of commitment-based HR practices is a critical factor driving knowledge exchange through Internet technologies. Hypothesis 4 was confirmed (-0.29, $p<0.01$), while hypothesis 5 did not found support, indicating a negative relationship between customer power and knowledge exchange through Internet technologies and a non-significant relationship between supplier power and knowledge exchange through Internet technologies. Implications of these results are discussed in the next section.

Figure 2. Empirical results



DISCUSSION

Using a data set of SMEs the effects of five TOE factors on knowledge exchange through Internet technologies are analyzed. The empirical results have revealed that factors have differential effects. Regarding the technological context, not only tangible but also intangible resources have been incorporated in our model: technology integration and IT expertise. Results suggested that though IT expertise is positively associated with knowledge exchange through Internet technologies, a non-significant relationship was found for the relationship between technology integration and knowledge exchange through Internet technologies. The first finding confirms recent research (Bordonaba-Juste et al. 2012), which found that IT expertise is one of the main factors that affect the extent of e-business use. However, the second finding counters existing research (e.g. Zhu et al., 2006, Zhu and Kraemer, 2005), which found that technology integration is positively related to the extent of e-business use (Zhu et al, 2006) and positively associated to e-business value (Zhu and Kraemer, 2005). A possible explanation to this can be that previous studies have focused on aggregate measures of the organizational adoption and use of Internet technologies and, within that context, technology integration may be more crucial. In contrast, within the specific context of SMEs and knowledge exchange, intangible IT resources (Bharadwaj 2000; O'Sullivan and Dooley, 2010) such as hiring specialized IT personnel seem to be the major technological drivers of knowledge exchange through Internet technologies. This results support the idea that IT per se do not create value, because every firm can purchase IT in the marketplace. Rather, IT value creation depends more on intangible IT assets (Soto-Acosta and Meroño-Cerdan, 2008).

Regarding the organizational context, the effect of commitment-based HR practices on knowledge exchange through Internet technologies is analyzed. Results showed a positive relationship between these two constructs, being commitment-based HR practices the strongest factor in our proposed model. This finding confirms support previous studies (Collins and Smith, 2006) which, though not focusing on Internet technologies, found that commitment-based HR practices were significantly related to knowledge exchange among workers. Thus, SMEs should focus on commitment-based HR practices, rather than on transaction-based HR practices, in order to create a social climate which promotes knowledge exchange through Internet technologies. With regard to the environmental context, results suggest a negative relationship between customer power and knowledge exchange through Internet technologies and a non-significant relationship between supplier power and knowledge exchange through Internet technologies. These findings partially support recent research (Chan et al. 2012; Zhu et al. 2006), which found that competition may detract firms from using Internet technologies. Thus, although external pressure from customers and suppliers affect e-business adoption (Del Aguila and Padilla, 2008; Wang and Ahmed, 2009), competition is not necessarily good for technology use. Too much competitive pressure lead firms to change rapidly form one technology to another without sufficient time to use the technology (Zhu et al., 2004; Zhu et al., 2006). Our findings also confirm previous research using SMEs. In this sense, Chang et al. (2012) found that competition intensity is negatively related to the extent of e-collaboration use in SMEs. Thus, this finding demonstrates that knowledge exchange through Internet technologies emerges from internal organizational and technological resources rather than from external pressure.

CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

Organizations' survival and success depend on the effort and interactions of employees as they carry the skills and generate knowledge to transform new ideas into innovations. Since firms are increasingly adopting Internet technologies for conducting business processes (Soto-Acosta and Meroño-Cerdan, 2008), it becomes essential to assimilate Internet technologies to support information sharing and knowledge exchange within firms. Hence, it is important to understand what factors influence the usage of Internet technologies for knowledge exchange. This study examines the influence of five contextual factors on knowledge exchange through Internet technologies. Empirical results identified significant factors shaping knowledge exchange through Internet technologies and their effects.

This paper makes several contributions to the literature. First, it analyzes significant factor shaping knowledge exchange through Internet technologies in SMEs. Previous studies in the literature tend to focus in large businesses, with very few and recent studies analyzing Internet technologies adoption and use in SMEs (e.g. Chang et al. 2012; Chong et al. 2009; Dholokia and Kshetri, 2004; Huy et al. 2012). Based on a large sample of SMEs, this paper favors the generalizability of results to SMEs. Second, using the TOE framework the usage of Internet technologies for knowledge exchange is conceptualized within SMEs. Previous studies have shown the usefulness of the TOE framework for understanding the adoption and use of Internet technologies within firms (e.g. Bordonaba-Juste et al., 2012; Chan et al., 2012; Gu et al., 2012; San Martín et al., 2012). However, much of the existing research is focused on a single aggregate view of the organizational adoption and use of Internet technologies (e.g. Bordonaba-Juste et al., 2012; Gibbs and Kraemer, 2004; Hong and Zhu, 2006; Xu et al, 2004; Zhu et al. 2003; Zhu and Kraemer, 2005). In this paper, we extend previous work by analyzing how Internet technologies use affect a specific activity within SMEs: knowledge exchange. Third, we theorized and tested differential effects of the TOE factors on knowledge exchange through Internet technologies in SMEs. Previous research has found that organizational factors are key drivers of Internet adoption and usage. However, to the best of our knowledge, this is the first study examining the effect of commitment-based HR practices on knowledge exchange through Internet technologies. The high positive influence found suggests that commitment-based HR practices affect the organizational social climate that motivates employees to work together and exchange knowledge.

While the contributions of the present study are significant, it has some aspects which can be addressed in future research. First, the sample used was from Spain. It may be possible that the findings could be extrapolated to other countries, since economic and technological development in Spain is similar to other OECD Member countries. However, in future research, a sampling frame that combines firms from different countries could be used in order to provide a more international perspective on the subject. Second, the key informant method was used for data collection. This method, while having its advantages, also suffers from the limitation that the data reflects the opinions of one person. Future studies could consider research designs that allow data collection from multiple respondents within an organization. Third, developing solid instruments in the IT literature is still an ongoing procedure of development, testing and refinement (Zhu et al., 2004; Zhu et al., 2006). Although reliability and validity were empirically tested in our data set, further confirmatory studies are necessary to determine the external validity of the results. Particularly, as discussed in the hypotheses section, competition constructs in our study capture vertical competition, which needs to be enriched in further research to include horizontal competition. Future research designs could consider other important organizational context factors such as organizational strategy and culture. Fourth, this research takes a static, cross-sectional picture of contextual factors affecting knowledge exchange through Internet technologies, which makes it difficult to address the issue of how contextual factors and their importance may change over years. A longitudinal study could enrich the findings. These suggestions should be taken into account in future studies to increase the validity of our findings.

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Appendix. Measures

Variables	Description
Technology Integration	
TI1	Extent to which the website is electronically integrated with back-end systems and databases (1-5)
IR2	Extent to which company databases are electronically integrated to that of business partners (clients, suppliers...) (1-5)
IT expertise (ITP)	Number of IT professionals (#)
Commitment-based HR practices	
HR1	Employees' interest are taken into account for decision-making (1-5)
HR2	Our company support employees willing to take further training (1-5)
HR3	Our company helps employees achieving work-life balance (1-5)
HR4	Selection processes are formalized and rigorous (1-5)
HR5	Our company has established career paths (1-5)
HR6	Promotion is based on objective criteria (seniority, objectives...) (1-5)
HR7	Performance appraisals are conducted on a regular basis (1-5)
HR8	Employees are informed about their performance appraisals (1-5)
Customer Power	Extent of pressure clients exert on purchasing conditions (1-5)
Supplier Power	Extent of pressure suppliers exert on purchasing conditions (1-5)
Knowledge exchange through Web tech.	
KE1	Extent to which the Intranet is used to exchange knowledge between employees (1-5)
KE2	Extent to which the Website is used to exchange knowledge or debate with customers (1-5)
KE3	Extent to which the Extranet and the WWW is used to exchange knowledge or debate with business partners (1-5)

Note. (1-5): five-point Likert-type scales; (#): continuous variable.

Balancing Push and Pull Information Management within the Supply Chain

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Abstract

The aim of this paper is to explore the management of information in an aerospace manufacturer's supply chain by analysing supply chain disruption risks. The social network perspective will be used to examine the flows of information in the supply chain. The examination of information flows will also be explored in terms of push and pull information management. The supply chain risk management (SCRM) strategy is to assess the management of information that allows companies to gather information which will allow them to mitigate that risk before any disruption to the supply chain occurs. There is a shortage of models in analysing the supply chain risk associated with information flows, possibly due to the omission of appropriate modelling techniques in this area (Tang and Nurmaya, 2011). This paper uses an exploratory case study consisting of a multi method qualitative approach using fifteen interviews and four focus groups.

Keywords

supply-chain, risk, scrm, push, pull, information-management.

Introduction

The aim of this paper is how to identify disruption risk in an aerospace supply chain through the examination of information flows by looking at individual's social networks. The social network perspective will be used to discuss the flows of information in the supply chain. The examination of information flows will also be explored in terms of push and pull information management.

Supply Chain Risk Management (SCRM) has become a popular area of research and study in recent years (Singh and Brookes, 2008). This can be highlighted by the number of peer reviewed articles that have appeared in academic literature. Our world is increasingly uncertain and vulnerable. Over the last 10 years, we have witnessed many types of unpredictable disasters, including terrorist attacks, wars, earthquakes, economic crises, devaluation of currencies in Asia, SARS, tsunamis, strikes, computer virus attacks, etc. (Tang, 2006). This coupled with the realisation by companies that SCRM strategies are required to mitigate the risks that they face, makes for challenging research questions in the field of risk management. The challenge that companies face today is not only to identify the types of risks that they face, but also to assess the indicators of risk that face them. This will allow them to mitigate that risk before any disruption to the supply chain occurs. Risk identification is the fundamental stage of the entire risk management process (Giannakis and Louis, 2011).

Social Networks

The concept of 'social networks' is well established. Social networks have been used as constructs in social sciences since the 1950's (e.g. Hayashi, 1957; Mouton et al., 1955). The features of the social network perspective have been summarised by Wasserman and Faust (1996). The social network perspective implies viewing systems in terms of relations between individual actors, where actors and actions are seen as interdependent rather than independent. The relational ties between actors allow the transfer of resources: physical or information based. Network structures are developed from combinations of these 'dyadic' relational ties between two actors. Network models explain structures in terms of lasting patterns of relations between actors. Combinations of relational ties can form 'paths' through the network by which non-adjacent actor nodes can communicate.

Supply Chain Risk

Supply chain risk is defined as the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety (Zsidisin, 2003). Chopra and Sodhi (2004) go on to argue that there are nine categories of risk: disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory, and capacity. The disruption to material flows can appear anywhere in the supply chain. Examples of causes of disruption include, natural disasters, labour strikes, fires and terrorism that have halted the flow of materials. This disruption can be routine and short term or catastrophic and long term. This paper will look at disruption risk in the aerospace industry. Having reviewed the literature on supply chain risk, (Chopra and Sodhi, 2004, Tomlin, 2006, Mohd Nishat et al., 2006) there are a number of tactics that can be employed to reduce disruption risk in a supply chain. These include:

- Increasing inventory
- Increasing capacity
- Acquiring redundant suppliers
- Increasing/improving communication

These solutions have cost implications but increasing and improving communication has potentially the least cost implication.

Information Management

There is a shortage of models in analysing the supply chain risk associated with information flows, possibly due to the omission of appropriate modelling techniques in this area (Tang and Nurmaya, 2011). These findings were found from a literature review of supply chain risk papers. Jorge (2009) suggests avenues of future research into how information management, IT and unpredicted interventions and sources of instability in the supply chain can be modelled. The importance of information management and the supply chain is also highlighted (Jorge, 2009). In the paper by Wakolbinger and Cruz (2011) they develop a framework to analyse the impact of information acquisition and sharing as well as risk-sharing contracts on production and transaction costs and disruption risks in competing supply chains. Risk sharing contracts are one way in which to mitigate disruption risk in the supply chain (Wakolbinger and Cruz, 2011). However, the types of information flows are not investigated, in particular the push and pull aspects of information flows.

Malhotra (2005), researches how to integrate knowledge management strategy and technologies in business processes for successful performance. The research suggests that there is a superiority of strategy-pull models made feasible by new plug and play information and communication strategies, over the traditional technology push models. The research suggests that the propositions “getting the right information to the right person at the right time” needs to be addressed alongside, the question of what knowledge to manage and towards what end.

Edwards, et al (2005) explores the role of technology in knowledge management in organisations, both actual and desired. Findings of empirical research found that organisations need to resolve four tensions:

- Between the quantity and quality of information/knowledge
- Between centralised and decentralised organisation
- Between head office and organisational knowledge
- Between push and pull processes

There is a tension between pushing information and knowledge out to people and leaving them to pull it when needed. There was general agreement, in the research, that universal push systems did not work. Other literature supports this, such as Damodaran and Olphert (2000). Holtshouse (1998) suggests the need to balance push and pull approaches. Certain people are more likely to choose to pull knowledge for themselves than others are. The research questions how do you involve those who least might wish to be involved.

Information Push and Pull

When investigating information management approaches on the internet (Herman, 2010); there are two ways in which information can flow from source to consumer:

Information Pull, where a consumer or user takes (or is given) the initiative to get the information; or

Information Push, where a supplier of information takes (or is given) the initiative to deliver the information.

These definitions can be further applied to supply chain information management.

Methodological Approach

One could argue that interpretivism could be the underpinning of this research since this epistemology advocates that it is necessary for the researcher to understand the differences between humans in our role as social actors (Saunders, et al. 2007). Thus, the research was conducted between people rather than objects such as computers or cars. One could argue that realism and interpretivism have an argument to be the underpinnings of the thesis, since the focus is on social interactions. Ontology is concerned with the nature of reality (Saunders, et al. 2007). The ontology of realism which argues that reality is real but only imperfectly and probabilistically apprehensible can be seen in this research.

The underpinnings of this research is interpretivism, therefore this paper will use a methodology that consists of a case study (Yin, 2002) which begins with an exploratory case investigation within the aerospace OEM. The literature review allowed the development of research themes that were used in the exploratory case consisting of thirteen semi-structured interviews at the OEM and two interviews in two of the OEM’s suppliers. In this research, case studies with multiple interviews, which are an appropriate way of establishing the field at the early stages of an emerging topic, will be used (Eisenhardt, 1989). The analysis of the interviews using Kruegar's (1994) thematic analysis approach allowed the propositions of the paper to be developed. These propositions will be discussed in the following section. The propositions were then discussed through four focus groups, consisting of two groups at the OEM, followed by two academic groups that were conducted with members of the Operations and Information Management Group at Aston University.

Research Propositions

The propositions that are developed in this research are:

- By improving information flows, through the use of social networks, we can identify supply chain disruption risk.
- The management of information to identify supply chain disruption risk can be explored using push and pull concepts.

The exploratory case study within the OEM found that social networks are currently being used to gather information to identify supply chain disruption risk. This process is tacit and not formalised.

Push and Pull Information Management

Supply chain risk information management was identified as an area of improvement in the exploratory case study. The triggers to identify risk were received into different departments of the organisation. The management of this information needs to be further explored. An emerging theme from the exploratory case study when analysing the triggers to identify risk, was that information can be pushed or pulled into the organisation. The push and pull concept is used to explore the management of supply chain disruption risk information in the organisation

Findings of Push and Pull Information Management Study

The interview transcripts were thematically analysed (Kruegar, 1994) and information flows were assessed as to whether they were pushed into the OEM by suppliers or pulled into the OEM by individuals in the OEM. Examples of cases where information was pushed into the organisation are:

"It was ABC that first contacted us, that XYZ was about to go into receivership. And then a couple of days later we got information from both the receiver and people from XYZ that they had gone into receivership."

(Operations)

"It was one of the senior guys at XYZ who tipped ABC off in our laboratory."

(Purchasing)

"Some companies will let you know, some companies will phone you up. Different people in the organisation, from your main contact to the production manager may phone you up, i.e. this product has got a problem, and gives you more time to deal with these eventualities."

(Purchasing)

It can be seen that information was pushed into the organisation from the above quotes. This is where the supplier has contacted the OEM and passed on information which the OEM has not necessarily asked for. It has been done under the initiative of the individual within the supplier.

Information was also pulled into the organisation by individuals in the OEM, an example of this is:

"Worst case scenario, we send off a hit list as to what should be in this week. I'll phone up where is it, and a lot of the time suppliers will let you go all the way, so there's no planning time."

(Purchasing)

The information when pulled into the OEM, is done under the initiative of the individual in the OEM. The individual thus would contact a supplier or other organisation to assess and request the risk information that they require.

Pull is Better Than Push, to Avoid Information Overload

All four of the focus groups found that pull is better than pushing because you can be selective as to which information that you require and that you can take onus on the information needed.

"But with far too much information, you need to sort it out to one company."

*(*OEM Focus Group 1-Purchasing)

"With me personally few emails is enough for me…"

*(*OEM Focus Group 1-Purchasing)

"We're at the pull end at the moment, but we should be at the other end…"

*(*OEM Focus Group 1-Purchasing)

"I just thought if we could pull more information it would help us out beforehand."

*(*OEM Focus Group 2-Purchasing)

Pulling information was seen as important, but it was also recognised that when information is pushed, it could be important risk information:

"Looking at both ways, I would not pick up the information I need, but should

that information come to you it could be key information…"

*(*OEM Focus Group 1-Purchasing)

"Don't forget the immediate problem always with any piece of knowledge is how do you work its significance? It may be that you would collect vast quantities of irrelevant items."

*(*Academic Focus Group 2)

The type of information management can thus be seen as important and related to the value of information coming into the OEM.

However, pushing information was seen as a type of information overload and made it difficult to select which information was important.

"I think if you're getting the push information the first thing is you're getting too much information and it's your job to sort out which one your want and which one you don't want."

*(*Academic Focus Group 1)

"Being slightly critical, is there a danger though, do you put everything onto it, then it will lose its value?"

*(*OEM Focus Group 2-Purchasing)

"I want to have a look at such and such today, but I don't want to have a look at it next week, whereas if you've got more of a push situation, you are going to be inundated with e-mails and enquiries."

*(*OEM Focus Group 2-Purchasing)

The importance of the type of information sent from a push information management system needs to be balanced by the quantity of information being sent by the system. With too much information being gathered it makes it hard to find and filter the important bits of risk information.

Individuals Will Not Push

Individuals may not push risk information within the OEM due to them being busy and maybe because the OEM hasn't a culture of pushing information:

"My concern when we spoke about it some while ago was that it very, very reliant on individuals still taking the onus to dump information into the a system and as we all know we're very busy people and the concern being is that unless you became very, very familiar as an organisation with this push type system you may have one person not really wanting this to work but if the engineers or the other people in the organisation did not input information then it wouldn't be a worth while tool ..."

*(*OEM1--Purchasing)

This again relates to how important it is in having the right people in the OEM to deal with risk information, but also as to deal with the types of risk information management systems. With certain types of people dealing better with push systems than others.

Individuals in some suppliers may also not be willing to communicate, let alone push information:

"We've almost given up speaking to people, mainly because we just can't get hold of people. We can't get hold of a person to speak to in the corporate, we can't get hold of people to speak to at ABC and XYZ well he's very, very difficult, they won't commit to anything on the phone."

. *(*OEM Focus Group 1-Purchasing)

This again relates to individuals, but this time in suppliers organisations, so social networks need to be built between certain individuals who would be willing to communicate and push information to the OEM.

The pushing of information to the OEM from suppliers and then from individuals in the OEM to a central risk champion in the OEM, was seen as a problem. The OEM saw the solution to be the use of both types of information management systems, which will be discussed in the following section.

A Combination of Pushing and Pulling Information Required

The information whether pushed or pulled was seen as important, and a balance of pushing and pulling risk information was seen as a way of identifying and mitigating supply chain disruption risk:

"Not one approach, is effective alone, you need to have a combination of approaches."

*(*OEM Focus Group 1-Purchasing)

"I suppose individually the information means nothing but collectively it could be a big pointer."

*(*OEM Focus Group 2-Purchasing)

The importance and use of pulling risk information was seen as important, but the information overload nature of push systems was also argued to be as important.

"It's all about going after the information yourself rather than waiting for the information to come to you because it doesn't always come does it."

*(*OEM Focus Group 2--Purchasing)

"The information comes out of there, but you haven't to go pushing… okay so you've got to go to it in the first place, so you've got to push to get the information, but once you've got the information, you can be ahead of the game."

(OEM Focus Group 2-Purchasing)

The nature of gathering information from suppliers was also seen as important and an aspect of the day to day role of a purchaser in the OEM.

"I think what I'm saying is that a push system, I would love to have the push system there because that's my job, I go out and I'm listening to all this stuff that's out there, but I think the push system, if you put a system in, it would have to be self-feeding site and you'd come to live with it."

(OEM Focus Group 2-Purchasing)

"We won't have the manpower to go out and attend these conferences or to network because we just don't… we don't network. It's not our culture to do networking. So the push system I guess if you get that networking information in from that somehow, that could be a benefit."

(OEM Focus Group 2-Purchasing)

Gathering information from push systems was seen as important but needs to be complemented by a pull system. A balance of both forms of information systems was seen as important:

"I think if you have a system that balances both approaches"

(Academic Focus Group 1)

"Both systems will of course have their own limitations. You may be not getting all the information with a pull approach, on the push approach might be getting loads of wrong information, and gossip."

(Academic Focus Group 1)

Pulling information and pushing information were both seen as important. Having the right individuals in the organisation are equally important as which type of information management system that they prefer. Certain individuals prefer push systems over pull systems and others argue that pull systems are better. A consensus was reached that both types of systems compliment each other and a balance of both systems needs to be created in the OEM to gather disruption risk information from the supply chain.

Conclusions

The literature highlights good communication and relationship management are important factors in reducing supply chain risk (Mitchell, 1995; Condon, 2007, Juttner, 2005; Juttner, et al, 2003; Khan and Burnes, 2007). However, little research has been done on examining the information flows that lead to the identification of disruption risk.

When analysing the interviewee's responses in the OEM in relation to communication and information flows with suppliers, a common theme that emerged was that information was being pushed into the organisation or pulled into the organisation. The literature looks at this aspect of information flow (Edwards, et al. 2005; Damodaran and Olphert, 2000) and sees a tension between pushing and pulling information, and a balance is required (Holthouse, 1998). Individuals contacting the OEM employees from the suppliers, in relation to risk information or any social information were seen as pushing information to the OEM. Examples of information being pulled into the OEM included individuals ringing suppliers for information, and also individuals analysing and searching for changes of the financial stability of suppliers. An individual using trade associations and forums to pull information about suppliers is another example of pulling information.

When push and pull information was explored in the OEM and University setting, pull was seen as better than having information pushed to you for many reasons. One reason being it was based on the individual pulling what is required, also it avoids information overload from a push based system. However the importance of push based information was recognised as being important as it could contain relevant risk information. As discussed earlier, there is a need to balance push and pull information processes (Holthouse, 1998). As with the exploratory case study, individuals in the OEM may not push information into a tool such as a social network based tool because of the busy culture and time to push such information. Others argued that a combination of pushing and pulling was required for an effective risk information management approach.

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Coach Education – Developing International Discipline of Knowledge

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ABSTRACT

The purpose of this study is to identify and understand the processes involved in the development of the coaching field in general and to explore sports coaches' development in terms of their education, qualifications and experiences. In order to gather the data, the field study involved travel to different countries (supported by Fulbright organization) to attend different types of coach education programs. The study used multiple methods of data collection including questionnaires and interviews with coach education stakeholders. Analysis of documentation and examination and evaluation of the available literature and systems of coach education also formed part of the research process. The results indicate that the training and development of sports coaches is considered central to improving the quality of sports coaching, which in turn develops the sports field in general. The coach learning and development process is a long-term commitment which takes place in a wide range of learning sources, and it is suggested that the coach qualification process should reflect the balance and combination of all of these learning settings in order to build up coaching expertise.

Keywords

coach education, knowledge, coach development, learning.

Introduction

In the field of sports science, there has been an increasing interest in the science of sports coaching in recent decades (Debanne and Fontayne, 2009; Levy *et al*., 2009). There has been 40 years of research into coaching, coach education and coaches' knowledge, and there are many active researchers (Ford *et al*., 2009). This research has been carried out from a number of different perspectives, utilizing an assortment of methodologies (Jones *et al*., 2009) which have established highly skilled coaching practices (Young *et al*., 2009) and led to better understanding of the coaching process and how coaches learn to coach (Taylor and Werthner, 2009). Many factors have led to this growing commitment to coach education; the success of athletes has become increasingly associated with coaching knowledge, methods, skills and analytical capability, and the stakes for winning have become higher politically and economically. Therefore, sports coaching has entered a period of increased recognition, development and provision. Consequently, the education and training of sports coaches is receiving more critical attention at present than previously (Johnston, 1996).

Despite interest in the science of sports coaching in recent decades, there is a perception that research in sports science does not meet the needs of sports coaches (Lyle, 2002; Williams and Kendall, 2007). Researchers have highlighted the differences between the activities of coaching and the focus of sports science research, and the difficulties in bringing together the interests of these two groups. The link between research and coaching practice needs to reflect the fact that coaching incorporates the outcomes of sports science research (Williams and Kendall, 2007). Thus, coaching research needs to be more linked with coaches' needs. An appreciation of issues such as 1. coaches' athletic and coaching profiles; 2. reasons why they become involved in coaching; 3. influences on their coaching; 4. the support they need and 5. reasons why they remain in or leave coaching, are all central to understanding the long-term development of coaches (Larkin *et al*., 2007). The coach qualification process needs to address such factors and such understanding needs to inform the design and delivery of coach education systems, because, through the development of relevant coach education structures and provision, participation and achievement rates would increase.

Therefore, there is a need to study the major perspectives and knowledge in the field of coach education. This study examines coach development and related issues such as what constitutes knowledge, resourcing, problems around qualification and accreditation, and development. The importance of coach education programmes and the context or situation in which they exist will also be examined.

Literature Review:

Sources of Learning for Sports Coaches

The research literature in coaching science continues to grow as more and more research is conducted to increase understanding, among other topics, of how coaches learn to coach, from recreational to elite levels of sport participation (Nash and Sproule, 2009; Werthner and Trudel, 2009). Learning resources for sports coaches have been studied for over a decade (Cushion *et al*., 2010) and many different learning situations have been identified (Erickson *et al*., 2008; Werthner and Trudel, 2009; Nelson *et al*., 2009). For example, Côté (2006) argues that there are three settings in which coaches learn to coach: coach education programmes; learning experiences as an athlete; and learning experiences as a coach. Others have a wider picture of coaches' learning situations. For example, Wright *et al*. (2007) conducted a study with 35 volunteer youth ice hockey coaches from five minor hockey associations in the province of Ontario, Canada. The results revealed seven different learning situations: (a) large-scale coach education programmes, (b) coaching clinics/seminars, (c) formal mentoring, (d) books/videotapes, (e) personal experiences related to sport, family, and work, (f) face-to-face interactions with other coaches, and (g) the Internet. The following sections continue to examine and map the conceptual territory of coach learning. They review literature that explores how coaches acquire the knowledge that underpins their professional practice.

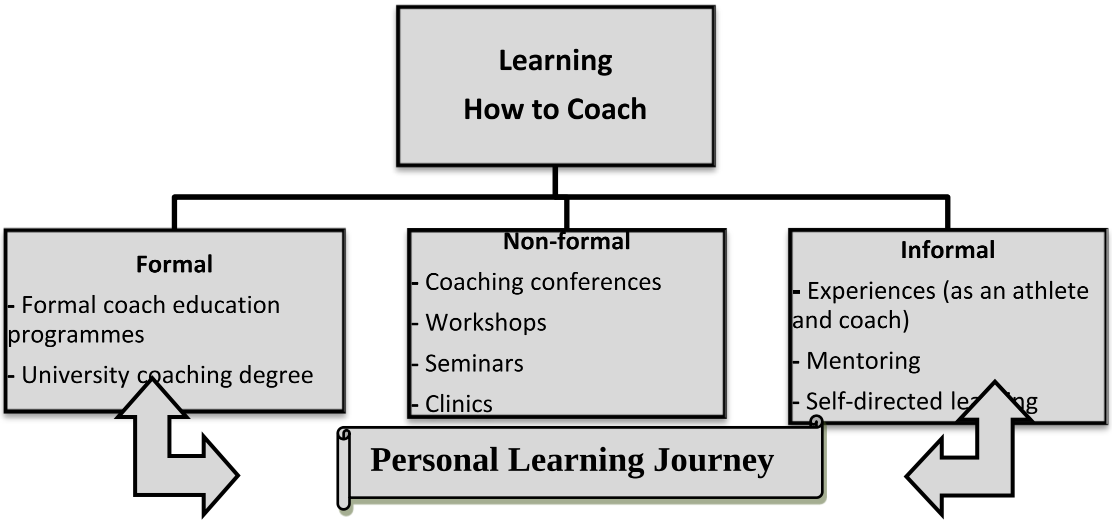
Formal, Non-formal and Informal Coach Learning

As indicated earlier, coaches learn to coach through a wide variety of learning situations. Formal, non-formal and informal educational processes are central to a coach's ongoing development (Côté, 2006; Trudel and Gilbert, 2006; Nelson *et al*., 2009; Reade, 2009) (Figure 1).

The formal learning situation refers to an "institutionalized, chronologically graded and hierarchically structured educational system" (Nelson *et al*., 2009: 249). Situations promoting formal coach learning are typically designed around a relatively standardized core curriculum and candidates must demonstrate facility with the supplied requisite knowledge in order to achieve certification (Erickson *et al*., 2008). This may involve studying for a coaching certificate (formal coach education programmes) and/or a university coaching degree. Non-formal situations have been conceptualized as any organized, systematic, educational activity carried on outside the framework of the formal system to provide select types of learning to particular subgroups in the population (Nelson *et al*., 2009), not necessarily leading to certification (Erickson *et al*., 2008). Non-formal learning may include coaching conferences, workshops, seminars and clinics (Jones *et al*., 2004; Nelson *et al*., 2006; Cushion *et al*., 2010). Although formal and non-formal learning share many similar characteristics, non-formal learning tends to present a particular subgroup of a population (for example, high performance coaches) with alternative sources to those of the formal structured learning pathway (for example, short courses on a specific area of interest) (Cushion *et al*., 2010).

Informal learning is acknowledged as the lifelong process by which every person acquires and accumulates knowledge, skills, attitudes and insights from daily experiences and exposure to the environment (Nelson *et al*., 2009). It is self-directed and based on personal experience and activity within the sport environment (Erickson *et al*., 2008). Informal learning has been shown to occur through previous experiences and opportunities such as interactions with peer coaches and athletes and mentoring, as well as self-directed learning, such as reading magazine articles (Erickson *et al*., 2008).

Figure 1: Learning How to Coach



Sources: Adapted from Erickson *et al*. (2008); Nelson *et al*. (2009); Cushion *et al*. (2010); Duffy, (2010).

Clearly, coaching literature offers an insightful discussion of the various forms of learning opportunity (formal, non-formal and informal). All the above-mentioned learning settings provide significant learning opportunities contributing to the development of coaching expertise (Owen-Pugh, 2009; Cushion *et al*., 2010), and can be called the personal learning journey (Duffy, 2010) (Figure 1). The next three sections offer more detailed discussion about how experiences (as athlete and coach), coach education programmes, and internet-based technology can develop sports coaches' knowledge.

Methods:

The field study of this research involved travel to different countries (Oman, Qatar, Bahrain, the UK and the US) to review and evaluate coach education programs, and to recognize the supporting resources that are available to coaches in order to help athletes achieve their full potential. Three data gathering instruments were selected for the study as methods of data collection as follows: interviews, questionnaires and analysis of documentation. Selecting different methods ensures triangulation in this study. Triangulation is the use of two or more methods of data collection in the study of some aspect of human behaviour (Cohen, 2007; Yin, 2003). Cohen *et al*. (2007: 112) suggest triangulation of techniques to map out, or explain more fully, the richness and complexity of human behaviour, by studying it from more than one standpoint and, in so doing, making use of both quantitative and qualitative data. The multi-method approach adopted increases the validity, or search for truth, of the research. It also "… helps to overcome the problem of method- boundedness" (Yin, 2003; Lacey and Luff, 2007). The participants are all involved in the coaching field in their countries, as sports coaches, sports officers, coach education deliverers, coaching academics and sports decision makers (men and women). Analysis of documentation also formed part of the research process in order to understand systems, organizations' rules, and coach education curricula.

Data obtained during the research trip in the United States of America in 2012 (supported by Fulbright organization) enriched the outcomes of this study. The trip also gave opportunities for the two authors to meet in order to plan and conduct the study. The research trip involved visiting and observing sports organizations, sports libraries, sports centres, youth sports academies and schools, observing coaching workshops/courses/sports training camps, visiting higher education institutes, conducting interviews and collecting and analyzing documents to provide information on the development and monitoring of coach education programme. The research design provided many opportunities to see, listen to and exchange ideas that might be helpful to develop future coach education programs.

Results:

Facilities and Resources for Coach Education (Five Cases)

As the level of sports performance rises, the level of knowledge of sports coaches has to rise as well. One of the responsibilities of coach education is to raise the coaches' knowledge, and it is clear that coach education systems and the resources underpinning them have been quite critical in doing this. Some argue that coach education has failed to enable coaches to integrate knowledge and skills because of over-simplification and de-contextualization in coaching courses (Cassidy *et al*., 2004). Some also argue that coach education provision has generally not been able to develop the knowledge and skills that reflect the demands made on coaches (Jones *et al*., 2004).

Coaches should recognize the supporting resources that are available to them in order to help athletes achieve their full potential (Cushion, 2006). It also suggested that sports coaches should use a balance between a range of learning settings (formal, non-formal and informal) instead of focusing on just one. In order to learn from other cases to underpin development in Oman, it was essential to investigate the preferred resources and formats for improving coaches' knowledge used currently in each case and their strengths and weaknesses, as well as the participants' experiences of these resources, and those they find most useful.

There are very limited resources available through which Omani coaches can update their coaching knowledge. There are more resources available in Qatar; sports coaches can obtain knowledge from coaching courses, whether the courses are organized as a part of the Canadian model or by other sports organizations in Qatar. In addition, coaches who participated in this study noted that they benefit from contact with the foreign coaches working in Qatar:

> We (as Qatari coaches) get benefits from working as assistants with foreign coaches. We also got benefits when we were athletes with them.
>
> (Coach, 2Q6)

Sports coaches in Qatar are also using other resources to update their coaching knowledge, such as the internet and attending sports camps. However, participants mentioned that it is necessary to establish fixed resources that are available for reference at all times, such as sports libraries and online resources. Because there is a lack of Arabic coaching literature, the participants also mentioned the importance of activating the translation process for English literature, as English is the dominant language of coaching texts internationally.

The case in Bahrain is better, as sports coaches have a variety of resources to improve their knowledge, including coach courses, the internet and sports libraries. Coaches also are using materials published by the Training and Development Department as well as resources provided by the sports library located in the department's building. In addition, sports authorities in Bahrain have partnerships with international sports organizations to obtain and share coaching literature and resources.

In the UK, Sports Coach UK has produced a Resource Development Strategy to develop and improve the resources that support the UKCC and CPD programmes. However, there have been few detailed attempts to understand what coaches in the UK require of resources and learning-material formats (Sports Coach UK, 2012). Therefore, the strengths and weaknesses of the existing coach education in the UK and the coaches' preferred learning formats should be recognized and addressed.

To develop knowledge and practice, sports coaches in the UK use a variety of methods and materials for teaching and learning. As learning depends on the individual, most of the coaches mentioned that practical and informal formats, such as contact between coaches and practising coaching in the field, are the preferred ways to improve knowledge. Picking up on this theme, 3UK4 and 9UK4 commented:

> …some of the best experiences they have is actually… working with and having a lesson from another coach, in terms of learning how to coach.
>
> (Coach, 3UK4)

> …its best learning…well you can't beat the practical. You know what I mean. Like the one-to-one or practice way of learning in a demonstration.
>
> (Coach, 9UK4)

Participating coaches from the UK in this study prefer to look for knowledge from other experienced coaches and from practising coaching itself. Previous literature also pointed out similar results. Timson-Katchis and North (2008) conducted a study on the learning sources/environments utilized by sports coaches in the UK since they began coaching. The study confirmed that practical and informal formats were considered the most important settings in which coach learning takes place. The findings suggest that those resources that are immediate to the act of coaching and enable learning through experience were most obviously useful; that is, coaching practice (93%), experiences as an athlete/ player/ participant (89%) and working with observing coaching from your sport (83%). Given the current emphasis on raising professional standards through qualifications, it is not surprising that a large majority of coaches noted the uptake of qualifications (86%) (Timson-Katchis and North, 2008:15). There was agreement in the literature review of this thesis that contact with other coaches and looking at their work as well as working as assistants with experienced coaches gives new knowledge as well as fresh feedback (Cushion, 2006; Trudel and Gilbert, 2006). In fact, the coaching field is where a lot of the information is exchanged and where coaches can meet face-to-face, see, and listen, and this can lead to an increase of knowledge. Learning by practising is also one of the popular educational methods (Cushion *et al*., 2003; Gilbert and Trudel, 2006, cited in Cushion, 2006: 128).

However, sports lecturers and coaching developers in this study held different opinions to the coaches, claiming that the formal learning formats (such as courses) are the best way to increase the coaches' knowledge. Participant 1UK4 gave a clear response on the subject:

> I would say the standard method, the traditional method, is a course, and that’s still the most common.
>
> (Sports lecturer, 1UK4)

Despite the disagreement in the responses of sports coaches and sports lecturers, it may be argued that the informal setting is the dominant mode of learning undertaken by sports coaches due to the limitations of current formal provision. Some (Nash and Sproule, 2009; Cushion *et al*., 2010) argue that qualification activities, such as courses, can be guilty of trying to condense too much information into a relatively short time; and coaches, later in their careers, have come to question much of the information acquired during their initial courses. The courses also often give little more than a basic understanding. As a result of such experiences, some sports coaches have admitted to attending subsequent levels of courses only because they are compulsory. Bodies involved with the UK coaching certificate (as well as in other cases of this study) should address these issues. It is also suggested that a balance of formal and informal opportunities should be offered to improve coaching knowledge and to fit the individual’s needs. Coach education systems should provide a range of learning methods such as courses, books, CDs, DVDs and web-based materials, as well as providing an appropriate environment to share experiences between coaches (Trudel and Gilbert, 2006).

The sports coach should improve different knowledge links and channels in order to build their coaching knowledge and experiences (Davies, 2001; Cassidy *et al*., 2004; Trudel and Gilbert, 2006). According to the data gathered in the current study, coaches in Oman generally use (as in the other cases in this study) the internet, books, CDs, coaching courses and contact with other coaches to improve their experiences:

> Yes, I use internet to update my coaching knowledge as well as looking for international coaching courses, as my (sports organization)

> does not offer me any course. In addition, I use books and contact with other coaches to improve my experiences.
>
> (Coach, 14O4)

As there is no support for attending international coaching courses, Omani coaches have very few opportunities for contact with expert external coaches. This relative isolation from global opportunities in sport exacerbates the inadequate attention to the professionalization of coaching and coach education in Oman. Recent consultations and sport development events appear to be changing this, but not yet in the field of coach education.

Discussion

Learning from Coach Education Programmes

The focus of this study is on the more formal context of coach development. Coach education programmes provide a formalized learning situation. Perhaps one of the greatest benefits of participating in formal coach education is an increase in coaching efficacy, which provides sports coaches with a sense of confidence in their ability to perform (Gilbert *et al*., 2009; McKenna, 2009). It has also been argued that formal coach education has the capacity to lead to the development of sports coaches' critical thinking skills. This is an aspect that has been shown to be vital to continued success for coaches, at least in the area of high-performance sports coaching (Mallett *et al*., 2009).

Comprehensive coach education programmes have been developed in many countries around the world. These formal programmes have many similarities in content and are typically structured around courses on general coaching theory, sport-specific techniques and tactics, and supervised coaching practice (Trudel and Gilbert, 2006). The role of coach education is to facilitate construction of knowledge through experiential, contextual and socio-cultural methods, to help coaches to learn better skills and become more knowledgeable in order to meet the new challenges that face them in modern sport. The learning environment should reproduce key aspects of practice, such as multiple experiences, examples of knowledge application, access to experts and a social context in which coaches collaborate in knowledge construction (Cushion, 2006).

Despite the importance of coach education programmes, the research literature has been highly critical in term of the programmes'/courses' design. Cushion *et al*. (2010) agree with Mallett *et al*. (2009) that formal coach education courses often give little more than a basic understanding, which sports coaches already have, and that the theoretical material covered is considered too abstract from everyday practice to be considered worthwhile. They also mention that courses can be guilty of trying to cram too much information into a relatively short period of time, with a lack of practical lessons. Such formal coach education programmes do not meet the learning needs of sports coaches. As a result of such experiences, some coaches have admitted to attending awards courses only because they are compulsory. To address such issues, the development of coaches and coaching knowledge has received increased research attention in recent years (Erickson *et al*., 2008).

To conclude this section on coach development, coaches are often selected for positions because of their technical abilities and knowledge of the sport. The achievements of the athletes and the success of the coaching process depend on the coaches' technical skills and their ability to impart their knowledge to the athletes. Therefore, it is suggested that coaches should recognize the supporting resources that are available to them in order to help athletes achieve their full potential (Cushion, 2006). Studies on learning situations that are reviewed in this section suggest that formal coach education is important and runs alongside non-formal and informal situations. This knowledge could be better used in the design of formal coach education programmes. All types of learning situations play a role, and there is particularly a need to provide an infrastructure for coaches to continue their professional development across their career and to help them to meet the ongoing needs of their athlete participants. It is not a matter of which form of learning is better, but acknowledging the unique contributions all forms may make to coach development. It is also suggested that research should concentrate on investigating the complementary potential of these situations and what can be done to make each of these situations more appealing to coaches (Wright *et al*., 2007; North, 2009a). Engaging with this literature in the current study, all of the learning situations mentioned should be taken into account when designing the coach education model for Oman, especially the need of formal systems to move forward.

Conclusion

The purpose of this study was to identify and understand the processes involved in the development of the coaching field in general and to explore sports coaches' development in terms of their education, qualifications and experiences. The literature reviewed in this study highlights the major perspectives and knowledge in the field of coach education. The discussion provided theories and knowledge of coach education, including coaching terms and the coach's roles. The main part of this study was about coach development, including issues of knowledge and resources, collective understanding on the varying types of learning opportunity and their contribution to coach accreditation and development. Coach education programmes, their importance and context have been also highlighted.

In light of the discussion in this study, there is growing evidence to suggest that the training and development of sports coaches is considered central to improving the quality of sports coaching and the ongoing process of professionalization (Lyle *et al*., 2009; Mallett *et al*., 2009). Qualifications are seen to be very important for developing coaches' knowledge and practice (Katchis and North, 2008), which in turn develops the sports field in general. On this point, it is important to recognize that the coach learning and development process is a long-term commitment which takes place in a wide range of learning sources, settings and environments to inform the coach's development, and improve their practice. These learning opportunities range through the informal, non-formal and formal (Blomqvist *et al*., 2009; North, 2009b; Taylor and Werthner, 2009). It is suggested that the coach qualification process should reflect the balance and combination of all of these learning settings in order to build up coaching expertise.

Despite the importance of experiential learning modes, the discussion section in this study also highlights the importance of coach education programmes. However, to contribute effectively to coaches' knowledge, programmes should be designed to include a range of learning settings, expanded and modified to reflect all aspects of knowledge used in practice as well as to equip coaches with the competence to do their job (Bale, 2007; Dorgo, 2009; Lyle *et al*., 2009; Mallett *et al*., 2009). Coach education is a continuous process and it is important that, once coaches have qualified, there are services available to support them in their work (Campbell, 1992). National and international federations, as well as national authorities, have a central role in the education of coaches and tutors, and in the recognition of coaching qualifications (Jody, 2012; Jones *et al*., 2004; Larkin *et al*., 2007).

Last but not least, the useful background information in this study raises the need for research in developing countries (such as Oman) to critically apply some of the knowledge put forward by researchers in developed, advanced sporting nations. Therefore, this study will look at some national and international models and frameworks that will eventually inform the emergent Omani proposal.

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Do We Have Time for KM? An SME Perspective

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Abstract

This paper describes the challenges of introducing a Knowledge Management (KM) initiative in a small to medium sized consultancy firm. Adopting a case study approach, the findings indicate that whilst the case study SME was actively seeking to introduce KM within the organisation in order to improve quality of service, it faced many challenges in terms of financial investment in KM activities. For an SME consultancy, 'time is money' as consultants are paid by the hour, and participation in any KM activity needs to be costed against the organisation's income. Hence, KM is viewed as a financial burden in the short to medium term, yet in the long term, these organisations cannot survive without effectively practising KM.This research is limited to one consultancy firm, but given the focus of introducing KM in a service SME, it is valuable to academics, shedding light on the gap between theory and practise and to practitioners highlighting the challenges faced when implementing KM in practise.

Keywords

knowledge management practice, tacit knowledge, case study, SMEs, time

Introduction

Whilst knowledge management (KM) has been studied extensively over the last two to three decades, there has been a tendency to focus on KM in large organisations without sufficient consideration of KM approaches in small and medium-sized enterprises (SMEs) and there has been a call by researchers (Chen et al, 2006, Wei et al, 2011) to fill this gap and conduct further research utilising a 'realistic lens' (Durst & Edvardssson, 2012, p900) in order to gain a better understanding of KM in an SME setting which is faced by very different constraints and challenges than those in a large organisation setting.

This paper addresses this gap in the literature by describing a six month project to introduce KM in an SME within the consultancy sector. Whilst many issues were raised as part of the project, this paper focuses specifically on the challenge that 'time' poses for SMEs trying to introduce KM in order to operate more effectively. The paper demonstrates the gap between KM theory and practise and highlights the importance of KM research that is specific to the SME area.

Adopting a case study approach, the findings indicate that whilst the case study SME was actively seeking to introduce KM within the organisation in order to improve quality and service delivery, it faced many challenges in terms of financial investment in KM activities. For an SME operating in the consultancy sector, 'time is money' as consultants are paid by the hour, and participation in any KM activity needs to be 'costed' against the organisation's income. Hence, KM is viewed as a financial burden in the short to medium term, yet in the long term, the organisation knows that it cannot survive without effectively practising KM and balancing this awareness of the importance of managing knowledge for firm survival with immediate cost and time pressures means that the organisation needs to make, at times, some difficult choices.

Literature Review

Debate in the literature that has explored KM in an SME setting has mainly centred on whether KM is easier to implement in smaller or larger organisations. Some authors (eg, Lim & Klobas, 2000) argue that KM is easier to implement in an SME due to the relative ease by which tacit knowledge can be captured in smaller organisations as compared to large organisations as well as the stronger likelihood of knowledge sharing due to the informality of the organisational setting. This is in contrast to others (e.g. Wong & Aspinall, 2004 and Hamzah & Wood, 2004) who report that SMEs' lack of understanding of KM together with their general resistance to adopting formailsed KM practices presents a real challenge to KM implementation in smaller firms. Challenges faced in implementing KM are of particular relevance to SMEs operating in the consultancy industry where their whole existence is dependant on their ability to draw on previous knowledge, either tacit or explicit, and their ability to create new knowledge, in order to address client needs more competitively than others in the market. Failing to do this, they are not able to operate effectively and market forces drive them out of the industry.

An organisation's ability to create new knowledge and/or draw on previous knowledge requires resources including staffing, IT, communication networks and time devoted to developing bespoke solutions to client needs either through the creation of new knowledge or the adaptation of existing knowledge to new contexts. Time is a critical resource for any organisation, but more so for consultancy firms, as time has implications on costs as well as quality of work performed (Maylor, 2010). Surprisingly, time has been mostly overlooked in the KM literature and any literature that does refer to time tends to focus on the time value in terms of reducing the time and cost of access to knowledge (mainly through improved IT systems) in order to aid KM effectiveness (Janicot & Mignon, 2011 and Hansen et al, 1999). Time as a resource has received limited attention in the KM literature and there is a paucity of empirical research that examines the impact of the availability of this resource on the implementation of KM initiatives. This paper addresses this gap by exploring the importance of time as an independent resource and sheds light on its significance in KM implementation projects.

Two approaches to the discussion of time can be taken. The first approach considers time as a resource which needs to be made available for employees to utilise, whilst the second approach considers the time lag between the knowledge being transferred, or the learning taking place; and the impact on the task in hand. For the purposes of this paper, the focus will be on time as a resource.

Intuitively, it seems reasonable to make a link between the availability of time and the success of KM initiatives. This is based on a number of assumptions. Primarily, knowledge creation, as has been widely discussed in the KM Literature (e.g. Davenport & Prusak, 1998, Kakabadse & Kakabadse 2003), is dependent on knowledge sharing. Among the conditions that need to be present for the sharing to take place, trust (Huber, 2001), reward (Nahapiet and Ghoshal, 1998), and reciprocity (Bock et al, 2005) have been identified as key factors. Yet, the presence of all of these factors is dependant, to varying degrees, on time investments from both the employees and management. Trust, for example, grows over time; it is not something that can be instilled quickly. Trust develops through interactions with others which are perceived to yield positive outcomes (Janicot & Mignon, 2012).

Reward and reciprocity are also time consuming efforts since there is a requirement to identify potentially rewarding knowledge sharing activities and knowledge sharing partners that may provide useful reciprocal knowledge. For employees, the search for the rewards and the potential partners can be extremely time consuming. Time implications for management include the consideration of suitable reward systems as well as the provision of sharing opportunities and possibilities of reciprocal arrangements.

Another factor which has been identified as a major obstacle to success in KM initiatives (Ribiere, 2001, Davenport et al., 1998) and which has strong links with the availability of time, is culture. Much of the literature discusses the importance of a knowledge-friendly organisational culture (Zheng et al., 2010, Meso & Smith, 2000, Davenport et al., 1998,) that supports the development of sharing relationships facilitated by face-to-face communication as well as communication through the use of technological tools. Comparisons drawn between Japanese and Western culture (Nonaka and Takeuchi, 1995) highlights the significance of informal meetings as a way of sharing information and strengthening the organisational culture. Yet, it seems evident that this is reliant on the availability of time so that employees can invest the scarce resource of time without feeling that it is being wasted or feeling that their job security is threatened.

The impact of time has been identified by Kanter (1984) as critical to the generation of innovations. The whole concept of innovation is based on both the interaction of individuals (Leonard and Sensiper, 1998) as well as the application of mental models and frameworks to problems in order to come up with a solution (Kanter, 1984). Both of these entities are time consuming and require an understanding from both employees and management that time invested may not necessarily generate the required results yet still needs not to be viewed as wasted time.

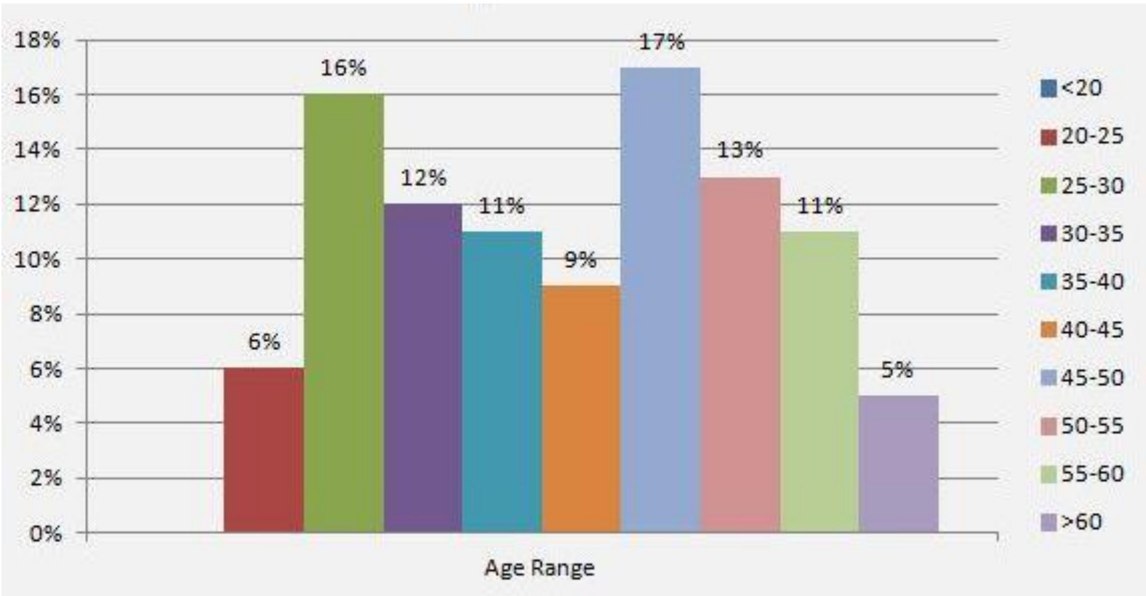
Further, much of the KM literature refers to the problems posed by IT in creating information overload (McDermott, 1999). Amongst the frenzy in organisations to acquire faster and more efficient tools, little consideration has been given to the amount of time employees are both willing and able to give up in order to learn how to use these tools. Even with an ability to use the tools, knowledge repositories are today capable of holding vast amounts of information and knowledge meaning increased time and effort in order to locate any required piece of information. Contributing to the knowledge repository as well as keeping the information updated is also a time consuming task and may be considered unrewarding depending on the culture of the organisation and the perceived returns on the time investment. Guptara (1998) cited the lack of time as one of the key reasons why KM fails, as organisations are too busy to invest in activities that do not immediately affect the bottom line.

One counter argument that has been posed is that no specific percentage of time needs to be allocated to KM activities as KM is seen as integral to the working of the organisation and therefore all tasks and processes should take a KM perspective (O'Dell et al., 1999). However, whilst this is an understandable and arguably, sensible approach, organisations such as SME consultancy firms operate by attaching a cost to time – i.e. they charge for time spent with clients, time spent on projects and generally time spent delivering their services. As such, building KM time into the daily workings of the organisation would be illogical as time is actually the product that is being sold and therefore needs to be costed against different tasks. This is one of the major challenges for consultancy firms embarking of KM implementation projects. Based on the above discussion which has highlighted the importance of time as a resource necessary for KM project implementation, the rest of the paper describes the outcomes of a six month KM implementation project in an SME consultancy firm.

Company Background and Problem Area

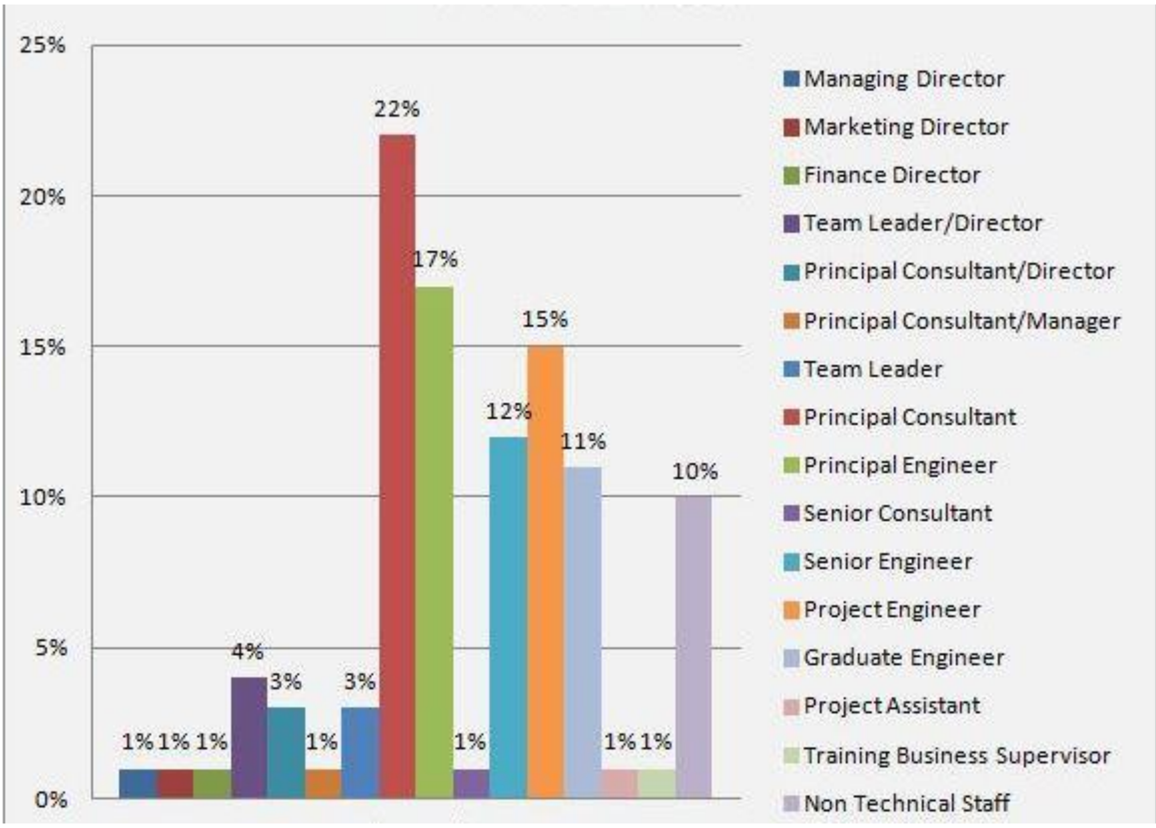
The participating company was a consultancy firm with their head office based in the North West of England. The company had grown rapidly from a small to medium-sized enterprise, providing an expanding service range across 7 diverse market sectors from 10 offices on 3 continents.

For more than 15 years, the company's consultants had provided engineering and strategic consultation to major global companies in various market sectors ranging from Oil and Gas to Transportation and Commercial. The success of the company was mainly because of its ability to recruit and retain experienced consultants with a broad range of knowledge and skills. Furthermore, senior management at the company realised that the company had reached a critical point in contained growth, after which it would be difficult to manage the existing knowledge in the company due to the geographical spread as well as the growth in consultant numbers. Also, to meet client demands and expand the business, recruiting less experienced and junior engineers was inevitable. Hence, the growth of the business had resulted in a "two –humped" profile in terms of the age, and position and a definite bi-polar profile in terms of experience, as shown in the graphs below:



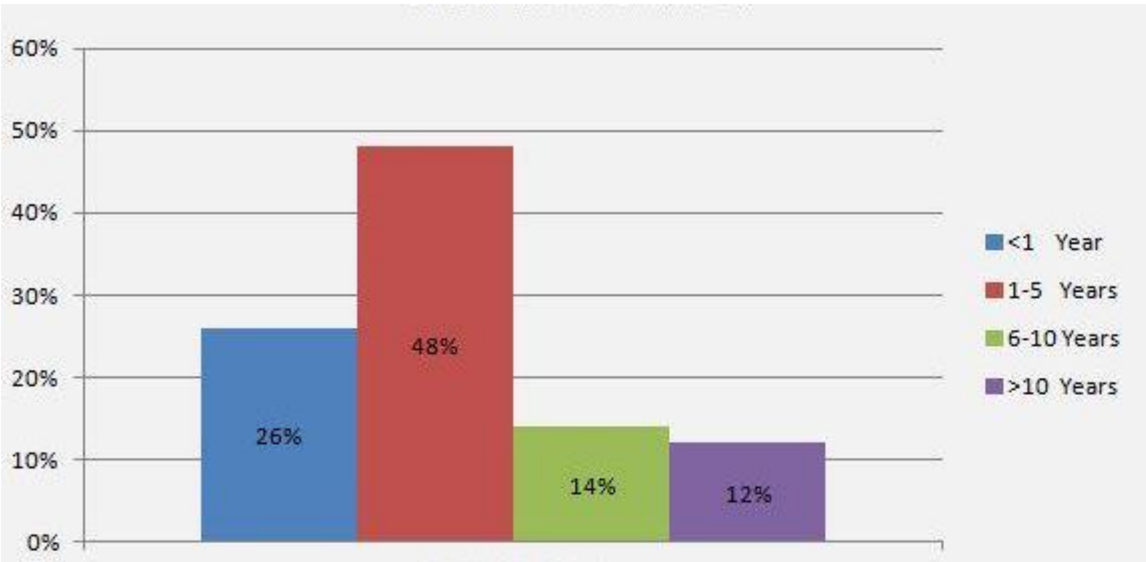
Graph 1: Age range at the company

As the graph shows, the participating company was a mature company as more than half of the workforce (55%) were over 40.



Graph 2: Positions at the company

As the graph illustrates, company's most experienced staff were a minority compared to less experienced staff.



Graph 3: Years with the company

As the company had reached a critical juncture in the development of the business, directors of the company felt that key strategic decisions needed to be made on how to capture and leverage the knowledge across the total business to create competitive advantage(Kanjanabootra et al, 2011), preventing a 'silo mentality' from emerging (typical of larger organisations) (Liebowitz, 2004) and "Corporate Memory" loss (Brooking,1999) as it grows further. The challenge was to address the unique knowledge held by experienced consultants and make it accessible, transferable and visible to others. Difficulties to be addressed included time constraints on experts working across time-zones, the differing industries served, the specialist technical nature of the services, and the broad cultural background of employees. Therefore, a six-month Knowledge Transfer Partnership (KTP) with Liverpool John Moores University was started to initiate Knowledge Management (KM) across the firm.

Apart from the company and the university, a recently qualified graduate, known as an Associate, is assigned to each partnership in order to manage the project and employ the new procedures and processes in the company (http://www.ktponline.org.uk).

The main objectives of the sKTP were to:

1. Create a step-change in how knowledge is perceived and utilised throughout the organisation.
2. Improve operating efficiency, technical quality and consistency of services delivered across the organisation.
3. Develop a knowledge management process that works for the nature of the company's business and culture, identify key knowledge holders, establish commonly agreed good practice and 'state-of-the-art' practices, and make all this visible and accessible across the whole business.
4. Identify areas of critical knowledge (including intellectual property) that would be best productised for commercial gain.

Methodology

As mentioned before, the aim of the project was to encourage knowledge sharing and capture among consultants. The project was divided into three key phases. The first phase included a baseline audit, options assessment, detailed design and stakeholder consultation. Phase two was dedicated to conducting a pilot study and developing forward implementation plans and phase three included an evaluation of the pilot study and project conclusion with plans for full roll out of the project.

Phase one was a key part of the project as it allowed the team to get an in depth understanding of actual KM activities as well as perceptions of KM within the organisation.

More specifically, phase one involved

- Conducting interviews with the main stakeholders of the project (consultants) to engage the stakeholders (n=7)
- Surveying the whole company (n=150) through a comprehensive "Knowledge Audit Questionnaire" to comprehensively study the company under three main themes:
  - Quality of Sources, Visibility and Awareness of Knowledge,
  - Finding and Sharing Knowledge,
  - Flexibility and Innovation across the company

The high response rate (85%) to the survey resulted in an exceptionally rich and valuable data set relating to working culture, knowledge related behavior of the employees, and the quality of the IT systems available in the company.

This set the foundation for the next stage of phase one which was options assessment, detailed design and stakeholder consultation. These three activities were conducted simultaneously and iteratively in as much as possible within the set timeframe. This allowed for stakeholders to have an input in options assessment as well as detailed design bearing in mind that the final decision remained with the senior management team of the company.

Phase two of the project was devoted to roll out of the chosen options. These options were

Company's Portal: The portal initially provided a knowledge sharing platform and a global IT platform which the company lacked at the beginning of the project. This would be used as the point of reference to access corporate announcements, KM tools, and the most important sources of information on the network drives.

Company's Enterprise

Search Engine: An enterprise search engine to enhance search functionality across company's network drives, making searches of data and information available on the network drives more efficient and less time consuming. This was to be accessed via the portal.

Company's Directory: Searchable directory of the company's personnel to provide a single point of access for up to date CVs and profiles of the workforce. This directory makes it possible for consultants to know colleagues outside their immediate teams. The directory was to be accessed through the portal.

Technical Forums: Technical forums facilitate knowledge sharing, capture and reuse across the company which provides the means to translate local know-how into corporate, collective knowledge. They provide opportunities for individuals across different teams and offices to exchange knowledge and information, collaborate, and learn from one another despite of boundaries created by workflow, functions, geography and time. These Technical Forums are one of the KM tools which could be accessed via the portal.

Lunch and
Learn Sessions: Lunch and learn sessions provide opportunities for knowledge sharing, capture, and reuse, also organisational learning and collaboration. The aim was to encourage a corporate, rather than team based approach to such sessions. Sharing knowledge and information of the sessions on a corporate scale, transforms team-level learning into organisational learning.

Lessons Learnt: To prevent accidental "reinventing the wheel" it is necessary to capture, share, and reuse the valuable knowledge gained through various projects. The aim was to encourage a corporate approach to capture the lessons and experience gained through accomplishing projects and sharing them with the workforce so they can be reused as appropriate. These project Lessons Learnt could be one of the technical inputs to the relevant Technical Forums.

Finally phase three was concerned with an evaluation of the pilot study in order to establish the strengths and weaknesses of the project and glean useful lessons learned before full roll out of the project.

Key Findings and Discussion

The findings from this project can be divided into three sections – quantitative, qualitative and observations.

Key quantitative finding revealed that

- **95%** of respondents believe that key source of knowledge for employees in the organisation was their own skills and experience
- **51%** of respondents believe that key sources of knowledge and information are not visible to them
- **23%** of respondents believe that others in the company are aware of their skills and experience
- **46%** of respondents believe that lack of time is the biggest barrier to sharing knowledge
- **51%** of respondents believe that innovation is encouraged in the organisation

Overall, the company had a promising knowledge sharing culture which means individuals were happy to share their knowledge and experience and knowledge hoarding was not an issue. However, the sharing activities tended to be confined to the team in which the individual was operating and did not usually extend outside the team, both in terms of sharing knowledge as well as seeking knowledge. As the company grows, this could potentially pose a problem developing silos of knowledge and lack of knowledge use and re-use. Interestingly, the view that time was a major barrier to the sharing of knowledge was held by almost half of the respondents indicating the extent to which time may have an effect of knowledge sharing behaviours. Innovation is one of the strengths of the organization and this is demonstrated in the perception held by over half the respondents that innovation is encouraged by the organization. This is typical of SMEs where the relatively flat organizational structure and smaller teams with less formalized structures allows more room for innovation and thinking outside the box.

Qualitative findings from this project were very rich demonstrating the conflicting agendas faced by the organisation which are typical of consultancy SMEs. Headline findings include all interviewee's belief that the amount of information available to employees is dependant on their personality and ability to interact with others. This again demonstrates the importance of developing trusting relationships, built over time, in order to provide knowledge sharing opportunities.

The other main theme coming out of the interview data was the perception that whilst IT is useful in providing some sources of information, it was too time consuming to search and thus easier to ask someone else in the team. This is demonstrated by the following quotes:

> *"Information is probably available on our network; it is knowing where to find it is the main issue. Information is also probably available from colleagues but it is knowing who to ask"*
>
> *"I regularly use the project library, but the first problem is to find the correct project, which means reference to others"*

Observations of staff provided another rich source of data during this project but more interesting was observation of how members of the senior management team addressed issues relating to the introduction of KM initiatives. Whilst senior management fully understood the need for most of the KM initiatives suggested and discussed, the guiding consideration was a financial one focusing not only on the costs associated with the introduction of the proposed KM initiatives but also on the costs of time allocated to participating in these KM iniatives. This was a consistent pattern throughout all of the discussions and meetings highlighting the significance of time as a cost to the organisation and one which could not be allocated to activities that did not have a direct return on the company bottom line. This is in accordance with Guptara (1998) who noted organisations resistance to committing time to activities that did not yield a tangible financial return.

Conclusion and Further Research

This paper has described a six month KM project undertaken in a consultancy SME. The project highlighted the conflicting agendas faced by SMEs in their adoption of KM as a way of operating in order to maintain competitiveness, efficiency and market presence. These conflicting agendas centre on SMEs awareness of the importance of KM for the safeguarding and promotion of their key asset (i.e. knowledge) but they are also faced by a need to ensure that time is allocated to activities that can be 'costed' and therefore provide a financial return. In the organisation where the research was conducted, KM did not always win this conflict and management felt that KM iniatives had to mostly come out of employees own time. Like most research, this one has certain limitations and they centre on the fact that this was a short project carried out in one SME. Further research needs to explore the issue of time in multiple organisations where KM projects have been running for longer periods.

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Feature Selection and Classification on Learning Attributes Analysis

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Abstract

This paper explores graduate attributes in Computer Science disciplines serviced by Naresuan University, Thailand. Several attributes are discussed to indicate the importance of learning achievement. The research process was divided into two stages. The first stage was the process of preparing a preliminary analysis of data using three feature selection techniques. The second stage was the process of forecasting. The data used in this research are 180 records of Bachelor's degree students in Computer Science program at Naresuan University, Thailand. The experiment results show that Correlation-based Feature Selection gives us the best subset and Support Vector Machines (SVMs) technique has the best prediction.

Keywords

feature selection; classification; learning attributes analysis

Introduction

The Faculty of Science, Naresuan University has serviced the Bachelors of Science Program in Computer Science since 1994 with a major curriculum revision in 2005. The students had then to study some general subjects before registering for major courses. A few subjects were obviously too difficult for some students, who left university or needed extra years to graduate. Regularly, students' data are recorded and advisors use these data to suggest suitable elective courses and to predict the learning achievements.

With the integration of ASEAN member countries, Thailand has been increasingly recognized as a hub of trade and services. International education in Thailand continues to attract foreign students both in basic and higher education. The most important point are standards to ensure interchangable curricula among ASEAN. This will help managing students' exchange programs. Therefore, the learning outcome has to be identified at the beginning to meet the National Qualifications Framwork for higher education in Thailand and other nations (NQF, 2006).

In this research, the major attributes were gained by data mining techniques and can be used to predict learning achievement to help current students manage their study behaviour. The graduate attributes are now part of the revised curriculum.

The remainder of this paper is organized as follows. Learning attribute, Feature selection methods and classification techniques are introduced. Then, experimental studies are presented as well as discussed in terms of their performance. Finally, conclusions are drawn.

Learning attribute

Learning attribute analysis has been an interesting topic in various projects. Zlatko (2010) used a data mining approach for early prediction of students' success with enrolment data for the Open Polytechnic Student Management System. The results show that the most important factors separating successful from unsuccessful students are ethnicity, course programme, and course block. Padmapriya (2012) applied data mining techniques to predict readiness for enrolment for higher education using decision tree and Naïve Bayesian algorithm, with the decision tree model being of higher accuracy. Agarwal et al. (2012) used LIBSVM with Radial Basis Kernel for classification and established the best classifier with maximum accuracy and minimum root mean square error (RMSE). Paulo and Alice (2008) used data mining techniques to predict student performance and achievement in secondary education. A student's grade, demographic and social background as well as school related features were collected by using school reports and questionnaires.

Feature Selection

Feature selection is one of the most important pre-processing steps in data mining and machine learning. In feature selection normally the space of attribute subsets is searched and each subset is evaluated by combining attribute subset evaluators with the search method. The basic idea of the algorithms is searching through all possible combinations of features in the data to find which subset of features works best for prediction. Feature selection, when used along with any learning system, can help improve performance of the systems with minimal effort. In this research experiment, three techniques have been applied to the data set as shown in the following subsections.

Correlation-based Feature Selection

Correlation-based Feature Selection (CFS) evaluates the worth of a subset of attributes by considering the individual predictive ability of each feature along with the degree of redundancy between them. CFS uses a search algorithm along with a function to evaluate the merit of feature subsets. Subsets of features that are highly correlated with the class while having low intercorrelation are preferred. The heuristics by which CFS measures the "goodness" of feature subsets takes into account the usefulness of individual features for predicting the class label along with the level of intercorrelation among them (Hall and Smith, 1998).

Consistency-based Feature Selection

Consistency measures are used to evaluate relevance of feature subsets in this feature selection technique. Consistency can be interpreted as zero inconsistency. A consistency measure is intuitively defined as a metric to measure the *distance* of a feature subset from the consistent state. When a feature subset is consistent, the inconsistency value is zero, and as an inconsistent feature subset approaches the consistent state, the measure decreasingly approaches zero (Kilho et al. n.d.; Manoranjan and Huan 2003).

Gain Ratio Attribute Evaluators

The information gain ratio is the ratio between the information gain and the intrinsic value. The information gain measure is used to select the test attribute at each node of the decision tree classification. The information gain ratio is a modification of the information gain that reduces its bias by taking number and size of branches into account when choosing the significant attributes (Asha et al., 2010). The attribute with the highest gain ratio is selected as the splitting attribute implying that it is the most significant attribute.

Classification Techniques

Classification or prediction is a task in data mining, that involves forecast in an unknown or a feature situation. It is the process of constructing a model that describes and distinguishes different data classes or of estimating target values to use the model to predict the class of objects (Sang, 2012) or the expected value of unknown attribute. In this research we use the following techniques.

Backpropagation Neural Network

Backpropagation Neural Network (BPNN) is an artificial neural network that studies on the weight vector for the multilayered feed forward. It emulates the human brain structure (Rinehart et al., n.d.) and is a common method of training in a supervised learning method. The BPNN network has many nerve cells fully connected with the general structure of three layers: input layer, hidden layer, and output layer. It uses the moving of the vector weight from the input layer to the hidden layer and then to the output layer to calculate the errors between output data and realistic goals. The error will be sent back to the network to adjust the weights using gradient descent and delta rule as a guideline.

Support Vector Machines

Support Vector Machines (SVMs) are supervised learning machines that can be used for pattern recognition and regression. It has strategy to find the best hyperplane on input space called the structural minimization principle from based on statistical learning theory (Luts et al., 2010). An SVM model is a representation of the examples as points in space mapped so that the examples of the separate categories are divided by a clear maximal gap. From all possible hyperplanes that separate the training examples the one is chosen which maximizes the *margin*, the sum of the distances between the hyperplane and the nearest examples. In addition to performing linear classification, SVMs can efficiently perform non-linear classification using a nonlinear kernel function, implicitly mapping their inputs into high-dimensional feature spaces.

Reduced Error Pruning Tree

Reduced Error Pruning Tree (REPTree) is an algorithm used to explain the problem of decision tree learning. A model based tree may suffer during the pruning phase, such that the tree grows linearly with the sample size without improving the accuracy of the tree. REPTree reduces the risk of over-fitting that occurs when learned tree is overspecialized to the training set. REPTree is a fast pruning algorithm to correct the effects of spurious or noisy training example on the decision tree. It uses information gain and prunes it using reduced-error pruning with back-fitting. This can be compared to the error rate, if the node is replaced by the most common class resulting from that node (Matti and Tuomo, 2001).

Experimental Studies

This paper discusses the use of a combination of data mining techniques to analyse learning attributes. The details of each step are as follows.

Data Preparation

The data of 180 students in the CS program, who graduated with same curriculum in 2008-2010, were collected. We included students' background data in our research experiment combined with grades of the first and second years. The data that were not related to prediction, such as educational status, addresses, phone numbers, and missing value data, were removed. The data set has 22 independent variables and 1 dependent variable as shown in the Table 1. The data set was separated into two data sets, the training and testing set.

Feature Selection

We applied and compared three feature selection techniques; Consistency-based Feature Selection, Correlation-based Feature Selection and Gain Ratio Attribute Evaluators, to select major variables used as predictors. These techniques help decrease the numbers of variables and result in good predictors. From the results of the experiments the three feature selection techniques can reduce the number of attributes from 22 to 9, 10 and 11, respectively, see Table 2. The 10 attributes data set obtained by the Correlation-based Feature Selection Technique gave the best accuracy.

Classification Modelling

After selecting suitable features, three prediction approaches on the training data for the purpose of determination of learning achievement were investigated. The three techniques are BackPropagation Neural Network, Support Vector Machine, and Reduced Error Pruning Tree. We applied all techniques to the training data set using various parameters for each technique.

Model Evaluation

Root mean square error (RMSE) indices were calculated to evaluate performance of the prediction models. SVMs model demonstrated the best performance in prediction. BPNN has slightly more errors than SVMs and has errors comparable to REPTree. The testing data were then applied to the prediction models to avoid over-fitting. Evaluation summary of the training data and the testing data for all techniques are presented in Table 3. As can be seen, the SVMs method demonstrated the best performance for both data sets.

Table 1 Variables in computer science

No.	Variables' name	Details	Data type
1	Entrance	Entrance Method	Nominal
2	Sex	Gender	Nominal
3	In_Fa	Father's income	Ordinal
4	Occu_Fa	Father's career	Nominal
5	In_Mo	Mother's income	Ordinal
6	Occu_Mo	Mother career	Nominal
7	Acad_Fa	Father's degree	Ordinal
8	Acad_Mo	Mother's degree	Ordinal
9	Old_GPA	Grade 12 GPA	Interval
10	GENERAL	General subjects	Interval
11	251100	Philosophy of Sciences	Interval
12	252111	Introductory Mathematics	Interval
13	256103	Introductory Chemistry	Interval
14	258101	Introductory Biology	Interval
15	261103	Introductory Physics	Interval
16	252112	Calculus	Interval
17	254271	Introduction to Programming	Interval
18	252351	Discrete Mathematics	Interval
19	254251	Data Structure	Interval
20	254261	Computer Architecture	Interval
21	254275	Object Oriented Programming	Interval
22	254351	Database System	Interval
23	GPA	Learning Achievement	Interval

Table 2 Compared feature selection techniques

Original Number of Attributes	Feature Selection Techniques	Feature Reduction
22 Attributes	Consistency-based feature selection	General, 251100, 252111, 258101, 252112, 254271, 254275, 254351, 254261 **(9 Attributes)**
	Correlation-based feature selection	General, 252111, 258101, 252112, 254271, 254275, 254351,252351, 254251,254261 **(10 Attributes)**
	Gain ratio attribute evaluators	General, 252351, 254261, 254251, 254271, 254351, 252112, 252111, 254275, 258101, 251100 **(11 Attributes)**

Table 3 Evaluation on training and testing data

Models	Evaluation	
	RMSE (Training data)	RMSE (Testing data)
BPNN	0.1672	0.1641
SVMs	**0.1168**	**0.1238**
REPTree	0.1996	0.1812

Conclusions and Further Work

This paper explores graduate attributes as is required of students in Computer Science disciplines. The research process was divided into two stages; feature selection and classification. The obtained results reveal that it is possible to achieve a high predictive accuracy, supporting the NQF. These experimental results of feature selection subset were used as valuable information during the revision of the curriculum. This confirms the results other researchers. As a direct outcome of this research, more efficient student prediction tools can be developed, improving the quality of education and enhancing school resource management. In the future, the presented method could be applied to more computer science programs in other universities, e.g. in ASEAN.

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Multi-Criteria Interval Valued Intuitionistic Fuzzy Decision Making Using A New Score Function

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Abstract

Multi-criteria decision making is aimed on the selection of the best alternative by aggregating an expert's elicitations / knowledge. Expert's knowledge is represented by quantitative, qualitative and incomplete information. Even though the theory of fuzzy sets paved a way to model qualitative information it can not be used to model incomplete information arising due to lack of knowledge. Such incomplete information are fed into the multi criteria decision making for enhancing the best alternative by using interval-valued intuitionistic fuzzy sets (IVIFSs). Existing techniques on ranking of interval-valued intuitionistic fuzzy numbers (IVIFNs) by score functions and accuracy functions do not give sufficient information about alternatives. In this paper a new method for ranking of IVIFNs using a new score function is proposed and illustrative examples are given to demonstrate its practicability and effectiveness through a multi criteria decision problem.

Keywords

incomplete information, IVIFN, score function, accuracy function

Introduction

The concept of fuzzy sets was introduced in (Zadeh, 1965) that helps to model qualitative information. (Atanassov, 1986) generalised this idea to intuitionistic fuzzy sets (IFS) to model qualitative information with the lack of knowledge.

Because of complexity and uncertainity, the problem of research in decision support systems given in the form of interval for criterion values received a great goal of attention. The idea of interval valued fuzzy sets (IVFSs) was further introduced and studied in (Turksen, 1986).

(Atanassov & Gargov, 1989) introduced interval valued intuitionistic fuzzy sets (IVIFSs). Some multi-criteria decision-making (MCDM) methods based on IVIF environment were studied in (Xu, 2007), (Xu & Chen, 2007a, 2007b), (Ye, 2009), (Zhoujing Wang , 2009).

In decision support systems, ranking of aggregated information is an important component by which the accuracy can be improved. (Deng feng Li, 2010), (Ehsan Jafarian, 2013), Hassan Mishmast Nehi (2010), (Mitchell, 2004) and (Lakshmana Gomathi Nayagam etal, 2008) studied ranking of IFNs. (Xu & Yager, 2006), (Xu, 2007), (Ye, 2009), (Lakshmana Gomathi Nayagam et al, 2011) proposed score function and accuracy function to rank IVIFNs. However in some cases they do not give sufficient information about alternatives.

In this paper we propose a new score function to rank IVIF information. In this paper preliminaries and existing results are given in section 2. In section 3, illustrative examples are given to show the invalidity of the score function, accuracy function and novel accuracy functions. And then a new score function by taking into account the unknown degree (hesitancy degree) of IVIFSs is introduced and studied. Illustative examples are given to show that the proposed score is more reasonable.

Preliminaries

Here we give a brief review of some preliminaries.

Definition 1 (Atanassov & Gargov, 1989): Let $D[0,1]$ be the set of all closed subintervals of the interval $[0,1]$. Let $X(\neq \Phi)$ be a given set. An IVIFS in X is an expression given by $A = \{\langle x, \mu_A(x), \gamma_A(x)\rangle : x \in X\}$, where $\mu_A : X \to D[0,1], \gamma_A : X \to D[0,1]$ with the condition $0 < sup_x \mu_A(x) + sup_x \gamma_A(x) \leq 1$.

We denote an IVIFS A in X by $A=\{\langle x,[\mu_{A_L}(x),\mu_{A_U}(x)],[\gamma_{A_L}(x),\gamma_{A_U}(x)]\rangle \mid x\in X\}$ with $0<\mu_{A_U}(x)+\gamma_{A_U}(x)\le 1,\ \ \mu_{A_L}(x)\ge 0,\ \ \ \gamma_{A_L}(x)\ge 0,$ where the intervals $\mu_A(x)=[\mu_{A_L}(x),\mu_{A_U}(x)]$ and $\gamma_A(x)=[\gamma_{A_L}(x),\gamma_{A_U}(x)]$ are the degree of belongingness and nonbelongingness of the element x to lie in A. The unknown degree (hesitancy degree) of belongingness of $x\in X$ in A is given by $\Pi_A(x)=1-\mu_A(x)-\gamma_A(x)=[1-\mu_{A_U}(x)-\gamma_{A_U}(x),\ \ 1-\mu_{A_L}(x)-\gamma_{A_L}(x)]$.

We denote the set of all the IVIFSs in X by IVIFS(X).

Definition 2 (Atanassov & Gargov, 1989): Let A, B $\in$ IVIFS(X). A subset relation is defined by $A\subset B\Leftrightarrow \mu_{A_L}(x)\le\mu_{B_L}(x),\ \mu_{A_U}(x)\le\mu_{B_U}(x)$ and $\gamma_{A_L}(x)\ge\gamma_{B_L}(x),\ \gamma_{A_U}(x)\ge\gamma_{B_U}(x)$, for every $x\in X$.

Definition 3 (Atanassov & Gargov, 1989): The equality of two IVIFS is defined by $A=B\Leftrightarrow A\subset B$ and $B\subset A$.

Definition 4 (Xu, 2007): For any IVIFN $A=([a,b],[c,d])$ the score function is given by $S(A)=\dfrac{a+b-c-d}{2}$.

Definition 5 (Xu & Chen, 2007a): The accuracy function H of an IVIFN $A=([a,b],[c,d])$ based on the unknown degree is expressed by $H(A)=\dfrac{a+b+c+d}{2}$.

Definition 6 (Ye, 2009): The novel accuracy function M of an IVIFN $A=([a,b],[c,d])$ is expressed by $M(A)=a+b-1+\dfrac{c+d}{2}$

Definition 7 (Lakshmana Gomathi Nayagam etal, 2011): The new novel accuracy function L of an IVIFN $A=([a,b],[c,d])$ is defined by $L(A)=\dfrac{a+b-d(1-b)-c(1-a)}{2}$.

Definition 8 (Xu &Yager, 2006): Let $A_j\,(j=1,2,...n)\in$ IVIFS(X). The weighted arithmetic average operator is defined by $F_w(A_1,A_2,...A_n)=([1-\prod(1-\mu_{A_{j_L}}(x))^{w_j},\ 1-$

$\prod(1-\mu_{A_{j_U}}(x))^{w_j}],[\prod\gamma_{A_{j_L}}(x)^{w_j},\prod\gamma_{A_{j_U}}(x)^{w_j}])$, where w_j is the weight of $A_j\,(j=1,2,\ldots n), w_j\in[0,1]$ and $\sum w_j=1$.

Definition 9 (Xu & Chen, 2007b): Let $A_j\,(j=1,2,\ldots n)\in$ IVIFS(X). The weighted geometric operator is defined by $G_w(A_1,A_2,\ldots A_n)=([\prod\mu_{A_{j_L}}(x)^{w_j},\prod\mu_{A_{j_U}}(x)^{w_j}],$ $[1-\prod(1-\gamma_{A_{j_L}})(x)^{w_j},1-\prod(1-\gamma_{A_{j_U}})(x)^{w_j}])$, where w_j is the weight of $A_j\,(j=1,2,\ldots n), w_j\in[0,1]$ and $\sum w_j=1$.

New Score Function

In this section, illustrative examples are given to show the invalidity of the existing score function, accuracy function and novel accuracy functions and a new sore function of IVIFSs is introduced and studied. Illustative examples are given to show the proposed function is more reasonable.

Note 1: In (Lakshmana Gomathi Nayagam et al, 2011), it is shown that Definitions 5 and 6 fail to rank even for the comparable IVIFNs for alternatives.

Note 2: Definitions 4, 5 and 6 fail to rank the in-comparable IVIFNs as in the following example.

Example 1: For two IVIFNs $A_1=([0.35,0.45],[0.2,0.3])$ and $A_2=([0.3,0.5],[0.15,0.35])$, we get $S(A_1)=0.15$, $S(A_2)=0.15$, $H(A_1)=0.65$, $H(A_2)=0.65$, $M(A_1)=0.05$ and $M(A_2)=0.05$ by applying definitions 4, 5 and 6. So the above definitions do not show which alternative is better.

Note 3: Definition 7 fails to rank the in-comparable IVIFNs as in the following example.

Example 2 : By applying definition 7 to IVIFNs $A_1=([0.4,0.45],[0.2,0.4])$ and $A_2=([0.3,0.5],[0.2,0.3])$, $L(A_1)=0.255$ and $L(A_2)=0.255$. So definition 7, does not show which alternative is better.

The accuracy functions proposed by (Xu & Chen, 2007a) and (Ye, 2009) do not give sufficient information about comparable alternatives and score function proposed by (Xu, 2007), new accuracy function defined by (Lakshmana Gomathi Nayagam et al, 2011) do not give sufficient information about in-comparable alternatives. Therefore it is necessary to pay attention to this issue and need to work on some other measuring functions.

Defintion 10: Let $A = ([a,b],[c,d])$ be an IVIFN. A new score function $VL(A)$ of an IVIFN based on the unknown degree is defined by $VL(A) = \dfrac{a+b+b(1-d)+a(1-c)}{4}$.

Proposition 1: For any IVIFN $A = ([a,b],[c,d])$, the new proposed score $VL(A) \in [0,1]$.

Proposition.2: For any IVFN $A = ([a,b])$, $VL(A) = \dfrac{a+b}{4} + 2ab$ and hence if $A = 1$, $VL(A) = 1$ and if $A = 0$, $VL(A) = 0$.

Proposition.3: For an IFN $A = (a,c)$, $VL(A) = \dfrac{a+a(1-c)}{2}$. In particular, for a fuzzy subset $A = (a, 1-a)$, $VL(A) = \dfrac{a(1+a)}{2}$.

Note 4: For any IVIFN $A = ([a,b],[c,d])$, $VL(A)$ has the following properties:

(i) $VL(A) = 0 \Leftrightarrow 2(a+b) = bd + ac \Leftrightarrow a = 0 = b$. (ii) $VL(A) = 1 \Leftrightarrow 2(a+b) = 4 + bd + ac \Leftrightarrow A = 1$

(iii) $VL(A) = \dfrac{1}{2} \Leftrightarrow 2(a+b) = 2 + ac + bd$. (iv) $a + b = 1$ *and* $c = 0 = d \Rightarrow VL(A) = \dfrac{1}{2}$.

Ranking of Interval Valued Fuzzy Sets

Definition 11: For any two IVIFNs, $A_1 \le A_2$ if $VL(A_1) \le VL(A_2)$.

Proposition 4: The above definition is validated in the class of fuzzy sets and IFS.

Importance of Proposed Score Function

Theorem 1: For any two comparable IVIFS A and B if $A \subseteq B$ then $VL(A) \le VL(B)$.

Theorem 2: If $A = ([a_1,b_1],[c_1,d_1])$ and $B = ([a_2,b_2],[c_2,d_2])$ are Comparable IVIFNs such that $VL(A) = VL(B)$, then $A = B$.

Note 5: Since the proposed method ranks all comparable IVIFSs correctly, it can be applied to incomparable IVIFSs as in the following discussion.

By applying definition 10 to the example 1, $VL(A_1) = 0.34875$ and $VL(A_2) = 0.345$ and hence A_1 is better than A_2 for which definitions 4, 5 and 6 are not applicable. By applying definition 10 to the example 2, $VL(A_1) = 0.4025$ and $VL(A_2) = 0.47375$ and hence A_2 is better than A_1 for which definition 7 is not applicable.

Multicriteria IVIF Decision-Making Using New Score Function

In this section, a MCDM problem in IVIF environment is presented.

Let $A = \{A_1, A_2, ..., A_m\}$ be the set of alternatives and $w_1, w_2, ...w_n$ be the corresponding weights of the criteria $C_1, C_2, ..., C_n$. The characteristic of the alternative A_i is represented by an IVIFS: $A_i = \{\langle C_j, [\mu_{A_iL}(C_j), \mu_{A_iU}(C_j)], [\gamma_{A_iL}(C_j), \quad \gamma_{A_iU}(C_j)]\rangle, | C_j \in C\}$, $j = 1,..,n$ and $i = 1,..,m.$ So we elicit a decision matrix $D = (\alpha_{ij})_{m\times n} = ([a_{ij}, b_{ij}], [c_{ij}, d_{ij}])_{m\times n}$, where $[a_{ij}, b_{ij}]$ indicates the degree that A_i satisfies C_j and $[c_{ij}, d_{ij}]$ indicates the degree that A_i does not satisfy C_j. The aggregated IVIFN α_i for A_i (i=1,..,m) is $\alpha_i = ([a_i, b_i], [c_i, d_i]) = F_{iw}(\alpha_{i1}, ..., \alpha_{in})$ or $\alpha_i = ([a_i, b_i], [c_i, d_i]) = G_{iw}(\alpha_{i1}, ..., \alpha_{in})$ by applying definition 8 or 9. Then the score and accuracy functions of IVIFN $\alpha_i (i = 1,..,m)$ by definitions 4, 5, 6, 7 and 10 are used to rank the alternatives $A_i (i = 1,..,m)$.

Illustrative Example

In this section, an example (Herrera & Herrera-Viedma, 2000) for a MCDM problem with minor corrections is used to demonstrate the proposed IVIF MCDM.

There are four possible alternatives car company (A_1), food company (A_2), computer company (A_3) and arms company (A_4) for an investment company to invest based on the three criteria: risk analysis (C_1); growth analysis (C_2); environmental impact analysis (C_3) with their weights 0.35, 0.25 and 0.40 respectively.

Evaluation of alternatives based on the criteria using IVIF information is given by

	C_1	C_2	C_3
A_1	([0.4 0.5] [0.3 0.4])	([0.4 0.6] [0.2 0.4])	([0.1 0.3] [0.5 0.6])
A_2	([0.6 0.7] [0.2 0.3])	([0.6 0.7] [0.2 0.3])	([0.4 0.6] [0.3 0.4])
A_3	([0.3 0.6] [0.3 0.4])	([0.5 0.6] [0.3 0.4])	([0.5 0.6] [0.1 0.3])
A_4	([0.7 0.8] [0.1 0.2])	([0.6 0.7] [0.1 0.3])	([0.4 0.7] [0.1 0.2])

We have weighted geometric average value α_i for $A_i (i = 1,2,3,4)$ using definition 9 as $\alpha_1 = ([0.2297, 0.4266], [0.3674, 0.4898])$, $\alpha_2 = ([0.5102, 0.6581], [0.2416, 0.3419])$,

$\alpha_3 = ([0.4181, 0.6000], [0.2260, 0.3618])$, $\alpha_4 = ([0.5384, 0.7335], [0.1000, 0.2263])$.

By definition (10), $VL(\alpha_1) = 0.2548$, $VL(\alpha_2) = 0.4971$, $VL(\alpha_3) = 0.4312$, $VL(\alpha_4) = 0.5810$. Hence the alternatives are ranked in accordance with the scores of $VL(\alpha_i)$, $S(\alpha_i)$ and $L(\alpha_i)$ as $A_4 > A_2 > A_3 > A_1$.

We have $\alpha_2 \subset \alpha_4$. But by the definition 6, we get $A_2 > A_4 > A_3 > A_1$ and by definition 5, we get $A_2 > A_3 > A_4 > A_1$, which are contradictions.

We obtain the weighted arithmetic average value α_i for $A_i (i = 1,2,3,4)$ using definition 8. By applying (10), $VL(\alpha_1) = 0.2982$, $VL(\alpha_2) = 0.5095$, $VL(\alpha_3) = 0.4441$, $VL(\alpha_4) = 0.6019$. Hence all alternatives are ranked in accordance with the accuracy degrees of $VL(\alpha_i)$ as follows $A_4 > A_2 > A_3 > A_1$. By definitions 4 and 7, we get $A_4 > A_2 > A_3 > A_1$.

But ranking the alternatives in accordance with the accuracy degrees of $H(\alpha_i)$ and $M(\alpha_i)$, we get $A_2 > A_4 > A_3 > A_1$ which is illogical. According to definition 7, a problem has two different rankings depending on the operator used.

Conclusions

In this paper, a new score function that ranks all comparable IVIFN correctly is introduced and studied. Since the problem of ranking IVIFS is important in real life problems that involve incomplete information such as decision making, information management and artificial intelligence, this proposed method has wide applications in all areas.

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Personal Knowledge Development in Online Learning: A Model for Measuring Externalisation, Combination and Internalisation

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Abstract

This paper presents a model for measuring personal knowledge development in online learning environments. It is based on Nonaka's SECI model of organisational knowledge creation. It is argued that Socialisation is not a relevant mode in the context of online learning and was therefore not covered in the measurement instrument. Therefore, the remaining three of SECI's knowledge conversion modes, namely Externalisation, Combination, and Internalisation were used and a measurement instrument was created which also examines the interrelationships between the three modes. Data was collected using an online survey, in which online learners report on their experiences of personal knowledge development in online learning environments. In other words, the instrument measures the magnitude of online learners' Externalisation and combination activities as well as their level of internalisation, which is the outcome of their personal knowledge development in online learning.

Keywords

personal knowledge development, SECI model, EC-I model, e-learning, online learning

Introduction

The ability to develop one's knowledge is of paramount importance for individuals, particularly in today's knowledge-based economy and information society. In addition to applying existing knowledge, one of the key activities individuals have to engage in is the development of their own personal knowledge. It is therefore important to conceive a model that helps one to understand personal knowledge development (PKD) in online learning environments (OLEs) and to measure the magnitude of online learners' knowledge development activities as well as outcomes.

For the purposes of this study, PKD in OLEs is defined as encompassing idiosyncratic and individualised processes and phases of creating new knowledge, evaluating and modifying knowledge, sharing knowledge, and finally applying knowledge in real-life situations and contexts.

At the organisational level, knowledge creation and conversion has been researched and described intensively by using Nonaka and colleagues' SECI model (e.g. Nonaka and Takeuchi, 1995). However, measurement instruments that enable the measurement of knowledge development activities and outcomes do not exist. In order to begin to close this gap, this paper – which is based on a doctoral research project described in detail in Haag (2010) and in Haag, Duan and Mathews (2007, 2008) – presents a measurement instrument for three of the four SECI modes, namely Externalisation, Combination and Internalisation – in the context of online learning. That means that the SECI model will be used as the basis for a new PKD model at the individual level of rather than at the level of organisational knowledge creation for which it has originally been conceived. It is argued here that Externalisation and Combination are PKD *processes,* whereas Internalisation encompasses the *outcomes* of PKD. It is also hypothesised that a higher engagement in processes will lead to a higher level of outcomes in the end. In other words, a higher engagement in Externalisation and Combination processes is likely to lead to a higher level of Internalisation outcomes.

In the remainder of this paper, the SECI model will be discussed. Then, the methodology of how the measurement instrument for Externalisation, Combination and Internalisation was devised will be provided. The paper then presents the findings of the research as well as a conclusion.

The SECI Model

Nonaka's SECI model describes four modes of knowledge creation through a series of knowledge conversions between explicit and tacit knowledge. These modes are called Socialisation, Externalisation, Combination, and Internalisation.

Socialisation is defined as a "process of sharing experiences and thereby creating tacit knowledge such as shared mental models and technical skills" (Nonaka and Takeuchi, 1995, p. 62), essentially involving observation, imitation and learning by doing. It is a tacit-tacit conversion. Externalisation is defined as "Articulating tacit knowledge through dialogue and reflection" (Nonaka, Toyama and Hirata, 2008, p. 19) and is a tacit-explicit conversion. Combination "involves combining different bodies of explicit knowledge" (Nonaka and Takeuchi, 1995, p. 67) and forms an explicit-explicit conversion. Finally, Internalisation is defined "Learning and acquiring new tacit knowledge in practice" (Nonaka, Toyama and Hirata, 2008, p. 19), and is closely related to learning by doing (Nonaka and Takeuchi, 1995). This is the conversion process from explicit to tacit knowledge. Figure 1 (based on Nonaka and Konno, 1998, p. 46) shows the SECI model.

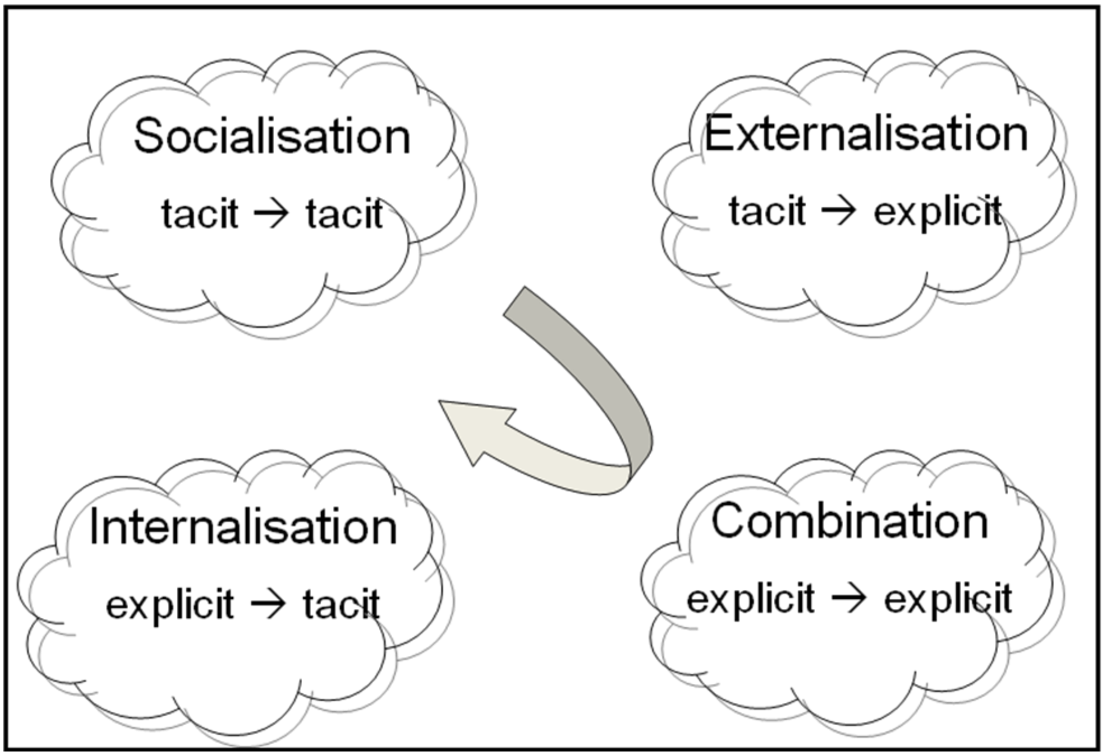

Figure 1: The SECI model (based on Nonaka and Konno, 1998, p. 46)

Not all four SECI modes have to be involved in knowledge development. Regarding Socialisation, it is argued here that the necessity for physical proximity necessary in the Socialisation mode is, by definition, not possible in an OLE. Nonaka and Toyama (2003) also stress that successful Socialisation is fostered by ‘indwelling’ and ‘living in’ the world, which in turn suggests that the context in which knowledge creation and PKD occurs has to be actively experienced and made sense of. In the case of OLEs, this active experience is not direct or face-to-face but mediated through the Internet and related OLE technologies. Therefore, it was decided *not* to include Socialisation in this study.

Methodology

In order to determine the level of PKD in online learning it is argued that it is essential to develop a measurement instrument of PKD processes and outcomes as there are no relevant measurement approaches available in the literature.

According to Mitchell and Boyle’s (2010) taxonomy of knowledge creation measures, knowledge creation can be measured using either external or internal criteria. External criteria lead to measures that are based on non-participant criteria (Mitchell and Boyle, 2010). This study, however, uses internal criteria, i.e. measures that are based on subjective observations made by the learners themselves (Mitchell and Boyle, 2010), i.e. self-reports.

Scales and Indexes

The constructs differ in terms of whether they should be conceptualised as a formative index or as a scale. The main approach to the development of measures focuses to a large degree on “scale development, whereby items (i.e., observed variables) composing a scale are perceived as reflective (effect) indicators of an underlying construct (i.e., latent variable)” (Diamantopoulos and Winklhofer, 2001, p. 269). An alternative to scale development (cf. Hinkin, 1995) is the creation of formative or causal indicators and requires the creation of an index rather than a scale (Bollen and Lennox, 1991).

Formative indicators can be regarded as causing rather than being caused by the latent variable (MacCallum and Browne, 1993); the two latent variables with such characteristics in this study are Externalisation and Combination whose various indicators add up to the score for the construct Externalisation or the construct Combination, respectively.

However, Internalisation is a different concept. It is argued here that Internalisation should be measured by reflective indicators, meaning that when Internalisation increases, all (and not merely some) of its reflective indicators will increase as well.

It is important to cover the full breadth of a construct, otherwise relevant indicators would be excluded (Nunnally and Bernstein, 1994). As both Externalisation and Combination are based on broad definitions, the indexes that measure Externalisation and Combination also need to be broad and multidimensional. Therefore, those indicators that are likely to account for the most frequently used Externalisation tools or Combination features provided by today's OLEs were chosen for this study. Other indicators can and indeed must be added as OLEs change over time, or indicators used in this study may become obsolete and should then be deleted from the measurement tool.

Measurement Instrument for Externalisation, Combination and Internalisation

Table 1 displays the short name of the measurement items that were created in the research and the SECI modes they refer to. The questions that were asked in the survey can be found in Appendix 1. The coding/answer options for the various items of Externalisation, Combination, and Internalisation, respectively, are given in Appendix 2.

Table 1: Measurement items and corresponding SECI mode

Measurement items	SECI mode
1. Discussion forums 2. Blog 3. Wiki 4. Instant Messaging (IM) 5. Online chats	Externalisation
1. Search engines 2. Different types of functions 3. Getting to know other learners' opinions 4. Sharing information 5. Working together with other learners	Combination
How strongly do you agree or disagree with the following statements? 1. Application of knowledge 2. Functions for self-assessment 3. Acquiring new knowledge 4. Improving my skills 5. I have learned a lot	Internalisation

Data Collection

The aim was to design measurement indicators that are valid in the context of high-level, more generic online learning. To this end, a maximally diverse and heterogeneous sample must be recruited. Therefore, it was decided not to restrict the sample to one particular course because the technical characteristics and the instructional design and pedagogies employed by the course may dominate the way how learners develop their personal knowledge.

In order to get a highly diverse sample, three different approaches to recruiting the sample were followed: the students of the eMBA course at the University of Bedfordshire, the members of three different Yahoo! Groups, and the members of dialogin The Delta Intercultural Academy, a knowledge community on culture and communication in international business. SurveyMonkey (www.surveymonkey.com) was used to host the survey. The data was then exported into SPSS (Field, 2009) and analysed using this tool.

The questionnaire was piloted with students and academics at the University of Bedfordshire, UK. Both the content and the wording of the questions were thus checked and the questionnaire was modified accordingly. Thus, validity issues of the scale were addressed (Moser and Kalton, 1971), and face validity could be established.

The total sample size is n=171 (three cases which answered ‘Not applicable’ for one or more of the ECI items were deleted from the data set). Females account for 71.8% of the sample (n=125), whereas males account for 28.2% (n=49). As this uneven gender distribution may induce bias into the analysis, a Mann-Whitney test was conducted to examine whether there are statistically significant differences between females and males; this was not the case.

Reliability and Validity

Reliability

Cronbach alpha (Cronbach, 1947, 1951) is an index of the internal consistency reliability of a measure (Rogers, Schmitt and Mullins, 2002). However, Cronbach alpha is often misused as it is based on the tau-equivalent measurement model which requires several assumptions to be met in order to accurately measure reliability (Graham, 2006). If these assumptions are not met Cronbach alpha underestimates the true reliability of a measure (Graham, 2006). The items for Externalisation and Combination use different units of measurement, i.e. they are not tau-equivalent, and Cronbach alpha would therefore underestimate the true reliability of the scale (Rogers, Schmitt and Mullins, 2002).

However, the situation is different for Internalisation, because Internalisation is represented by a scale consisting of items that aim to measure exactly the same concept, i.e. a concept that is restricted in conceptual breadth and that is also quite uni-dimensional. Therefore, deleting items from the Internalisation scale in order to improve Cronbach alpha is perfectly acceptable and indeed advisable (Field, 2009). This was done by checking the output called “Cronbach’s Alpha if Item Deleted” which is provided by SPSS (Field, 2009). By deleting two items in such a way, the value Cronbach alpha for the Internalisation scale is 0.878. The construct of Internalisation is made up of the following three items: ‘acquiring new knowledge’, ‘improving skills’, and ‘having learned a lot’.

Validity

Referring to Winter (2000), validity is relative to a particular piece of research: not all categories of validity, such as for example discriminant validity, construct validity or face validity, are equally important or indeed feasible to assess.

Face validity of the measurement tool was established by discussion with academic colleagues. They were asked to check whether the items proposed by the researcher can be considered to be a valid representation of how the ECI modes are defined and conceptualised. Several rounds of modification were carried out and items were either added or dropped or modified.

Content validity is concerned with the ability of a measurement tool to include all of the content of a particular construct. In the case of this study, the question is whether the instrument includes all of the content of Externalisation, Combination, and Internalisation, respectively. The aim of this study is to investigate the impact of personal values on PKD in online learning at a high level, i.e. for online learning in general. This means that for Externalisation and Combination, items have to be created that reflect typical and frequently used features of today’s OLEs. Based on a literature review, those features and functions that are likely to be part of a typical OLE were chosen as formative indicators.

In terms of assessing external construct validity, Spector (1992) proposes to correlate each indicator to a latent variable which is external to the construct. In this case, the ten indicators for Externalisation and Combination were correlated with Internalisation as a latent variable external to Externalisation and Combination; the ten indicators should theoretically be positively correlated with Internalisation. It was found that only one item for Externalisation (wikis) and one item for Combination (search engines) were not statistically significantly correlated with Internalisation. However, both of these values were slightly positive (τ=.088 and τ=.076, respectively). It was decided not to drop these two items from the index, because this would have changed the content domain represented by the various items and would also run against the very nature of formative indicators.

In terms of external validity, the heterogeneous sample which was recruited from a wide variety of countries, with considerable diversity in terms of age, gender and other background variables, is likely to represent well typical OLEs of today. Thus, the results of this study are likely to be generalisable to more generic, high-level online learning.

The survey questions were largely at an ordinal/rank-level rather than at an interval level. This suggests that Spearman's correlation coefficient or Kendall's tau correlation coefficient should be used instead of Pearson's product-moment correlation (cf. Field, 2009). As Howell (2009) suggests that Kendall's tau is a better estimate of the correlation in the population it was decided to use Kendall's tau in this study.

Intercorrelations between the Measurement Items

For all of the various measurement items that were chosen as indicators to measure Externalisation and Combination processes as well as Internalisation outcomes, Kendall's tau correlations were calculated – these are discussed one-by-one in this section.

Intercorrelations between Externalisation Items

Table 2 shows the interrelationships, i.e. the correlation coefficients, between the items for Externalisation and the aggregate value for the Externalisation index. All correlations are positive and significant at the $p<.001$ level (2-tailed).

Table 2: Interrelationships between Externalisation items and their aggregate

	Discussion forum	Blog	Wiki	Instant Messaging	Online chats	Externalisation
Discussion forum	–	.508**	.271**	.292**	.278**	.586**
Blog	.508**	–	.318**	.397**	.406**	.609**
Wiki	.271**	.318**	–	.302**	.313**	.437**
Instant Messaging	.292**	.397**	.302**	–	.580**	.692**
Online chats	.278**	.406**	.313**	.580**	–	.672**

The inter-item correlations range between τ=.271 for the discussion forum – wiki relationship, and τ=.580 for the instant messaging – online chats relationship. The wiki item has the lowest inter-item correlations throughout, suggesting that a wiki is a distinct feature that stands somewhat apart from the other four Externalisation items. The item-to-total, i.e. item-to-Externalisation aggregate correlation is also very high, ranging from τ=.437 to τ=.692.

Intercorrelations between Combination Items

Table 3 shows the interrelationships between the items for Combination and the aggregate value for the Combination index. The significance levels (2-tailed) are also displayed.

The spread of the inter-item correlations for the Combination items is larger than for the Externalisation items. Only one was negative, albeit only slightly, namely the correlation between 'search engines' and 'interest in other learners' opinions' (τ=-.019). The strongest correlation was found between 'working together with other learners' and 'sharing information with other learners' (τ=.414).

All items are significantly positively correlated with the Combination aggregate, with coefficients ranging from τ=.309 for 'search engines' and τ=.624 for 'types of functions'.

Table 3: Interrelationships between Combination items and their aggregate

		Search engines	Types of functions	Interest in other learners' opinions	Sharing information with other learners	Working together with other learners	Combination
Search engines	Corr. Coeff.	–	.168*	-.019	.041	.057	.309**
	Sig.	.	.011	.773	.537	.414	.000
Types of functions	Corr. Coeff.	.168*	–	.230**	.321**	.277**	.624**
	Sig.	.011	.	.000	.000	.000	.000
Interest in other learners' opinions	Corr. Coeff.	-.019	.230**	–	.149*	.215**	.429**
	Sig.	.773	.000	.	.022	.001	.000
Sharing information with other learners	Corr. Coeff.	.041	.321**	.149*	–	.414**	.550**
	Sig.	.537	.000	.022	.	.000	.000
Working together with other learners	Corr. Coeff.	.057	.277**	.215**	.414**	–	.560**
	Sig.	.414	.000	.001	.000	.	.000

Intercorrelations between Internalisation Items

Table 4 shows the interrelationships between the items for Internalisation and the aggregate value for the Internalisation index. All correlations are significant at the p<.001 level (2-tailed).

Table 4: Interrelationships between Internalisation items and their aggregate

	Acquiring new knowledge	Improving skills	Having learned a lot	Internalisation
Acquiring new knowledge	–	.710**	.599**	.782**
Improving skills	.710**	–	.662**	.828**
Having learned a lot	.599**	.662**	–	.824**

For Internalisation, the inter-item correlations range from τ=.599 to τ=.710. As mentioned above, the aggregate for Internalisation is calculated on the basis of taking into account only the following three items: ‘acquiring new knowledge’, ‘improving skills’, and ‘having learned a lot’.

The EC-I Model: Personal Knowledge Development in Online Learning

The proposed model of PKD in online learning includes Externalisation/Combination as PKD *processes* and Internalisation as PKD *outcomes*. The interrelationships between the three modes are shown in Table 5. All correlations are highly significant at the $p<.001$ level. The strongest correlation is between Externalisation and Combination with τ=.533. The effect size of ‘Externalisation as a PKD process’ on ‘Internalisation as a PKD outcome’ is lower than the effect size of ‘Combination as a PKD process’ on ‘Internalisation as a PKD outcome’ (τ=.226 versus τ=.309). This suggests that Combination processes have a stronger impact on Internalisation, i.e. PKD outcomes, than Externalisation processes have on Internalisation.

Table 5: Interrelationships of the ECI modes: Correlation coefficients

	Externalisation	Combination	Internalisation
Externalisation	–	.533**	.226**
Combination	.533**	–	.309**
Internalisation	.226**	.309**	–

The strong correlation between Externalisation and Combination (τ=.533) suggests that Externalisation and Combination could be interpreted as the two constituents of one latent factor that shares some characteristics with both Externalisation and Combination. It is argued here that the main shared characteristic is that both modes deal with *processes* as opposed to outcomes (Internalisation). Figure 2 shows the EC-I model. It is emphasised here that the EC-I model is only applicable in the context of PKD in online learning. The model contains Externalisation and Combination (PKD processes), and Internalisation (PKD outcomes). A more detailed discussion of EC-I can be found in Haag (2010).

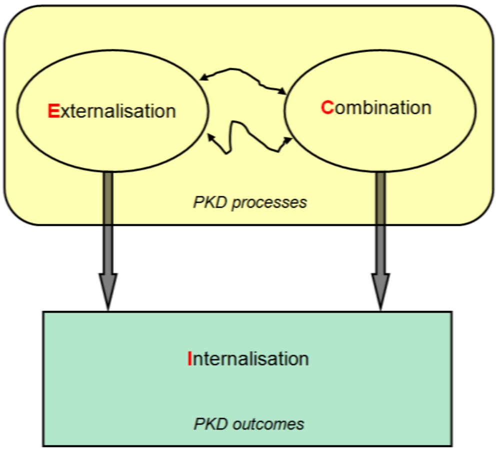

Figure 2: The EC-I model: A model of PKD in online learning

Limitations

The research has its limitations. The empirical data of this study are based on self-reports and neither include observations by the researcher of interactional data (e.g. online forum discussions, joint working on wikis) nor an analysis of grades of the learners which would provide another perspective on Internalisation, in addition to the self-reports used here. Adding external criteria would lead to a broader and more objective view on the outcome of Internalisation.

As the concrete characteristics of the various OLEs that are used by the participants in the online survey is unknown, one cannot rule out that the sample represents a relatively small number of instructional designs of online learning and that the results of the study therefore only apply to exactly these OLE types. However, as the sample was recruited from a relatively large number of countries using various sources, the results are likely to be generalisable to online learning at a higher level.

Conclusion

A gap in research was identified regarding the measurement of self-reported PKD in OLEs. The EC-I model and associated measurement instrument starts filling this gap. The measurement instrument which was designed here measures the magnitude of the knowledge development processes of an online learner (Externalisation and Combination) as well as the learner’s knowledge development outcomes (Internalisation). The instrument can only be applied in the context of online learning and must be modified to make it suitable and relevant to a different context. The model suggests that a higher engagement with both Externalisation activities and Combination activities when using online learning environments is likely to lead to a higher level of learning/Internalisation. More importantly, the EC-I model presents an approach to actually measuring learning outcomes and levels of learning processes from a perspective stemming from knowledge creation.

Tutors can use the measurement items for Externalisation and Combination to measure their students’ engagement with an online learning course and, on that basis, make a prediction of the level of learning outcomes. In sum, the instrument presented here makes a number of key contributions to our understanding of PKD in OLEs and how this can be measured.

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Appendix 1

The following questions were asked in the survey (in the order in which they appeared in the survey):

- How often do you use search engines to find materials in addition to those provided by the online learning environment?
- How many different types of functions do you usually access when learning about one particular topic? Examples of these functions, among others, are: discussion forums, blogs, wikis, instant messaging, chats, listening to audio files, watching video files, self-assessment quizzes, downloading course documents, etc.
- How interested are you in getting to know other learners' opinions through reading their postings in discussion forums?
- How often do you post in discussion forums?
- How often do you contribute to a blog (e.g. adding, changing or deleting parts of it)?
- How often do you contribute to a wiki (e.g. adding, changing or deleting parts of it)?
- How often do you take part in Instant Messaging (IM) with other learners or tutors?
- How often do you take part in online chats with other learners or tutors?
- How often do you share information with other learners (e.g. posting links or other documents for them to read, using online communication tools to let them know about something, etc.)?
- How often do you work together with other learners to create new materials (e.g. wikis, blogs, etc.)?
- How strongly do you agree or disagree with the following statements?

    I can apply the knowledge that I have acquired in the online learning environment in other contexts.

    The functions for self-assessment (e.g. quizzes, tests, simulations) help me to learn.

    The functions of the online learning environment contribute to me acquiring new knowledge.

    The functions of the online learning environment contribute to improving my skills

    Overall, I have learned a lot through the online learning environment.

Appendix 2

Coding/answer options for Externalisation:

Five items representing Externalisation were formulated after a process of re-conceptualising and re-writing the items based on feedback from colleagues and other academics. The answer options are based on a Likert-type ordinal scale, and are as follows: 'Never' was coded as 1, 'once or twice a month' as 2, 'once or twice a week' as 3, '3-5 times a week' as 4, and 'more than 5 times a week' as 5. This was the same for all five Externalisation items. The cases that answered 'Not applicable' for a particular item were not included in the calculations.

Coding / answer options for Combination:

The coding for the five Combination items was similar to the Externalisation items, with a coding of 1 to 5 starting from the lowest to the highest intensity. The wording of the five Combination items for the codes of 1 to 5 differs; the respective wordings are:

For 'search engines': never, rarely, sometimes, often, very often, not applicable

For 'different types of functions': only one, two, three, four, five or more, not applicable

For 'getting to know other learners' opinions': very much interested, somewhat interested, neither interested nor disinterested, somewhat disinterested, not interested at all, not applicable

For 'sharing information with other learners' and for 'working together with other learners': never, once or twice a month, once or twice a week, 3-5 times a week, more than 5 times a week, not applicable

Coding / answer options for Internalisation:

The answer options for all five Internalisation items were identical, namely: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree, not applicable .

Resource Indicator of Knowledge Differentiation

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Abstract

The purpose of the present research is classification of institutions for knowledge generation and formulation of a strategy regarding knowledge generation, which would allow introducing modifications into production technologies. The classification of economic institutions for new knowledge generation is presented. This classification affords an opportunity to reduce uncertainties in terms of knowledge management. Authors had been revealed structure of external and internal risks of new knowledge generation. The results of empirical research have shown that internal risks are much more significant for than external risks. Comparative analysis of external effects of knowledge allows to draw a conclusion of positive influence of new technological knowledge on ecological and social branches of knowledge. The differentiation of new knowledge in terms of profoundness of changes made in production processes is suggested. The received results allow the enterprises to carry out an estimation, forecasting and planning of generation of new knowledge.

Key Words

knowledge management, new knowledge generation, knowledge differentiation, classification of institutions, risk, external effect, enterprise

Introduction

In today's economy – knowledge-based economy – the value of goods, services and companies is created not only by tangible assets but mostly by assets based on all kinds of knowledge – Intangible Assets. Results obtained from traditional factors such as labour, land and capital are more and more dependant on effective usage of knowledge and therefore knowledge management.

A fair number of researches are dedicated to resolution of issues in the context of knowledge-based economy. Significance of knowledge for economics was first accentuated by F. Hayek in the Nobel lecture of the prize winners in economics (Hayek, 1974). Hereafter the issues related to the given field of economics were considered by well-known researchers of economics in their scientific works. F. Machlup substantiated significance of new knowledge generation for development of production activity by economic agents (Machlup, 1962). A.Marshall, one of the founders of neoclassical economics, acknowledged significance of knowledge in economic processes; he believed that «knowledge is one of the most powerful production engines» (Marshall,1965). K.Wiig determined position of knowledge in a modern company (Wiig, 1993), and D.Stonehouse & J. Pemberton investigated conditions favoring knowledge control system functioning (Stonehouse, Pemberton, 1999). E.Brooking (Brooking, 1997) and T.Stewart (Stewart, 1999) studied significance of intellectual capital for a company. P.Druker considered importance of transition to knowledge management as a specific strategic concept (Drucker, 1991). I.Nonaka determined capability of an economic entity to transform nonformalized knowledge into formalized one as a fundamental criterion of assessment regarding knowledge generation efficiency (Nonaka, 1991). F.Valenta introduced classification in terms of profoundness of changes made in a production process (Valenta, 1985). B.Twiss, carrying out research into new knowledge generation issues, determined that 80-90% of activity in the context of new knowledge generation are not economically efficient in terms of real market activity (Twiss,1995).

However, the mentioned researches are generally narrowed down to consideration of knowledge-based economy in terms of instrumental approach and opportunities for economic and mathematical modeling of innovation development. The issues concerned with cost estimate and generation of new knowledge remain unsolved. Processes of generation of new knowledge imply considerable risks, and that is ground for application of techniques related to institutional economics.

The objective of the present research is classification of mini-economic institutions for knowledge generation and formulation of a strategy regarding knowledge generation, which would allow introducing modifications into production technologies.

The structure of the paper is as follows: The second section presents the classification of institutions for new knowledge generation. The third section presents the research framework about internal and external risks concerned with new knowledge generation. The forth section presents the results of the institutional analysis for external effects of new technological knowledge. The fifth section presents the discussion about differentiation of new knowledge in terms of impact on technologies change and the last section is the conclusion.

Classification of institutions for new knowledge generation

Classification of mini-economic institutions for new knowledge generation is required in order to understand a conception regarding probable lines of development, an essence of institutional structure of new knowledge generation activity by economic agents.

There are two approaches (transformation and transaction) in the context of institutional economy which describe economic entities activity. The first approach emphasizes internal factor impact on activity by economic entities. In turn, the transaction approach considers external factor impact. Thus, in compliance with classification of institutional theories by O.Willianson, classification of institutions should primarily be accomplished in terms of such criterion as «relationship to an economic entity», namely, internal and external institutions should be distinguished. Considering the fact that knowledge generation is one of business lines by enterprises, an initial criterion in terms of classification of institutions for new knowledge generation is their relationship to an economic entity. Therewith, the first line provides analysis of enterprises and firms «on the inside», i.e. through a system of standards, agreements and contracts specified by various management approaches to new knowledge generation. The second line studies economic organizations «on the outside», i.e. it considers regulations of economic entities' interaction (Williamson, 1985).

Since dominant features of institutions are endogeneity or exogeneity of their generation or application, and the influence of institutions either on the activity by singular employees or the enterprise as a whole, so it is exactly those features of mini-economic institutions for new knowledge generation that have to be employed as basic features for classification.

Elements of market potential of an enterprise can be structured in terms of four management functions: planning, organization, stimulation and control, and in terms of three scopes of activity by an enterprise: analytics, production and communication (Popov, 2004).

Institutions for knowledge management are subject to the established system of decision-making inside of a particular economic entity. Regarding the issues related to new knowledge generation, it is exactly the established knowledge management standards at an enterprise – institutions for knowledge management – which determine activity lines, necessity and capability of financing new knowledge generation at an enterprise. *Endogenous institutions* include standards of interaction between economic agents, which are established inside of a particular economic entity. *Exogenous institutions* are standards established due to external factors in reference to an enterprise.

In the process of building of an institutional structure for new knowledge generation by economic entities, the following functions referred to *endogenous institutions* should be singled out: management, use of resources, interaction with third parties; for *exogenous institutions* – relationship with contractors, market condition influence.

The block referred to *institutions for management* includes newly developed mission, strategy and objectives of new knowledge generation. The given block is presented as a set of components relative to the system of management: planning, organization, stimulation and control (Oldcorn, 1999).

There is an established conception in the economic literature concerned with external uncontrolled factors of enterprise's macroenvironment; the conception includes analysis into technological, economic, social and political factors. The author of the present research considers it essential to add analysis of environmental factors as well (Kotler, 1990). A complex of the given factors generates the block of *institutions for market condition impact*.

The elaborated classification of institutions for new knowledge generation based on the criteria stated above is demonstrated in fig. 1.

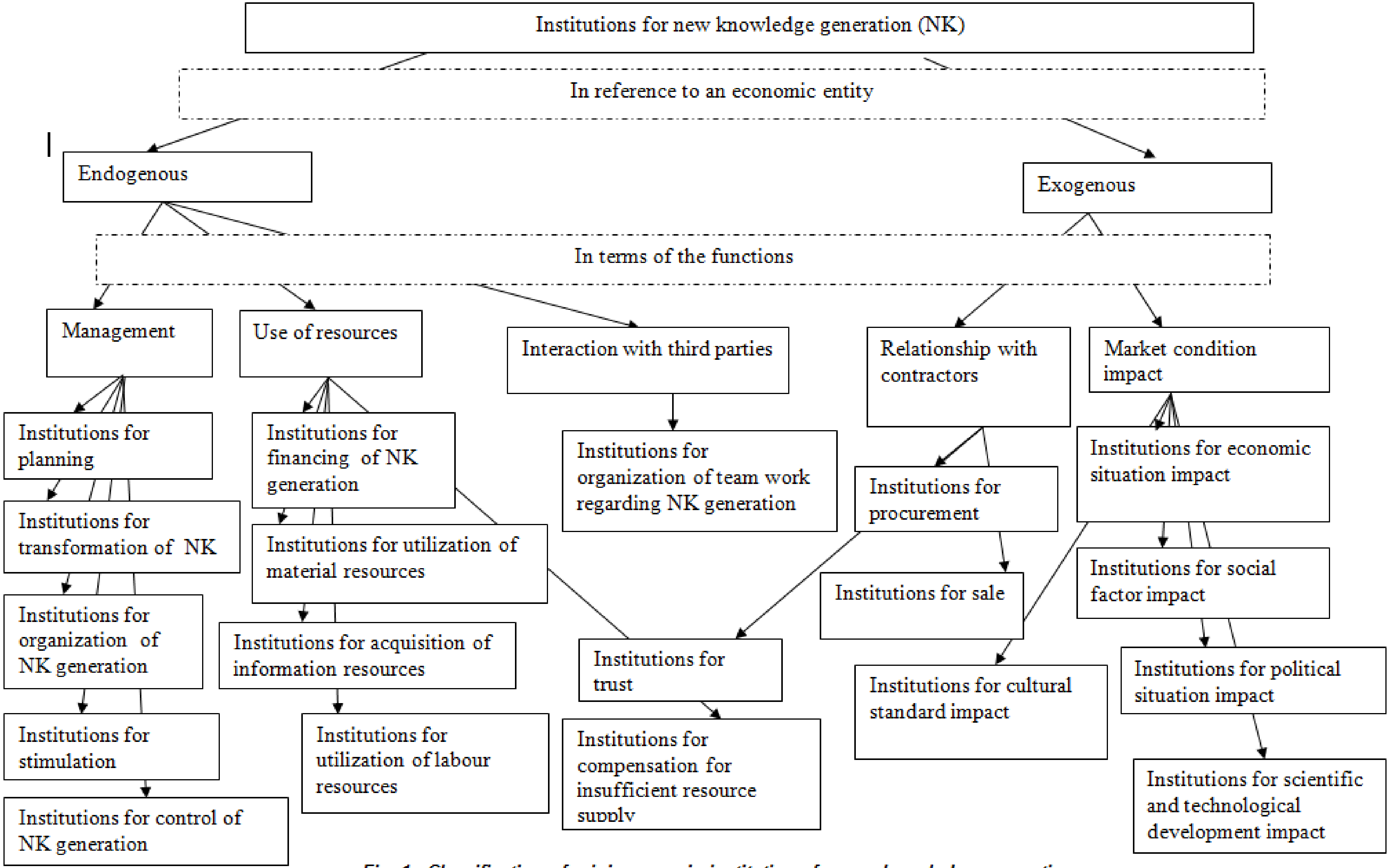

Fig. 1. Classification of mini-economic institutions for new knowledge generation

Thus, classification of mini-economic institutions for new knowledge generation affords an opportunity to reduce uncertainty in terms of analysis and organization of new knowledge generation, in terms of evaluation and prediction of development of the given economy elements. Development of institutions for new knowledge generation as standards and regulations of organization referred to it has an effect of considerable reduction of costs and risks, and, correspondingly, satisfaction of needs in new knowledge by economic entities.

Internal and external risks concerned with new knowledge generation

New knowledge generation processes are, in most cases, associated with considerable time lines between decision-making regarding knowledge generation and introduction of new knowledge into economic activity. Considerable span time predetermines uncertainty in terms of prospective conditions for new knowledge introduction, which results in emergence of various risks related to its generation. One should mention that new knowledge generation risks are part of integral risks of economic entity operation.

A *new knowledge generation risk* is an estimate of contradictions regarding prognostic and actual results of activity referred to new knowledge generation.

Considering the fact that new knowledge generation is one of business lines of enterprises, the risks related to such activity should be subdivided according to their relationship to an economic entity; subject to the field of occurrence; to external and internal. *External risks of new knowledge generation* include those with the source in external environment in reference to the considered object. *Internal risks of new knowledge generation* are those occurred due to immediate activity by an economic entity.

As a result of the research carried out by us the structure of external and internal risks in the context of new knowledge generation has been determined; evaluation of risk factor significance has been made; weighting coefficient values for each risk factor have been determined through expert estimation (Tables 1 and 2).

Table 1: Structure of internal risks in the context of new knowledge generation

Type of risks	**Weighting coefficient. %**
Low staff proficiency	17.80
Staff instability	11.26
Negative result of the activity	15.82
Lack of result within the established time limit	17.65
Unconformity of the results obtained with those planned	20.92
Practical use impossibility	16.57
Total	100

Table 2: Structure of external risks in the context of new knowledge generation

Type of risks	**Weighting coefficient. %**
Nonacceptance by the market	27.42
Noncompetitiveness of new knowledge	28.76
Infringement of intellectual property	26.48
Availability of analogs in the global practice	17.34
Total	100

One should mention that internal risks are much more significant for new knowledge generation than external risks. According to the empirical study results, internal risk weighting coefficient is 63.8%, external risks – 36.2%.

Thus, opportunity to predict and estimate risks of new knowledge generation allows to increase effectiveness of knowledge management in the organization.

External effects

One should mention the fact that new technological knowledge increased manufacturing efficiency has also external impact on other domains. A study into innovation activity by enterprises demonstrated the fact that enhancement of the material base of new knowledge appliance results in reduction of negative impact on the environment, ecology and improvement of personal well-being. Therefore particular importance is given to institution for external factor assessment in terms of new knowledge generation.

The technique referred to assessment of external effects in terms of new knowledge generation is based on classification of new knowledge in terms of fields of appliance, identification of their potential, share, their interrelation and correlation. External effects in terms of new knowledge generation are most effective provided they are allowed for in material production.

To substantiate the external effects, the author relies on a methodological statement concerned with the fact that the highest efficiency can be achieved in case of maximal interrelation of measures.

The *institution for external effects assessment* in terms of new knowledge generation is a certain complex of traditions, habits and mechanisms of assessment of mutual influence of external effects of new knowledge generation by economic entities. Significance of the given institution increases in case the required financing of new knowledge generation is not provided. The essence of the institution is in wide application of external effects in the processes of new knowledge generation, dynamic response to changes in external economic environment, satiation of activity by economic entities with new knowledge.

An analysis of new technological knowledge influence on other fields allowed estimating (according to the empiric research data) the following external effects in terms of new knowledge generation (Table 3).

Table 3: External effects in terms of new knowledge generation in the field of technology according to the scopes of appliance

Fields of new knowledge	External effect
Economic	0.17
Social	0.09
Cultural	0.04
Political	0.04
Ecological	0.17

In other words, to produce 100% of technological knowledge, up to 17% of economic and ecological, 9% social, 4% (each) cultural and political knowledge are generated simultaneously.

The analysis given in Table 3 demonstrates the fact that external effects of production and introduction of new technological knowledge with the lowest risk values and maximal efficiency afford an opportunity to reduce considerably the risks referred to production and introduction of new knowledge in other spheres with high risk coefficients, such as ecological, political and social.

Thus, growth in production and introduction of new technological knowledge exerts an influence on other scopes of activity and allows reducing the risks related to production and introduction of new knowledge. Therefore influence of new technological knowledge on other fields of activity is required to be taken into consideration in the process of calculation of new knowledge value.

Differentiation of new knowledge

Imbalance of actual and desired output of new knowledge is attributed to the shortage of elaborated methodologies that are referred to differentiation of changes introduced by this knowledge into production processes.

J.Shumpeter singled out the following typical changes of production processes: application of innovative technologies and technological processes; introduction of new-quality production; readjustment of industrial organization and logistics (Schumpeter, 1952).

Czech researcher F.Valenta introduced in his monograph classification in terms of profoundness of changes made in a production process: simple change of quality specified by low material costs, lack of change-related risks and, correspondingly, minor profit variance, with initial system characters are not subject to change; more profound process change concerned with more considerable investments and risks, which allows increasing production activity profitability level, with all or most part of system characters are subject to change, but the basic structural concept is retained; major change in functional properties of the system or its part, which modifies its functional principle and imply considerable financial expenditures and risks (Valenta, 1985).

Introduction of new knowledge in the activity by economic entities modifies production processes, and it requires classification of new knowledge in terms of profoundness of changes made. The author suggests the following differentiation of new knowledge in terms of profoundness of changes made in production processes (Table 4.).

Table 4: Differentiation of new knowledge in terms of impact on technological change

Type of new knowledge	Impact on technological change	Share of the given type in total volume of new knowledge	Influence on profit
Qualitative knowledge	Weak. Immediate response to change in external environment. Does not affect technological processes.	Share reduces with increase in new knowledge generation	dP=0
Structural knowledge	Moderate. Change of structure of an economic entity. Does not affect technological processes.	Share reduces with increase in new knowledge generation	dP=const<dTC
Functional knowledge	Strong. Change of technological processes.	Share grows with increase in new knowledge generation	dP>dTC

Note: ***dP – change in profit; dTC – costs referred to new knowledge generation.***

The author has conducted an empirical study concerned with allocation of shares of new knowledge generation according to the degree of change impact on production processes of economic entities (fig. 2).

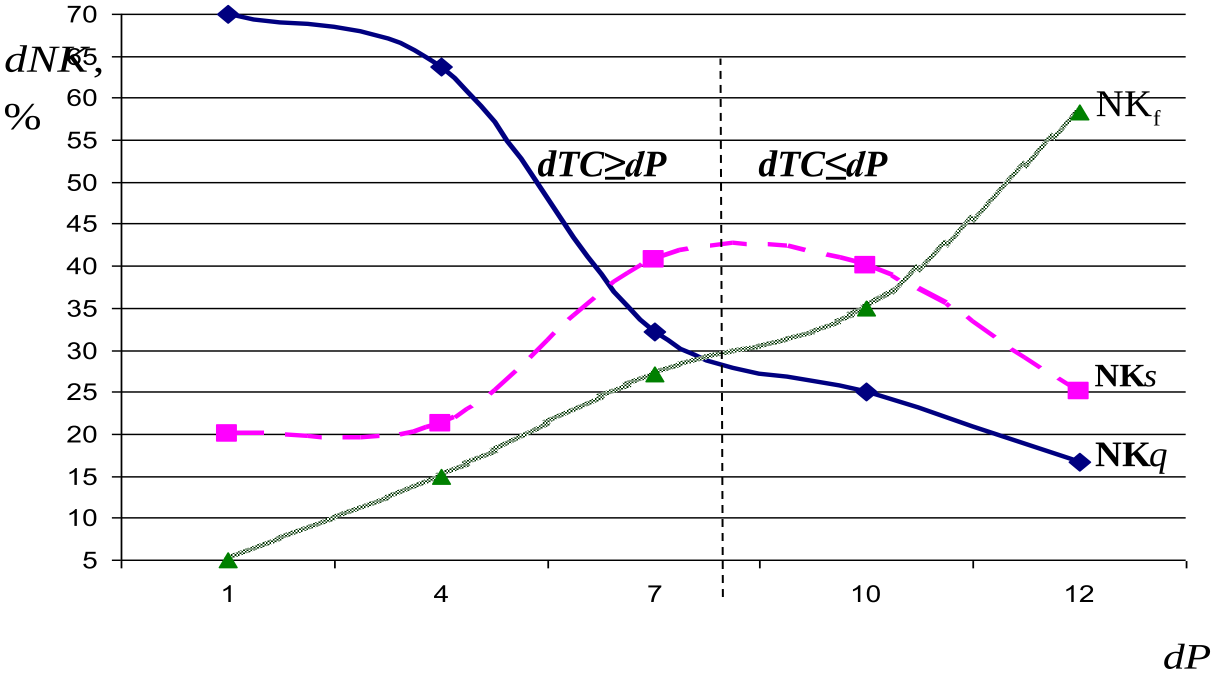

Fig. 2. Time history for profit (dP) to depend upon allocation of new knowledge generation volumes according to degree of impact on production processes (%).

(NK_q- qualitative change; NK_s - structural change; NK_f - functional change)

Based on the analysis in fig. 2, the following conclusions can be drawn:

First, financing of new knowledge generation within the scope less than 8% of profit and high share of quality new knowledge does not afford an opportunity for economic entities to optimize technological processes and gain significant profit as a result of new knowledge introduction.

Second, substantial changes in technological processes and profit from new knowledge introduction occur when amount of financing of new knowledge generation is more than 8% of profit and share of functional knowledge is more than 30% of the total volume of new knowledge introduced.

In the context of the present situation over the half of Russian enterprises finance new knowledge of a quality nature as a basic strategy for new knowledge generation, which does not give rise to technological process change and seizing the competitive edge, and, correspondingly, growth of profits.

Strategy that affords opportunity to optimize the activity in terms of new knowledge generation and, correspondingly, to increase profit as a result of new knowledge introduction, can be described by way of the following structure (1):

$$\begin{cases} \mathbf{dNK_q \leq 0{,}28} \\ \mathbf{dNK_s \leq 0{,}43} \\ \mathbf{dNK_f \geq 0{,}29} \end{cases} \quad (1)$$

Where:

$\mathbf{dNK}_q$ - share of qualitative new knowledge;

$\mathbf{dNK}_S$ - share of structural new knowledge;

$\mathbf{dNK_f}$ - share of functional new knowledge.

The model of new knowledge differentiation allows to optimize interaction of scientific and production processes in a knowledge management system and to develop strategy of new knowledge generation corresponding to objectives.

Conclusion

The research conducted by the author has yielded the following results:

First, based on the methodological apparatus for institutional economics, classification of economic institutions for new knowledge generation has been accomplished. It affords an opportunity to reduce uncertainties in terms of new knowledge generation, evaluation and prediction of development of elements referred to a certain economy.

Second, the author identified the structure of external and internal risks referred to new knowledge generation; assessment of risk factor significance has been made; weighing coefficient estimation for each risk factor has been accomplished in an expert way.

In the issuance of the conducted research classification of risks referred to new knowledge generation has been implemented. Trends towards reduction of external and internal risks referred to new knowledge generation have been identified. In order to assess capabilities for prediction of new knowledge generation risks and work out the means to reduce them, the apparatus for institutional economics was suggested.

Third, external effects of new technological knowledge introduction into economic domain and other scopes of activity by an enterprise have been exposed. Thus, external effects of new technological knowledge generation make it possible to substantially meet requirements in ecological and social branches of knowledge.

Fourth, differentiation of new knowledge in terms of profundity of changes introduced into technological processes has been accomplished, which is ground to consider new knowledge generation processes from different aspects of economic activity. A diagrammatic model of new knowledge generation structure has been developed; it allows optimal structuring of scientific and manufacturing processes on the basis of their differentiation. By reference of numerical criteria analysis related to the structure of the generated knowledge, guidelines regarding development of a strategy of its generation have been set forth.

Based on results obtained, enterprises are capable of making evaluation, prediction and planning in reference to new knowledge generation. The found means of reduction risks and costs referred to new knowledge generation are ground for its intensified introduction into business activity, which predetermines innovation economy development.

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Rethinking Knowledge Hierarchies - Bridging the Gulf between Theory and Practice: The Case of Frankfurt Airport's Billing Department

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Abstract

This paper examines the value of concrete empirical data in enhancing the understanding of knowledge hierarchies (KH). Theoretical debate has generated different insights and perspectives, but the term (KH) remains a misconstrued principle. In today's age of austerity, managing complex administrative processes in an airport-billing environment is challenging while striving for effectiveness and efficiency. These billing processes are influenced by the existing organisational KH. This study sheds light on the hybrid forms of KH: firstly, the theoretical impact: through data, information and knowledge (DIK) as knowledge hierarchies; secondly, the stakeholders' understanding of their role within business processes. The method adopted for this study is influenced by the nature of the problem to be addressed using a qualitative approach, analysing the billing processes and conducting interviews to gauge the stakeholders' perceptions in order to demonstrate that there are significant variations in understanding organisational key roles.

Keywords

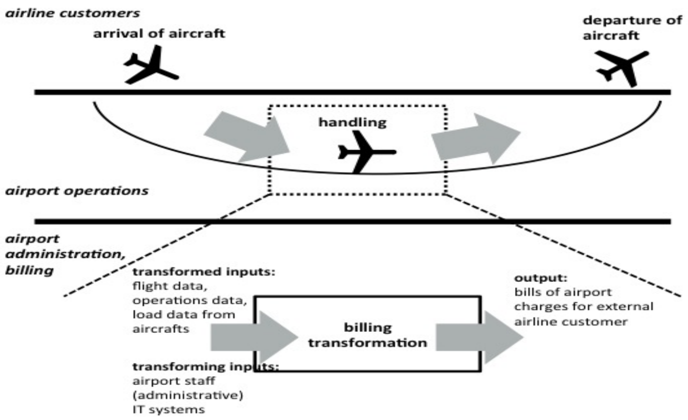
business process reengineering, explicit knowledge, knowledge and information, knowledge dissemination, knowledge hierarchy (kh), knowledge management practice

Introduction

The 21st century is truly knowledge–driven age. Knowledge has not only enhanced the quality of life but also improved standards of goods and services. There is extensive literature on the development and implementation of knowledge management (KM) and the role of knowledge hierarchies (KH), as organisations and institutions are undergoing transformational change and restructuring to alleviate and absorb the pressure of the global recession. A common and important purpose is to shed light in the core elements of KH, such as data, information and knowledge (DIK). Managing organisational and process knowledge across different IT systems in the airport billing is a constant challenge. Process specifications, increasing complexity, enhancements of a customer related process design and the internal company needs for effectiveness are the main issues. The company related hierarchy consists of two connected streams: firstly, there is the business process, which deals with routine tasks, IT coding and programmes. This includes the three DIK elements. Secondly, there is the usage of skills which involves 'knowing how, what and when' in the employees' minds. Within that, the application and definition of DIK supports the business practice.

Objectives

The key aim of this paper is to examine how KH might support Fraport billing department to deal with the complex challenges and multifaceted functions. Fraport is experiencing growing complexities and difficult operating tasks. Its business portfolio is undergoing significant transition from conventional ways of doing business to mechanisms for KH, the sharing of data and information as enablers rather than solutions to the many issues that Fraport seems to be facing. The main thrust of this paper is to assess the extent to which the vast body of literature on KH is of practical value. It argues that a successful implementation of KM requires the application and effective understanding of KH. The selected billing department includes typical complex DIK elements as business service activities. Core elements of the business processes are DIK input, transformation and output procedures as illustrated in figure 1:



(Source: Fraport internal documents, Evers R., REW RP 2010)

Figure 1: Input-Output model (Fraport)

Literature overview

The scope and depth of theories of organisational knowledge creation (Nonaka, 1994) varies from the focus of creation, based on the perspective and positioning of firms as knowledge creating entities (Nonaka et al., 2000), the role of the individual, defining expressing knowledge as tacit and explicit, to organisational focus and conversions such as information, communication and technology (Hislop, 2009) to descriptions as a fluid mix of embedded experiences and information in organisational routines and processes (Davenport and Prusak, 2000). In recent debates the views about knowledge sharing has been described as a two-faced Janus nature (Cockrell and Stone, 2010) and KM as a fashion (Hislop, 2010). The discussion regarding the conception, interpretation and implementation of the DIK hierarchy as a data, information, knowledge and wisdom hierarchy (DIKW), is still generating interest but with little practical implication. Similarly, the understanding and shaping of the term-definition data, information and knowledge still engender conflicting views (Tuomi, 2000; Hicks et al., 2006; Zins, 2007; Rowley, 2007; Rowley and Slack, 2009; Aven, 2013).

KM and business processes

As far as the airport industry is concerned, the debate clearly reveals the effects of the current usage of KM within business administrative processes, e.g. the impact of complex and high risk operational activities, connectivity and lack of explicit procedures and role descriptions.

The aviation sector criteria of organisational processes and employees' behaviours are under constant pressure to reduce costs. The business interest in KM and KH could be summarised as the recognition of difficulties regarding complexity and their externalisation and formalisation (Kalpic and Bernus, 2006). The related terms of complexity, transfer and dissemination across the business are obviously influencing factors. It illustrates a potential gap between business practice and KM theories. While business practice can be characterised as focusing on action and results, and thus are more short-term-oriented, KM theories focus on delivering rigour in models and setting up standards with a long-term perspective. This illustrates parts of the dilemma between business and academia: business and firms require immediate solutions. In contrast, the academic world takes time to adequately develop and test models.

KH discussion

The application of KH constitutes a challenging pre-requisite for practical conversion. From the beginning of KM research, the importance of distinguishing between DIK has been addressed (Tuomi, 2000). Similar to other fields of KM, the underlying assumptions and concepts of the knowledge hierarchy are widely debated. In particular, the terms data and information spilled over to other fields of academic research: Information Science, Technology, IT, Total Quality Management (TQM) and Re-Engineering. Referring to the business perspective, process data and information systems are often described as consisting of facts and figures. The debate highlights the crucial dilemma regarding the concept of hierarchy. If there is no common understanding about the content or in particular the meanings of the core terms, how can a hierarchy therefore exist? Furthermore, how can the debate contribute to the application within business practice? Since the beginning of the hierarchy development, the discussion focused on the classification, characteristics and the flow within the hierarchy terms. As a result one criticism of the knowledge pyramid is that information is more extensive than data and in many instances logically stronger (Frické, 2009). The statement links to the content and the underlying foundation of the billing department aims: process data and information systems.

KH elements

Similar to the discussion regarding the characteristics and descriptions of explicit and tacit knowledge, the DIK and DIKW terms carries different shades of meaning. The discussion varies from short criteria- descriptions, (→ data = symbols) to detailed classifications (→ data = …are defined as symbols that represent properties of objects, events and their environment).

The following table illustrates a collection of different perspectives and characteristics related to DIK:

Table 2: The characteristics of DIK (Sources: Chen, et.al, 2009, Rowley, 2007, Nonaka, 1994, Zeleny, 1987)

Literature sources	***Data***	***Information***	***Knowledge***
As a metaphor (Zeleny, 1987:60)	KNOW-NOTHING	KNOW-HOW	KNOW-WHAT
Theory of organisational knowledge creation (Nonaka, 1994)		*Information* is a flow of messages	*Knowledge* is created and organised by the very flow of information, anchored on the commitment and beliefs of its holder
Research summary regarding DIK definition (Rowley, 2007)	*Data* has no meaning or value because it is without context or interpretation	*Information* is formatted data, (and) can be defined as a representation of reality	*Knowledge* is the combination of data and information, to which is added expert opinion, skills, and experience, to result in a valuable asset which can be used to aid decision making
View in computational space (Chen, et.al. 2009)	Computerised representations of models and attributes	*Data* that represents the results of a computational process, …for assigning meanings to the data, or the transcripts of some meanings assigned by human beings	*Data* that represents the results of a computer-simulated cognitive process, such as perception, learning, association, and reasoning, or the transcripts of some knowledge acquired by human beings

Parallel to the discussion shown in table 1 the school of the ‘reversed hierarchy’ has been developed. Within that approach the hierarchy elements and linkage to business processes starts with knowledge, then information and then data (KID). In the following table the main perspectives of the revised knowledge hierarchy (KID) have been collected and compared:

Table 3: The characteristics of KID (Sources: Fricke, 2009, Braganza, 2004, Tuomi, 2000)

Literature sources	***Knowledge***	***Information***	***Data***
Tuomi (2000)	*Knowledge* has a close connection to bits stored in computer memory. Indeed, the whole knowledge-based economy can then be reduced to "information-economy", ... *(Tuomi, 2000:115)*	*Information* can be created only after there is *knowledge…* *Information* can be defined as "anything that can be digitized" *(Tuomi, 2000:115)*	*Data* emerge as a by-product of cognitive "artefacts" that assume the existence of socially shared practice of using artefacts *(Tuomi, 2000:115)* *Data* emerge last-only after knowledge and information are available (Tuomi, 2000:107)
Braganza (2004:355)	*Knowledge* is used to achieve higher order organisational strategies and is located in each cross-functional business process	*Information* is used to exploit opportunities and solve problems and is located in one or more work practices	*Data* are fundamental to both, as they are elements derived from information.
Fricke (2009:140)	For an account of *knowledge*, …, information science should use a propositional account of knowledge, …This makes knowledge and information synonymous. Knowledge and information collapse into each other.	*Information* is both more extensive than data and many instances of it are logically stronger than data. Information is irreducible to data	All *data* is information. However, there is information that is not data. Almost all of science is information, but, in most contexts, it is not data

KH concepts: DIK versus KID

Despite the popularity of KH, the flow from data to information to knowledge is not universally accepted (Nold, 2011). The literature has also highlighted inconsistencies and conflicting viewpoints. It seems to have overlooked, that KH are influenced by the country, environment and the institution or organisation in which they operate. It was stated as an argument for KID, that the process of the hierarchy should be treated while data emerge (Tuomi, 2000). This argument suggests that the process depends on crucial factors like the influence of actors (people, customised IT systems). In other words, knowledge exists in the minds of individuals and becomes information when articulated and shared and then converted to data (Nold, 2011). The comparison of these arguments with the existing reality in airport billing processes - see figure 2 - shows the practical dilemma: mass of data, running through systems and directed, changed and led by human beings. Therefore, the application of models in business is faced with people interacting with their individualism and the company as a powerful organisation with inherent culture. Thus a harmonious engagement and transparent KH structure involving all the stakeholders is paramount. The main hierarchy models discussed are illustrated in figure 2.

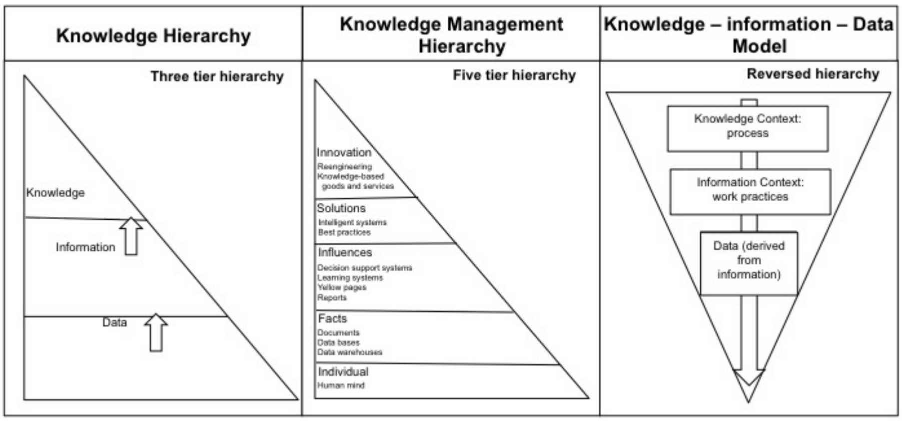


Figure 2: Model of knowledge management hierarchy

(Source: adopted from Hicks et al.: The five tier knowledge management hierarchy, 2006:20, 22 and Braganza, A.: Rethinking the data- information – knowledge hierarchy, 2004:349)

Contrasting and comparing these models, two ideas can be highlighted. Firstly, the bottom-up approach is rooted in traditional IT methods and begins typically with requirements (Braganza, 2004; Rowley, 2007). Secondly, the extended top-down-approach can be described as a concept, which is reorganised to be top down with knowledge leading to information and subsequently determining data (Braganza, 2004). From a business perspective the usage depends on specific process needs. Additionally, the application of business routines and group interactions is also important within the hierarchy context (Lazaric and Raybaut, 2005). The influence of business information systems and procedures is shown in the extension of the DIKW (Rowley, 2007). Similar to the five-tier hierarchy development (Hicks, 2006), the mapping system developed (Rowley, 2007) tries to include the main driver ‘IT’ and influencing element ‘Complexity’ from business practice. In summary, the broad discussion over more than ten years within that specific field shows the need for bridging the gulf between theory and business practice.

Research methodology and methods

The rationale for adopting an interpretivist/qualitative approach stems from the nature of the problem i.e. to investigate the influence of organisational centralisation and subsequent business process changes within the KH. As the case is dealing with non-measurable issues that are not generalizable, assessing billing processes and perceptions and opinions of stakeholders of an individual company and in order to analyse the KH in-depth, a qualitative approach is deemed appropriate. The research strategy applies the method of the exploratory single case study. The centralisation of three process-structured departments has been managed in a project, which covers the development of a process inventory to fulfil the completeness requirements (accounting standards). The case study investigates the project activities from the KM point of view by analysing the outcome of process meetings by interviews of the participants.

Table 4: Methodology of the research

Methodology	***Research Approach***	***Research design***	***Content***	***Interviewees Stakeholder groups***	***Process-structured departments***
Interpretivist	Qualitative and inductive research	Case study	Study of KM impact on change and process development over the time	Billing experts: 5 Product process supervisors (PPS): 5 Management: 4	AC – Airport charges GH – Ground handling services OS – Other services

Research process

Sources of evidence for the data collection are interviews, documentations and archival records. Closed and open questions of semi-structured interviews have been analysed by descriptive statistics and content analysis. The triangulation with results of recent studies increases the reliability of the outcomes. Employees who were involved (billing experts, PPS and management) have company experiences from 3-35 years. The researcher himself is part of the company as the department leader. The data collection method used interviews as the main data source. The interviews were conducted over the period of February to June 2012 involving a total of 14 participants. The interviews consisted of a structured list of mainly closed questions, which were in line with the nature of the problem and the research objectives. In cases where the participants were asked about their perceptions, experiences and opinions a 7-point scale has been applied. For the specific question of this paper the qualitative outcomes of the interviews have been contrasted against the theoretical debate by using tag clouds and word analysis.

Findings

Complexity of billing processes in the airport industry

One result of the study includes a complete set of the billing department processes. This covers the processes of all three areas and the extracts of shared tacit knowledge on a group-based experience. The outcome shows high and varying numbers of main and sub processes (25 – 110) and fundamental distinctions between the three billing areas (AC, GH, OS).

Application of the KH to billing processes

To examine the different descriptions and perceptions regarding the knowledge hierarchies the participants were asked to give their definitions of the hierarchy terms data, information and knowledge in the context of the developed processes. Firstly, they described in their own words the definitions (audio record). Afterwards, they had to summarise the main content (written statement). Examples from each group:

Table 5: Individual definitions of KH content

Group	*Data*	*Information*	*Knowledge*
Billing expert	*Data* is the basis or the input needed	*Information* is something someone asks for to get an answer for the customer, *Information* is learning	*Knowledge* is to know the components which influence each other; therefore *knowledg*e is experience
PPS	Countable, measurable data like aircraft types, slots, prices for specific services	All kind of relevant and needed data (verbally or on paper) to fulfil the given task correctly and efficiently	Combination of data, information, personal and professional experience of the employee
Manage ment	Certain details which are relevant for the billing process	*Information* is a set of data	*Knowledge* is data, information and to know how to proceed

The different descriptions regarding the terms DIK showed some interesting insights. Firstly, the data description is mainly focused on master data and systems. Secondly, the information definition is based on data and covers the need to fulfil the given process task. Thirdly, the knowledge description summarises the quality, combination and usage of data and information. A further outcome is the fact that the order of data, information and knowledge as the three-tier hierarchy is logical. In other words, from the perspective of the interviewees the definition is strongly related to the business processes. Therefore "data" consists of billing master-data, "information" consists of relevant and needed data (so far, enriched data) and "knowledge" describes the how to use (the developed description in the process inventory includes the first transfer to codified explicit-knowledge). The participants have been asked to explain for all processes in general and in detail, if the process is more data-related, information-related, knowledge-related or a combination:

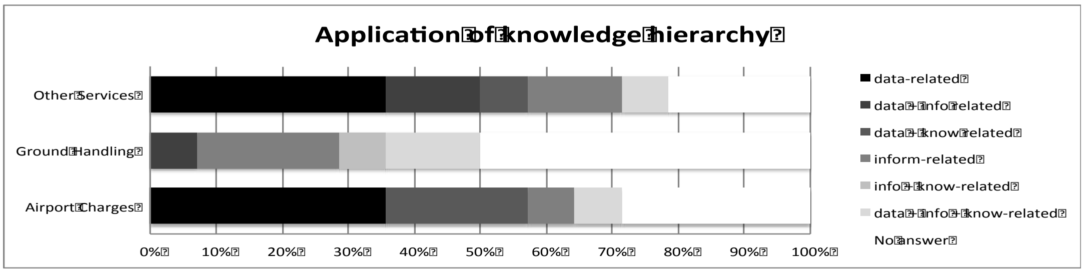


Figure 3: Application of KH to billing processes

The combination of data with information and knowledge determines the billing processes in the perception of the majority of the participants (60%). There is no billing process in general which depends on knowledge solely. The importance of information is higher than the knowledge for the billing of AC and OS. The results for the billing processes of ground handling are quite different. They are more information-related and depend on the combination of information and knowledge.

Variation of KH perceptions by organisational groups

In the next step the perceptions regarding the KH have been analysed by the organisational levels. There is clear evidence that the perceptions of the billing experts differ from the view of the management and the PPS. In particular, AC seems to be more 'mixed' in relation to DIK from billing experts view. This shows a significant change in perception depending on organisational role:

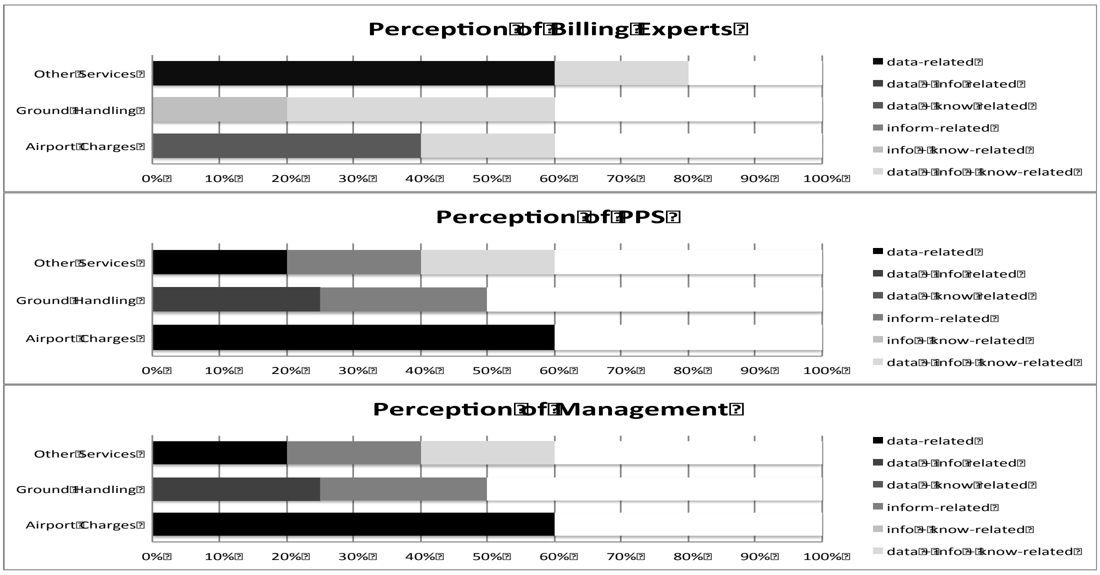


Figure 4: Variation of KH to billing processes

Limitations

It is generally accepted that any research is by its nature limited. This limitation is given for this research, because the chosen organisation with its billing department determines the outcome. Therefore the generalisation of this study is limited to those companies with a comparable environmental situation.

Contribution to knowledge and practice

The evident contribution this paper makes is at sharp variance with the dominant narrative, which depicts KH as a multiple uses concept and having a range of diverging definitions. Discussions of the various hierarchies of data, information, knowledge, and other related terms, although beneficial, are limited in providing practical support for KM. This paper argues, that the driving force which provides the competitive edge in these turbulent economic and uncertain political times is developing a framework for the knowledge sharing process at Fraport. This paper has provided fresh initiatives to stakeholders involved in KM and determined the future orientation of KM within Fraport. The current discussion could be extended by the additional view of the managerial level of employees. This leads to additional practical implications by developing and setting up a framework for the knowledge sharing process at Fraport, which will consider the different understandings of the processes regarding the data-related, information-related and knowledge-related perception of billing processes.

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The Barriers to Tacit Knowledge Sharing in Franchise Organisations

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Abstract

Contemporary discourse among knowledge management and franchising scholars, points to five key barriers that obstruct franchisors and franchisees from leveraging tacit knowledge as a resource for competitive advantage. Cumberland & Githens (2010; 2012), in their seminal works, identified these as Trust, Maturation, Communication, Competition and Culture. Usually, these barriers have been considered holistically as influencers of tacit knowledge transfer. So there has been limited debate on the individual influence of each factor, and scant robust testing of these barriers to determine whether they are indeed distinct factors. This paper revisits the ideas that have led to the identification and justification of these barriers; and explores the complex relationships that often exist between franchisors and franchisees, and also between franchisees themselves. Finally, this paper will offer some novel ideas on how these barriers could be mitigated, and tacit knowledge transferred, through better structuring of vertical and horizontal information flows.

Keywords

knowledge sharing, franchise operations

Introduction

Whereas knowledge development and sharing are both vital aspects of knowledge management, it appears that knowledge sharing is especially important for franchise organizations to successfully leverage their knowledge resources. The franchise has a community of very knowledgeable franchisees, and the degree to which this knowledge is shared will ultimately determine the quality of product and service development and delivery. The collective knowledge only becomes powerful if it is shared among those who possess common goals. However, the issue of 'common goals' is usually contentious within franchises organizations, because a large proportion of franchisees feel that the franchisor is 'autocratic, legalistic and insensitive to their challenges of staying in business'. Franchise guidelines might be viewed with suspicion since franchisees feel those directives are primarily aimed at deriving accurate and timely royalties for the franchisor, so, there is little incentive to share knowledge with the franchisor. Whilst O'Dell and Grayson (1998) have argued that where a particular franchisee has a unique competence, that knowledge should be shared with other franchisees without having to go through the franchisor, this mode of communication is often discouraged by franchisors.

Most franchise organizations employ information technology tools for transmitting data and various forms of knowledge (Seideman, 1998). Resources such as programme manuals, risk assessments, and health and safety documents are freely accessible to all franchisees. There are also robust intranet and extranet facilities that can support every aspect of the franchisees' activities, such as on-line revenue reporting. These are excellent facilities for storing and sharing explicit knowledge, because there is often a legal requirement for franchisees to use these tools. The weakness of most of these systems lies in their limited ability to record, store or share tacit knowledge. For instance, the on-line scheduling of a programme does not indicate how appropriately it was actually executed; the on-line registration of a customer does not state whether or not that customer was well served; just as the on-line reporting of revenue cannot reveal if a franchisee is actually putting their best efforts into growing that business.

Scholars have long recognised that there are risks and rewards for franchisees and franchisors when knowledge is shared (see, for example, Nault and Dexter, 1992). Franchisors generally hope to increase their royalty fees (a percentage of sales); while franchisees hope to improve their systems so as to increase their sales, cut costs, introduce new products, and implement more effective marketing. Franchisors can also encourage knowledge sharing through programmes that compensate franchisees for sharing tacit and explicit knowledge (McCann III and Buckner, 2004). For example, some franchisors operate a mentoring programme where stellar franchisees are matched with those that are struggling, so as to help them improve their processes. In return, the mentor receives a fee that is jointly paid by both the beneficiary and franchisor.

The major risk inherent in the franchisee's sharing of knowledge with franchisor is the potential of a franchisor using the knowledge gained from them to the detriment of franchisees in the future (Nault and Dexter, 1992). On the other hand, a franchisor could suffer serious losses when franchisees quit the franchise in order to set up rival businesses and utilising the knowledge gained from the franchise. Regardless of these potential cases of conflict, both franchisees and the franchisor stand to gain enormous rewards if knowledge is freely shared within a franchise system. Successful knowledge transfer enhances the organization's position of competitive advantage (Morgan and Hunt, 1997), and also facilitates innovation (Brockman and Morgan, 2006). Therefore, the long-term success of a franchise is largely determined by its ability to leverage all its assets through a framework of franchise learning and knowledge management, which enables it to develop dynamic capabilities and value-creating strategies (Chen, et al., 2002). This will be affected by factors such as the way it conceptualises, stores and shares knowledge; the type of information technology tools that it employs; as well as the inert mechanisms that enable every member of the franchise community to learn.

Tacit Knowledge within Franchise Systems

There are two types of franchise organizations – the 'traditional' and 'network'. In traditional franchises, there is an explicit delineation of roles between the franchisor and the franchisee (Bercovitz, 1999); therefore knowledge is more likely to be created by the franchisor and disseminated to franchisees. However, network franchises are guided more by relational dimensions rather than contracts (Achrol and Kotler, 1999); thus knowledge may flow in either direction within the network. But in reality, most franchises are hybrids; neither purely traditional nor network.

In 2010, there were over 897 franchise systems in the United Kingdom, employing more than 521,000 people in 36,900 units (NatWest/BFA, 2011). Around a third of the UK franchisors have international franchisees. All members of these franchise communities possess knowledge resources that could be shared within their franchise community to everyone's benefit. Resources such as programme manuals are excellent for sharing explicit knowledge, but are limited for recording, storing and sharing tacit knowledge.

The term *tacit knowledge* was first used by Polanyi (1958) to describe knowledge that cannot be adequately articulated by verbal means. This assertion presupposes that knowledge should normally be easily articulated and shared, which would imply *explicit knowledge*. As a result, many scholars through the decades have tended to define tacit knowledge from the perspective of how it differs from explicit knowledge. While explicit knowledge can be codified and easily transferred, tacit knowledge is intuitive and cannot be communicated.

However, Collins (2001) introduced a new dimension to the debate by arguing that it is flawed to view explicit knowledge as the norm, and tacit knowledge as the exception (knowledge which is not explicit). According to him, 'explicit' is a relative term, because tacit knowledge transforms to explicit knowledge at varying rates, and to varying degrees, depending on how explicable is that tacit knowledge. Therefore, "tacit is that which has not or cannot be made explicit".

The process of transforming tacit knowledge into explicit knowledge is known as codification or articulation. The tacit aspects of knowledge are those that cannot be codified, but can only be transmitted via training or gained through personal experience. Polanyi (1966) takes this further by stating that not only is there knowledge that cannot be adequately articulated by verbal means but also all knowledge is rooted in tacit knowledge in the strong sense of that term. Collins (2001) adds that classic treatments of tacit knowledge put the emphasis in the wrong place, because "all knowledge is either tacit or rooted in tacit knowledge" therefore, explicit is without significance in the absence of tacit knowledge.

With tacit knowledge, people are not often aware of the knowledge they possess or how it can be valuable to others. This relativity has been captured by Collins (2001) in a theory that describes tacit knowledge as weak, medium or strong, based on the degree of resistance of the tacit knowledge to being made explicit. Strong tacit knowledge, also described as collective tacit knowledge, is the kind of knowledge that is very difficult to make explicit. Medium tacit knowledge or somatic tacit knowledge is the type that can be made explicit with reasonable effort; while weak tacit knowledge or relational tacit knowledge is more readily explicable.

Five types of relational tacit knowledge have been identified. The first is concealed knowledge, as exemplified in the quote "I've always told the truth, nothing but the truth, but not the whole truth" (Collins, 1985). Next there is ostensive knowledge, which can only be learned by practice because the description in words would be too complex to understand. Thirdly, there is "mismatched saliences" (Collins, 2001), knowledge that has been told, but remains hidden because the person telling it assumes that the receiver already possesses some essential piece of explicit knowledge, when in fact they do not. Then, there is 'unrecognised knowledge', where someone carries out certain procedures in certain ways but cannot tell others about it because they do not know that certain of the ways in which they do things are important'. The final type concerns logistically demanding knowledge where physical proximity becomes especially important in knowledge transfer (Ribeiro, 2007; Hedesstrom and Whitley, 2000).

Somatic tacit knowledge is less structured, and includes the bicycle riding metaphor that has become a paradigm of tacit knowledge. We cannot 'tell' somatic knowledge, but we can pass it on through close contact and practice (Polanyi, 1958). This idea was popularised by Dreyfus, who concluded that human beings do many things much better if they do not process the instructions with the conscious mind. The Dreyfusian five-stage model of skills acquisition (Dreyfus and Dreyfus, 1986) articulated five stages that a driver would pass through before becoming an expert; novice, advanced beginner, competent, proficient and finally, expert. These same five stages could be applied to the learning of Chess, and have been widely used in the creation of artificial intelligence.

Collective tacit knowledge is the most difficult to articulate because it requires a social judgement about the right way to do things, and therefore, cannot be captured in writing. Collective tacit knowledge requires learning with a degree of flexibility, so that style can be changed to fit different situations. It has been argued the change required would be too varied and frequent, thereby rendering collective tacit knowledge virtually inexplicable (Collins, 2010).

Sharing Tacit Knowledge within Franchise Organizations

Both tacit and explicit knowledge can become part of the organizational capital of any company (Edvinsson and Malone, 1997); this also applies to any franchise community. Explicit knowledge can be shared by franchisors and franchisees through documentation such as training manuals, but tacit knowledge is harder to capture in formal organizational procedures.

Von Krogh et al. (2001) have identified five ways that tacit knowledge is typically shared. The first is by direct observation as in an expert-novice situation, where the observer comes to share beliefs about which actions work and which do not. Next is through direct observation and narration, where beliefs are further shaped by metaphor or in the form of narrative about similar incidents or activities. Then there is the situation where franchise members attempt to imitate a task based on direct observation of others. Also tacit knowledge can be shared through imitation and comparison when members try out various solutions, observe others at work, and then compare the results. Finally, franchise members could try to solve a task through joint execution.

The common theme in these five modes of sharing tacit knowledge is that ‘language is not the primary mechanism for this process’ because the intrinsic aspects matter much more than the description of the activity (Mackenzie and Spinardi, 1995). Furthermore, it could even be an oversimplification to assume that all tacit knowledge has an intrinsic aspect. According to Shanks and Johnstone (1998), many business tasks involve a high level of expertise and therefore are difficult to deconstruct, verbalise and categorize.

Research Methodology

In testing the barriers to tacit knowledge sharing, this study focuses on two franchise organisations. It employs a qualitative methodology centred on these two in-depth case studies of these two very different service sector franchises. The first (referred to as F1) is an international provider of education and entertainment for children. The author is an experienced franchisee within this franchise. The other (F2) is a British-based franchise that provides accounting and tax services to small and medium sized enterprises. Between them, they have over 400 franchises globally. The semi-structured interview schedule for the second franchise (F2) covered ten key themes. These themes were drawn from both the extant literature, and the author's prior experience when giving advice to potential franchisees seeking to join franchise community F1.

In addition to these two cases, the on-going research explores knowledge sharing in a wide array of franchise organizations spanning the food, hospitality, and service sectors. This is being carried out through the use of questionnaires, focus groups and in-depth interviews with franchisors, franchisees and other industry experts. The dataset is currently at the preliminary stage, and the author has carried out the initial interviews. In respect of his own franchise, he has spent several months reflecting upon his experience and formalizing his reflection with his research supervisor. This process has led to the articulation of key research hypotheses such as: Tacit knowledge in a franchise system will only be shared is the sharers believe that sharing would further their own goals.

The Barriers to Tacit Knowledge Sharing

In any franchise situation, knowledge will only be shared if the sharers genuinely believe that sharing knowledge will further their goals, or if the sharers are forced to share. Most franchisors operate systems that compel franchisees to share knowledge, but these systems invariably fail to inspire the open sharing of tacit knowledge. This failure is a result of some factors that either discourage knowledge sharing, or make it impossible. Clearly there has to be gains for both the franchisor and the franchisee –otherwise they would not contract one with the other but the typical franchisor business model is not without tension. The franchisor is keen to grow turnover since they often receive eight percent of total sales as royalty whereas the franchisees are more concerned about making their operations profitable even if that implies that growth is slower.

In both F1 and F2, the systems were weak due to a limited ability to record, store or share tacit knowledge. For instance, the on-line scheduling of a programme does not indicate how appropriately it was actually executed; the on-line registration of a customer does not state whether or not they enjoyed the programme; just as the on-line reporting of revenue cannot reveal if a franchisee is actually putting their best efforts into growing that business.

The major risk inherent in the franchisee's sharing of knowledge with franchisor is the potential of a franchisor using the knowledge gained from franchisees to the detriment of franchisees in the future. For example, some franchisees cited cases where franchises were repossessed in circumstances that they would consider to be unfair (such as when a franchise was repossessed because the franchisee could not meet up with revenue expectations due to long-term ill health). However one franchisor countered by referring to a few cases where franchisees quit the franchise in order to set up direct competition as rival businesses.

Testing the Barriers

Cumberland and Githens (2010) identified five barriers to tacit knowledge sharing within franchise organizations. The first barrier is trust, because members share knowledge based on their perceptions of the recipients as a friend or foe. Husted and Michailova (2002) defined this as 'knowledge sharing hostility'. The second identified barrier is maturation, where they argue that franchisees in their formative stages welcome knowledge sharing, while those in a mature stage are less likely to adopt new ideas. Next is communication barrier whereby the health of a franchise community is believed to depend on how freely the members transmit their knowledge to others. Fourth is the competition barrier which could apply if the franchisor owns some franchises which coexist with other franchisees. Lastly, there is the culture barrier which states that franchisees have their distinct sets of beliefs and practices which differ from those of the franchisor.

After reviewing the activities of F1 and F2, this paper wishes to submit that the five listed barriers cannot all be supported by evidence. Instead we have identified three barriers – Trust, Culture and Knowledge Fit.

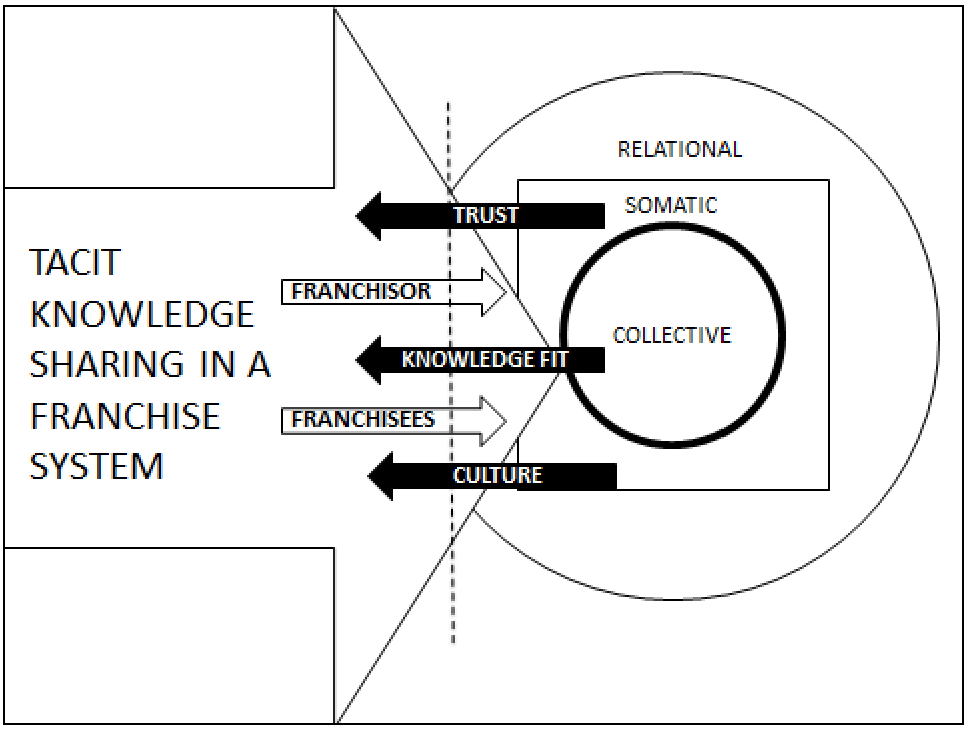

Diagram 1: Mapping the barriers to tacit knowledge sharing in franchise systems

(Adapted from Collins, 2001)

Communication cannot be a defined as a barrier to the sharing of tacit knowledge within franchise organizations because it is the common thread that binds all tacit knowledge sharing activities, being only an impartial mode of transmission between the giver and receiver of tacit knowledge. It is either present or absent and therefore cannot be relativized in the form of a limiting factor or barrier to knowledge sharing. At best, what appears to be a communication barrier is actually a symptom of the trust, culture and knowledge fit barriers. For instance, when a franchisee limits what he wants to pass on to a franchisor due to the survivor mentality, it is not about communication but actually about trust.

Also, our research revealed that maturation on its own is not a barrier to the sharing of tacit knowledge because there is no evidence that franchisee behaviour is determined directly by the age of their operation. Instead we found that the real age of a franchise (as against nominal age) is relative, and is heavily influenced by other factors such as the demographics of its territory and whether the franchise ownership has changed hands over the years. There could be differences between formative and established franchises, between new ways and old ways of doing things; but these are not necessarily due to maturation but more about knowledge evolution within the franchise community. So, maturation is at best only a control variable in an assessment of the barriers to tacit knowledge sharing.

In the same vein, competition does not pass the test as a barrier to tacit knowledge sharing. Even when a franchisor operates a franchise unit, that unit is really just an operational outpost, which does not change the principal relationship between the franchisor and the franchisees. Failure to share tacit knowledge in this situation is not because franchisees consider the franchisor as a competitor in that sense, but because they do not see a level playing field, and do not trust the franchisor to use that knowledge for their (franchisees) benefit. The reverse view of this relationship is that the franchisor also does not consider the franchisee as a competitor; when they hoard knowledge, it is simply due to a knowledge fit barrier between franchisor and franchisee.

Trust passes the test as a barrier to tacit knowledge sharing because of the very nature of franchise relationships which are legalistic, territorial and fraught with paranoia, hostility and self-serving behaviour. In F1 and F2, the trust barrier is most prevalent in the sharing of concealed and ostensive tacit knowledge, driven by rigorous provisions in non-competition agreements signed by franchisees. Concealed tacit knowledge involves sharing knowledge on a need-to-know basis, and keeping secrets without appearing to be. It involves answering questions when asked, but not volunteering information that would help create the correct context for your answers. In F1, trust is a major barrier to the sharing of ostensive tacit knowledge. For instance, we found that some franchisees have developed more effective methods of using operational equipment, but cannot share these practices for fear of reprisals from the franchisor.

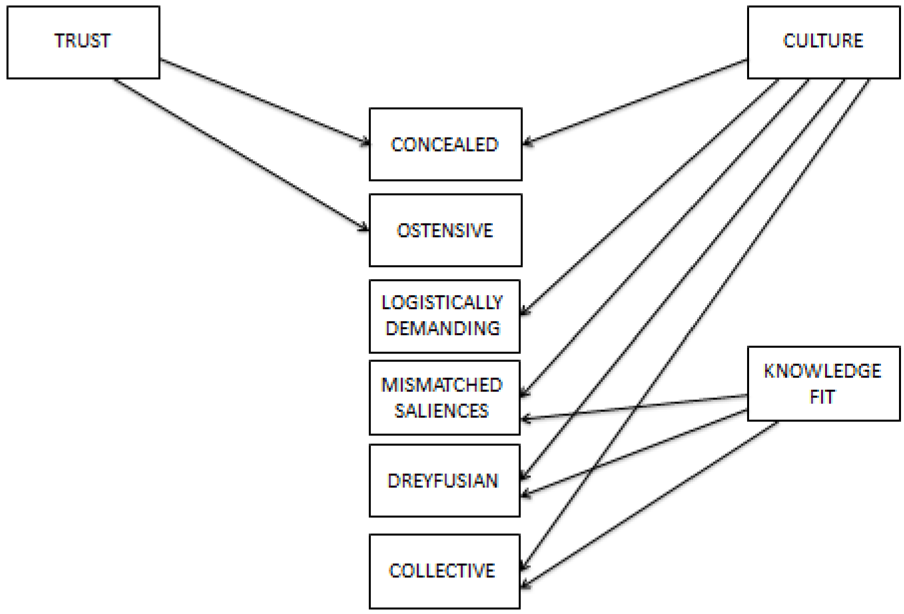

Diagram 2: The Barriers – Trust, Knowledge Fit and Culture – which affect sharing of various types of tacit knowledge (Source: Author)

Based on our findings, culture is probably the most critical barrier to sharing virtually every type of tacit knowledge. Besides the differences between the organizational cultures of the franchisor and various franchisees, sharing tacit knowledge is often disrupted by the social and economic cultures of the diverse communities where franchisees operate. The cultural barrier is even stronger in multinational franchises where local nuances and interpretations could be crucial to knowledge transfer. For instance, an America franchisee might be more open to blunt assessment, while a Japanese franchise would prefer subtle hints and a quiet word. Concealed tacit knowledge transfer would therefore suffer from the cultural barrier; likewise logistically demanding knowledge and collective knowledge which inherently rely on the subjective interpretation and social judgment involved in any knowledge transfer situation. Cultural barriers also disrupt the acquisition of Dreyfusian skills due to diverse local articulations of the five stages from novice through to expert. However, the most serious cultural barriers result from mismatched saliences where knowledge sharing failure occurs because either party has made some basic, but wrong, assumptions about the knowledge already possessed by the other.

Whereas trust and culture account for most of the barriers to sharing tacit knowledge, we found that there are still a few instances that are neither trust nor cultural. This we have chosen to call the Knowledge Fit barrier. The term 'knowledge fit' is normally applied to technology and corporate strategy; but we believe that tacit knowledge sharing in a franchise organization suffers a lot from the mismatch that exists between the knowledge and information resources available to the franchisor and franchisees. Most of the symptoms originally thought to result from communication and maturation barriers are actually caused by knowledge differences; this affects the sharing of ostensive, logically demanding, mismatched saliences and Dreyfusian tacit knowledge. Even more importantly, it is the pre-eminent barrier to the sharing of tacit knowledge because its existence is the main reason why a franchising relationship becomes necessary in the first place.

Conclusion

The long-term success of any franchise organization will mostly be determined by its ability to leverage all its assets through a framework of franchise learning (Chen, et al., 2002). This is affected by the way it conceptualizes, stores and shares knowledge; as well as the inert mechanisms that enable every member of the franchise community to learn.

Franchises are susceptible to the 'four- phase lifecycle' (Shreuder et al., 2000) beginning from the 'courting phase' when all parties are still very excited; to the 'rebel' phase when the franchisees start to challenge the restrictions placed upon them and demand more independence. Such frictions are caused by dysfunctional knowledge sharing structures, especially with respect to tacit knowledge.

This author believes that the misidentification of the barriers to tacit knowledge sharing within franchise organizations, is a major reason why little progress has been made in researching how they can be mitigated. This paper provides a framework contextualizing these barriers and aligning them directly with the various types of tacit knowledge. Further research opportunities could provide additional evidence regarding the impact of these barriers on tacit knowledge sharing in franchise organizations, as well as the steps that could be taken to mitigate this impact.

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The Concept of Knowledge Object Management System as a Tool Reducing the Knowledge Deficit in the Functioning of Machine-Building Industry Enterprises

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Abstract

This article presents the concept of Knowledge Object Management System, which constitutes an information tool that comprises methods for the acquisition and processing of contextual knowledge, necessary for the proper functioning of enterprises of machine-building industry. The concept is based on the universal structure in the form of unified elementary objects, combining a single formal structure with the possibility of recording various types of information. The functionality of the system is grounded on research that was conducted in selected Polish machine-building industry enterprises. The research was conducted with the use of questionnaires and direct interviews. It enabled the assessment of knowledge deficit in knowledge management processes in these enterprises. Machine-building industry enterprises belong to the production environment, defined in literature as engineering-to-order, ETO. This environment is a short-run production, i.e. the production to customer's individual order that requires specific engineering studies.

Keywords

knowledge object management system, knowledge management system, machine-building industry enterprises

Introduction

The global economy is evolving towards "knowledge-based economy" in which the market success of a company depends to a larger extent on the efficient knowledge management, i.e. the acquisition, storage, transmission and use of knowledge in organisations. The strategically important nature of knowledge arises firstly from its imitation and substitution which is more difficult when compared to the material resources, and secondly, from its greater flexibility, i.e. usefulness to create or improve various elements of the company's offer. Currently, knowledge is perceived as a company's strategic warehouse, and as such it should be subject to constant identification, measurement, acquisition, development, use and protection. In other words, it should be subject to appropriate management processes. The growing importance of knowledge for company management is influenced, among other things, by a rapid increase in the amount of knowledge; radical changes in technological knowledge; progressive globalisation driven by the growth of internet, computer and communication technologies and constant changes in the political, economic and social environment of the modern world. Intangible resources (such as patents, licenses, trademarks and service marks, know-how, employees' expertise, motivational systems, developed forms of teamwork, etc.) create sources of developing competitive advantage of modern enterprises.

The main aim of this article is to present Knowledge Object Management System (KOMS) as a macro-tool allowing the reduction of knowledge deficit within the methods and tools used in the knowledge processes (i.e. acquisition, storage, transfer and use of knowledge) in Polish machine-building industry enterprises. In order to determine the knowledge deficit, questionnaire-based surveys and interviews were carried out in 38 selected Polish machine-building industry enterprises. Possible areas for the fields of KOMS in such enterprises were identified.

Identification of knowledge deficit in Polish machine-building industry enterprises – study results

In many enterprises, particularly at the early stage of development, limited financial capacities or development of knowledge management, as well as the lack of effective and efficient completion of knowledge management processes (i.e. gathering, storing, transfer and use of knowledge), and in particular, deficits in the competent use of methods and tools in these processes, are important problems. These deficits in tools and organisation of knowledge management should be considered as a serious lack of knowledge in the enterprise. Without knowing how to implement knowledge management processes, it is difficult to build efficient and effective stores of knowledge in the enterprise.

The results of research on knowledge deficit presented in this article are part of wider studies on knowledge management in selected machine-building industry enterprises. These studies were two-stage research and they included the following assumptions:

1. Identification of key business processes implemented in the enterprises.
2. Evaluation of IT level in the enterprises and the establishment of the deficit in supporting the key processes by IT solutions.
3. Identification of key areas of knowledge and ascribing them to its main recipients.
4. Determination of the scope of used solutions, methods and tools in knowledge management processes, such as obtaining, storing, transferring and using in the activity of the analysed enterprises.

Studies were conducted in 38 Polish machine-building industry enterprises located in Silesia, recognised as small and medium-sized companies (they are the target group for which the system is developed). The enterprises that were studied include machine-building enterprises producing machinery of general purpose (number of enterprises 8), machine-building industry enterprises producing mining machinery (15), machine-building enterprises producing equipment for the defence industry (6), machine-building company for the automotive industry (9).

Qualitative methods dominate in collecting data necessary for the analysis in the audits of knowledge. Often used tools include questionnaires for data collecting, in-depth interviews, focus groups, observations of the work in progress (Liebowitz et al. 2000). Such tools constitute a good opportunity to gain additional insights and understanding of the employees' perception of KM.

Therefore, the study was conducted with the use of targeted interviews with employees from enterprises selected for the study. Among others, they included company owners, directors, managers of cells responsible for the development of new products and implemented technologies (e.g., design departments staff, production technical staff) and employees of IT departments. The questions asked during the interviews concerned the future, i.e. the assessment of desired, according to the respondents, conditions knowledge support of actions implemented within the order processing. Detailed results and their discussion were presented in previous articles of the authors (Dohn & Matusek 2011a, Dohn & Matusek 2011b, Gumiński & Zoleński 2011, Gumiński 2012). In the later part of this article, due to its goal, the authors focus on the presentation of the results concerning the fourth assumption, which is determination of the scope of solutions, methods and tools used in knowledge management processes, such as obtaining, storing, transferring and using in the activity of the analysed enterprises. In consequence, this allowed the determination of knowledge deficit in knowledge management processes in the enterprises that were studied.

It should be emphasised that the results are generalized conclusions that reflect the situation in the vast majority of enterprises that were studied. In spite of that, according to the authors, they allow to draw firm conclusions concerning presented concept of Knowledge Object Management System.

<u>The knowledge deficit within the knowledge acquisition in analysed machine-building industry enterprises</u>

In any enterprise, knowledge acquisition constitutes an important part of the organisational knowledge life cycle [Jemielniak & Koźmiński 2008, Nonaka & Takeuchi 2000]. Knowledge can be acquired throughout purchasing (e.g. recruiting employees with the appropriate store of knowledge) or borrowing (e.g. consultants or scientists). Another way is to open the company to the signals coming from the changing external environment. It is also important to create new knowledge inside the enterprise, as a result of processing of accumulated knowledge (mostly as a combination process) by key employees using knowledge [Gumiński 2012, Jashapara 2006]. Machine-building industry enterprises should be open especially to new technological solutions and solutions within modern methods of organisation and management.

The undertaken research concentrated on the determination of knowledge deficits in analysed Polish machine-building industry enterprises in the range of the knowledge processes realisation, i.e. applied methods and tools. The problem of existing limitations in this area affects the effective and efficient realisation of contracts in machine-building industry enterprises.

The detailed specification of the observed knowledge deficits in the range of applying methods and tools of explicit and tacit knowledge acquiring in the machine-building industry enterprises that were studies is presented in Table 1.

The knowledge deficit in applied methods and tools in the process of acquiring of both explicit and tacit knowledge concerns mainly the lack of standardisation and formalisation of knowledge acquisition from internal and external sources.

Table 1: The knowledge deficit in applying methods and tools in the analysed enterprises in the process of explicit and tacit knowledge acquisition

Explicit knowledge	Tacit knowledge
1. Insufficient use of benchmarking methods – lack of proper analysis and classification of high standards in manufacturing enterprise functioning. 2. Lack of possibility to analyse and verify employees' experience in the scope of participation in national and international conferences. 3. Insufficient opportunities for professional development and employees training with the use of electronic platform. 4. Insufficiently refined procedures for acquiring knowledge of the problems emerging in the contracts execution, insufficiently refined procedures for acquiring explicit knowledge from customers. 5. Limited employee access to the specialist literature in an electronic form. 6. Lack of verification of the validity level of codified knowledge.	1. Insufficient use of cooperation with other business entities. 2. Limited abilities to seize the tacit knowledge from the enterprises' employees. 3. Limited possibilities for professional training through national internships. 4. Limited possibilities for professional training through internships abroad. 5. Insufficient opportunities for professional development and training of employees with the use of electronic platform. 6. Insufficiently refined procedures for acquiring knowledge about the experiences of workers involved in the execution of contracts. 7. Insufficiently refined procedures for the tacit knowledge acquisition from customers.

The knowledge deficit within the knowledge storage in analysed machine-building industry enterprises

The accumulation of knowledge in enterprises takes place in three major knowledge repositories: employees’ minds (in the form of tacit knowledge), paper documents (in the form of explicit knowledge) and computer databases (in the form of codified knowledge). In the enterprises that were studied, the particular importance lies in the unique employees’ knowledge of the engineering and technology located in their minds as tacit knowledge, which should be converted into a codified form.

The detailed specification of the observed knowledge deficits in the range of applying methods and tools of explicit and tacit knowledge storage in the studied machine-building industry enterprises was presented in Table 2.

The knowledge deficit in applied methods and tools in the process of storage of both explicit and tacit knowledge concerns mainly the lack of IT tools for its standardisation, validation and upgrading. One can observe the limited capabilities in the storage of qualitative information concerning experiences in the contract’s realisation, e.g. benchmarks, good and bad practices or risk factors.

Table 2: The knowledge deficit in applying methods and tools in the analysed enterprises in the process of explicit and tacit knowledge storage

Explicit knowledge	Tacit knowledge
1. Insufficiently refined procedures for paper and electronic documents selection, insufficiently refined procedures for collecting and updating paper and electronic documents. 2. Lack of possibility to analyse and verify employees' experiences in participation in national and international conferences. 3. Insufficient records of certificates, licenses and patents possessed by the enterprise. 4. Limited knowledge of good practices in the contracts implementation. 5. Limited knowledge of the experiences from completed contracts. 6. Insufficiently refined procedures and tools for collecting and updating knowledge of contracts. 7. Lack of verification of the validity level of codified knowledge.	1. Limited knowledge of employees' competences. 2. Limited knowledge of employees' education and certifications. 3. Limited knowledge of external experts. 4. Insufficiently refined procedures and tools for the collection and updating of knowledge concerning the employees' experience linked with contract execution. 5. Lack of verification of the validity level of codified knowledge.

The knowledge deficit within the knowledge transfer in analysed machine-building industry enterprises

The main aim of knowledge transfer is to enable employees to have an access to knowledge, necessary in various technological and managerial processes. In order to reach that objective, an appropriate IT infrastructure for knowledge transmission is necessary. The transfer of codified knowledge is implemented mainly by electronic communication channels. The transfer of non-codified knowledge is, in turn, implemented primarily in the form of formal and informal employees meetings, knowledge fairs and moralizing programmes. [Jashapara 2006, Jemielniak

& Koźmiński 2008].

The detailed specification of the observed knowledge deficits in the range of applying methods and tools of explicit and tacit knowledge transfer in the studied machine-building industry enterprises is presented in Table 3.

A significant knowledge deficit both in the range of explicit and tacit knowledge is the lack of standardisation and formalisation of the knowledge transfer process in the area of sharing good practices, traineeships and specialist trainings. An associated deficit is the lack of the information platform for knowledge transfer in the analysed machine-building industry enterprises.

Table 3: The knowledge deficit in the methods and tools used in the analysed enterprises in the process of the explicit and tacit knowledge transfer

Explicit knowledge	Tacit knowledge
1. Limited conditions for employees meetings and knowledge exchange. 2. Insufficiently elaborated procedure of creating task forces as part of implemented contracts. 3. Insufficiently elaborated procedure of transfer of knowledge acquired during apprenticeships, traineeships or conferences. 4. Insufficiently elaborated procedure of internal trainings and lectures. 5. Insufficient use of bulletins and newsletters within knowledge transfer. 6. Limited infrastructural opportunities of knowledge exchange among employees.	1. Limited conditions for employees meetings and knowledge exchange. 2. Insufficiently elaborated programme for sharing good practices. 3. Insufficiently elaborated procedure of internal trainings and lectures. 4. Limited use of moralizing programmes. 5. Insufficiently elaborated procedure of transfer of knowledge acquired during apprenticeships, traineeships or conferences.

The knowledge deficit within the knowledge use in analysed machine-building industry enterprises

The process of knowledge use requires an effective implementation of the other knowledge management processes, i.e. the processes of knowledge acquisition, storage and transfer. The use of knowledge requires an adequate knowledge processing for a particular objective, supported by various systems which, among other things, include data management systems, knowledge management systems and new generation systems (e.g. artificial intelligence systems) [Gołuchowski 2007, Kisielnicki & Sroka 2005].

The detailed specification of the observed knowledge deficits in the range of applying methods and tools of knowledge use in the studied machine-building industry enterprises is presented in Table 4.

A significant knowledge deficit in the applied IT solutions is the limited use of codified knowledge in decision-making processes and in the implementation of process innovations and product innovations.

Table 4: The knowledge deficit in the methods and tools used in the analysed enterprises in the process of the knowledge use

1. Insufficient use of After Action Review tool concerning executed contracts. 2. Limited use of codified knowledge while introducing process innovations. 3. Limited use of codified knowledge while introducing product innovations. 4. Limited use of codified knowledge in decision-making processes. 5. Limited opportunities in the access to technological and managerial contextual knowledge in the realisation of contract portfolio.

In conclusion, it should be emphasised that the analysed machine-building industry enterprises have limited capabilities in the range of the effective management of knowledge processes. It should be given necessary functionalities in all knowledge processes to reduce the knowledge deficit in the area of applied solutions and methods.

A particularly important matter is to make the process of the knowledge acquisition and storage more effective, especially, the appropriate categorisation, verification and evaluation of knowledge according to the criterion of its usefulness in the activity of analysed enterprises, e.g. in the range of the storage of experiences in the form of database of good and bad practices. Another issue in the analysed enterprises which needs to be rationalised is the increase of the formalisation and standardisation level in the processes of knowledge acquisition and storage. It is also important to create the information platform which would enable the exchange of codified knowledge and its use in decision-making processes.

The answer to the above-mentioned knowledge deficits in the range of applied tools and methods for the realisation of knowledge processes in the analysed machine-building industry enterprises should be the information system based on the qualitative information.
Functionalities enabling the reduction of the existing knowledge deficit in the knowledge processes are specified in the proposed concept of the macro-tool presented in the following part of this article.

The concept of KOMS macro-tool

In supporting knowledge management system, the use of stores of knowledge of various structure, including both quantitative and qualitative information, which may take the form of text, drawings, diagrams, charts, calculations or addresses, requires suggesting a solution different from the standard formula of processed information in relational database management systems. An important aspect is to operate qualitative information in knowledge systems.

Table 5 shows the search for functionality of the proposed KOMS within the reduction of knowledge deficit. The authors present for each tool the range of knowledge deficit and the specific functions implemented by KOMS macro-tool to limit the existing deficit. The proposed KOMS macro-tool allows to share the information (mainly qualitative) for elementary knowledge objects, edit, classify and categorise them (by structuring and organizing). Moreover, it enables an easy access to contextual knowledge. The concept of macro-tool is understood here as a versatile solution that can be used in different areas of the company (that are involved in the implementation of the contracts portfolio) at different stages of the process of knowledge management.

Table 5: Potential effect of using the KOMS macro-tool within the limitation of the knowledge deficit

In.	**Solutions, tools and methods used in the knowledge management processes**	**The scope of knowledge deficit in knowledge management processes**	**Functions performed by Knowledge Objects Management System to reduce the knowledge deficit**
Knowledge acquisition processes			
1.	Participation in national and international conferences, participation in trainings.	The lack of archiving and sharing forms.	The possibility of the appropriate categorisation of experience, contextual link with other knowledge objects.
2.	The acquisition of knowledge through its extraction from competitors' products or processes by means of benchmarking method.	The lack of standardised forms of archiving. The difficulty in getting to this type of knowledge (a long time of searching for the same information by different employees).	Possibilities of information storage and classification.
3.	The acquisition of knowledge by the employees from their co-workers, documentation and databases, books and magazines available.	The lack of standardised forms of archiving. The difficulty in getting to this type of knowledge (long searching for the same information by different employees).	Possibilities of information storage and classification.
4.	The acquisition of knowledge from the mass media, especially including information about potential opportunities and threats.	The lack of standardised forms of archiving. The difficulty in getting to this type of knowledge (a long time of searching for the same information by different	Possibilities of information storage and classification. Knowledge in the form of photographs, scanned documents, PDFs, and others.

		employees).	
Knowledge storage processes			
1.	Tacit knowledge storage.	The lack of support for knowledge externalisation.	The storage of descriptions of good and bad practices, ways of acting in specific decision situations supported by photographs, films, drawings, references to experts.
2.	The storage of codified knowledge involving the collection of information contained in the notes, articles, books, films, photographs, various local databases.	The lack of standardised forms of archiving. The lack of assessment concerning the level of knowledge importance.	Creating a useful collection for the purpose of knowledge selection and storage. Knowledge can be shared in different ways, for instance, in sections of function (marketing, production, finance, personnel, etc.), time (knowledge of past, present, future), the degree of accessibility (generally available knowledge, with limited access, secrecy protected by competitors) , according to the opportunities and threats for the organisation, concerning the close and distant environment.
3.	The collection of reinforced knowledge, whose means of conveying are the	The lack of procedures for storing this type of knowledge. The lack of standardised form of	Classification, assessment of knowledge validity and its archiving. Saving photographs, videos,

	competition's products or their prototypes.	archiving this type on content.	descriptions in databases to make them available in the future.
Knowledge transfer processes			
1.	Experience exchange.	The lack of standardised (formal) electronic platform allowing current completing experience database.	Possibilities of current verification of experiences, contextual relations among knowledge objects.
2.	Placing case descriptions or best practices in textbooks or papers presented at conferences. Storing knowledge on open hardware solutions.	The lack of standardised (formal) electronic platform allowing current knowledge storage.	Knowledge sharing as a process targeted at specific people. Protection of knowledge so that it could not be reached by unauthorised persons.
3.	Mutual transfer of knowledge by people in communication and cooperation process.	The lack of procedures for storing such type of knowledge. The lack of standardised forms of archiving this type of content.	Employees' stored knowledge in knowledge objects with the information about an employee who placed it.
4.	Transfer through codified knowledge derived from organisational documentation / procedures and analyses, such as product damage.	The difficulty in getting to the current knowledge of procedures.	The possibility of developing electronic patterns for acting and procedures using logical dependencies as elements of a decision support system.
Knowledge use processes			
1.	New products and services design, technology design and its use, solving everyday project, design and maintenance problems.	The lack of standardised (formal) electronic platform allowing current completing experience base, limited access to contextual knowledge.	Processing of contextual knowledge. Sharing: descriptions of good practices, bad practices, registered notes of Service Department and sales department staff and

			procedures in certain decision situations. Providing access to different types of information (photographs, videos, drawings, references to experts).
2.	The use of After Action Review.	The lack of formal procedures for knowledge storage of contracts, the lack of a platform that provides knowledge of contacts.	Qualitative information processing, determining key success factors for the effective implementation of contracts.
3.	Decisions in business processes.	Limited use of codified knowledge, limited access to contextual knowledge, limited abilities of platform supporting decision-making processes.	Qualitative information processing, interactive access to contextual information.
4.	Methodology of Project management in the implementation of contract portfolio.	The lack of platform for storing, classifying and analysing knowledge about implementation and control.	Processing of qualitative information concerning contracts implementation, interactive access to contextual information about contracts.

An opposed to the data, which is well-structured information and can be organised, knowledge requires a more complex approach. Problems concerning stores of knowledge include:

- the need to register knowledge which includes information of a diverse form and content,
- the lack of information structure determined in advance. Structuring is of great importance in the qualitative information processing, especially the establishment of "whole – part" and "generalisation – specialisation" links. The creation of such

links cannot be made automatically, it requires an adequate interpretation of the information.

- difficulties in operating qualitative information. Qualitative attributes (unlike quantitative attributes) cannot be easily ranked and classified. Therefore, there is no possibility to organise knowledge algorithmically (determining order, selection) on the basis of formal criteria.

In order to solve the presented problem it is necessary to:

- set certain standards of knowledge recording in the form of elementary objects that combine a uniform formal structure with the possibility of recording various types of information,
- possess functionalities enabling the establishment of superiority – inferiority links among elementary objects of knowledge,
- possess tools supporting the valuation of qualitative information. The valuation of objects described by qualitative characteristics is based on an expert valuation that ascribes numerical value to an object. Valuation is one of the most important methods of structuring poorly defined quality problems, enabling the creation of a quantitative, homomorphic model with reproduced quality problem.

KOMS Macro-tool is an original suggestion that allows the reduction of the knowledge deficit in the knowledge processes supporting contract implementation in machine-building industries. KOMS macro-tool will be used in elaborated IT system supporting knowledge management in a machine-building industry enterprise within the research and development project financed from public funds and implemented by Faculty of Management and Organisation of Silesian University of Technology (Dohn et al. 2012).

The system concept was proposed on the basis of studies conducted in enterprises and initial assumptions. The system formation is based on a uniform, universal structure that enables the management of knowledge presented in the form of unified elementary objects. These objects can be combined by means of any structure by superiority – inferiority links. An elementary object combines a uniform formal structure with the possibility of recording various types of information (numerical, text, graphics, and other, even more complex). The structure of knowledge elementary objects allows to assign different attributes (metadata): describing and interpreting, classification and valuation, verbal and numerical attributes (e.g., ordinal number, updating date, information source, assessment of importance and reliability), that characterise substantive information.

During the elaboration of KOMS macro-tool it was assumed that:

- “the elementary object of knowledge” is the essential element of the system that is being built. The elementary object of knowledge can contain information about the complex structure consisting of different types of data,
- at least two tables of records in the database are assumed. The first table contains a set of records of elementary objects of knowledge. The second contains a set of records concerning the link between elementary objects of knowledge (object – link – object and a field for comments about links),
- each elementary object of knowledge can be linked with any number of superior or inferior objects of elementary knowledge. It is also possible to establish links that create a loop and register free records, unrelated to other records,
- links between objects will be introduced (direct superiority/inferiority, indirect superiority/inferiority, equivalence, similarity).

The elementary object of knowledge (as record in database) comprises following fields:

- object identifier,
- object name,
- content that constitutes the characteristics stored by the knowledge object (complex data of different type),
- metadata that aims to complete the characteristics of knowledge object (key words, elementary knowledge object attributes).

The system of knowledge object management will enable, among other things, the implementation of following functions:

- knowledge storage and organisation for processes of implementation and control of contracts implemented in machine-building industry enterprises,
- rapid access to contextual knowledge,
- matching different objects of knowledge in the form of link networks,
- enabling the synthesis necessary in decision-making processes,

– creating patterns of acting and procedures using logical dependencies (creating the sequences of actions and decisions associated with the objects of knowledge as a form of decision-making support system).

Conclusions

During the research conducted in selected Polish machine-building industry enterprises the following conclusions were drawn:

1. One of the key factors of determining an effective functioning of machine-building industry enterprises, mainly design and construction processes, is the assurance of the access to technical and managerial contextual knowledge and the effective implementation of knowledge management processes.
2. The effectiveness of contract implementation is determined by ensuring an appropriate environment for knowledge management in analysed enterprises. It is particularly meaningful to process qualitative information that can be the base to define key success factors decisive in successful execution of contracts.
3. The selected Polish machine-building industry enterprises were the base to conduct research, the aim of which was to identify knowledge deficits within particular knowledge management processes. This identification allowed to clarify the functional range of the original solution, which is Knowledge Object Management System, as a macro-tool limiting the deficit within knowledge acquisition, storage, transfer and processing.
4. The concept of the presented solution was based on the standards of knowledge storage in the form of elementary objects. These objects combine uniform formal structure with the possibility of recording various types of information, possessing system functionality that enables the creation of superiority – inferiority links between elementary objects of knowledge, and possessing tools supporting qualitative information valuating. The valuation is used as one of the most important methods for structuring poorly defined quality problems, enabling the creation of a quantitative, homomorphical model with the reproduced quality problem.
5. Particularly important functions of the KOMS macro-tool in the aspect of reducing the knowledge deficit in knowledge management processes in machine-building industry enterprises include:

- the storage and organisation of contextual knowledge for specific processes of contract realisation and control,
- qualitative information processing in order to facilitate the access to technical and managerial contextual knowledge and to improve the effectiveness of contract realisation,
- the creation of electronic patterns of acting and procedures using logical dependences as elements of systems supporting decision-making.

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The Early Warning Concept in the System Supporting Knowledge Management in Polish Machine-building Industry Enterprises

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Abstract

The article discusses the issue of implementing the elements of the early warning system concept in the information system supporting knowledge management in Polish mechanical engineering enterprises. Activities of the studied companies are strongly determined by changes in the external economic situation. The specific features of the analyzed enterprises need to be responded by early reactions to the economic changes. The appropriate identification and interpretation of weak signals can be an important element for supporting the effective functioning of enterprises, both in the economic development and in the recession. Therefore, the authors proposed the implementation of selected early warning elements in the information system supporting knowledge management in machine-building industry enterprises. The system developed within the research project is financed from public science funds of the Ministry of Science and Higher Education in Poland.

Keywords

early warning system, knowledge management system

Introduction

Modern enterprises operate in conditions characterized by a high complexity and dynamics of changes. Apart from predictable processes, the elements of surprise appear. Managing a given enterprise requires considering multiple information whose current analysis and interpretation is necessary. Information about the possibility of a significant loss, such as bankruptcy, liquidation of a large part of the enterprise or the occurrence of long-term, structural crisis is of a particular importance. Such phenomena occur relatively frequently in business activity.
Information about the possible threats is of warning value only if it is acquired suitably early, and when it is possible to take preventive measures. The key point of prevention is to avert irreversible destructive processes, often violent, that can be initiated by a weak stimulus. In such cases, preventive measures are characterized by a very high economic efficiency, unattainable in actions of a different type. Therefore, in early warning, research information of a relatively low certainty may be useful.

The observation of processes and effects difficult to predict that are a potential source of large losses cannot be an action taken occasionally. A suitable solution is the early warning system (EWS), that is the structure of people, equipment and procedures, organized for the purpose of obtaining, recording, processing and distributing information for users, especially top management.

Literature describes methods for developing early warning systems for enterprises based mainly on determining indicators of high prognostic value and comparing them with the exemplary values (see Zhu, Huaiyi et al, 2002, Ed. Koyuncugil, Ozgulbas, 2011),. Such systems objectify the evaluation of existing threats, but do not signal elements of a surprise. A lot of described EWS indicators are bankruptcy forecasting systems, which, by and large, are intended for external observers, not for enterprises management.

Studies conducted in machine-building industry enterprises have shown that the needs for information within the early warning are diverse and changeable. In identification of threats various concepts and partial methods were used. Each of them is useful only in certain cases and is limited in scope. In particular, there are no universal, certain, well operationalized methods for identifying threads of a surprise nature.

One of the reasons of surprise is the omission. It often arises due to the difficulty in managing a large collection of diverse information of different importance, reliability and diligence. Problems are mainly posed by processing qualitative information.

Another reasons of surprise are difficulties in identification and correct interpretation of cause-and-effect relationships, especially in the case of feedbacks, or a complex logical structure of conditions.

The presented findings suggest that EWS should support the following tasks:

- Integration of different methods and concepts of early warning.
- Managing the set of diverse information.
- Clarification and interpretation of complex cause-and-effect relationships.

The authors have attempted to study the concept of realisation of these tasks in constructed IT system supporting knowledge management in Polish machine-building enterprises.

The concept of using information related to the early warning system within the built system supporting knowledge management in Polish machine building industry enterprises

Within the research and development project, research was conducted in 38 selected enterprises of machine-building industry, located in Silesia, divided into four main groups:

– machine-building enterprises producing machinery of general purpose,
– machine-building enterprise producing mining machinery,
– machine-building enterprise producing machinery for the defence industry,
– machine-building enterprise for the automotive industry.

On the basis of the studies conducted, the following characteristics of enterprises were defined (Dohn et al, 2011):

– machine-building enterprises production is highly complex and discrete,
– a great part is a unit production, including the production of large machines, mainly as make to order production,

- the activity of analyzed enterprises is particularly sensitive to changes in economic situation, the sensitivity to contraction is stronger and more violent than the reaction to the economic improvement,
- in the medium term perspective production activity is characterized by a relatively high degree of uncertainty and changeability of production capacity use (with reference to the size and structure of production capacity) and for this reason there is a production capacity surplus for machinery and equipment, as well as the deficit in employment,
- business activity requires high technical and organisational competences of personnel, especially in the preparation of production (constructors, technologists, production planning staff),
- in the piece production, a lot of various factors of low stability influence profitability, particularly orders received, parameters of contracts with customers (a price per product may vary), parameters of contracts with suppliers and co-operators (prices may vary greatly)
- in order to enter into profitable contracts and avoid contracts which are unprofitable, it is necessary to posses at least estimate knowledge of manufacturing costs , production capacities, stock in hand and supply capacity as well as knowledge of potential suppliers and co-operators (a list of suppliers and co-operators wide as possible, information about their reliability, prime costs, willingness to cooperate, negotiating potential).

Moreover, at the initial stage of the research information concerning the following issues was gained:

- the knowledge of the issue of EWS in the studied enterprise.
- the practical use of EWS in the studied enterprise.
- obtaining information about potential threats in business activity .

With reference to the above-mentioned issues the following conclusions were formulated:

1. In the studied enterprises there are no organisational structures focusing on obtaining information about threats, which could be defined as early warning systems. The

exception is narrow EWS that warns against specific hazards, such as fire or building disaster.

2. The knowledge concerning the problems of early warning is insufficient for proper evaluation of benefits and expenditures, associated with the implementation and use of the EWS. The possibilities of EWS are generally overestimated and warning information that is completely certain, not obvious, essential for company activity is awaited. On the other hand, the expenditures on the use of EWS and the cost of preventing potential threats are insufficiently taken into account.
3. In the studied enterprises the importance of system solutions are underestimated. In particular, it is not recognized that the desired features of warning information (certainty, non-obviousness, significance) derive from system acquisition, processing and use of a number of information, that are less important, relatively obvious and less certain.
4. In the studied companies information, which may include early warning information, is obtained and processed. Therefore, in individual companies, various actions are performed. One monitors the completion of the planned tasks, sets quantitative indicators (especially financial and efficiency), comparing them with the previous values or exemplary values. Also economic trends, stock market index, changes in exchange rates are observed. What is more, in some situations, methods of strategic analysis are also used, for instance, to prepare business plans or loan applications. These actions, however, are not systemic.

On the basis of the results of the research conducted, requirements that should be met by a system supporting knowledge management in acquiring, processing and distribution of early warning information were define:

1. The system should provide a systematic and comprehensive storage, processing and distribution of information. In order to meet this requirement, it is particularly necessary to integrate all categories of warning information as well as considering and integrating various methods and concepts of early warning .
2. The system should be characterised by a high degree of flexibility. It should be enabled both to adjust to enterprise's individual requirements and to modify and adapt currently to changing needs.

3. The system should be equipped with a knowledge base that contains the necessary information in the field of early warning. It is advisable that users are provided with information in the following areas:
   - Information about the enterprise and its environment.
   - Knowledge of the early warning methods and models.
   - Knowledge of the interpretation and verification of early warning information.
4. The system should particularly contain computer tools that support the processing of qualitative information of early warning. In addition, it is advisable to have the opportunity to appeal to quantitative information of early warning, which is processed by means of standard computer tools used in enterprise.

The concept of an IT system for supporting knowledge management in studied enterprises is the product of expectations of potential users, the needs of early warning information and the general principles of the design of IT systems. The quantitative processing of early warning information uses standard IT tools. Nonetheless, the processing of qualitative information is provided by dedicated tools. Dedicated EWS tools are created on MS Office platform with VBA programming language (Visual Basic for Applications). Such solution has many advantages. The creation of tools on a high-level computer platform is much easier. Running system maintenance, introducing little extensions and modifications can be performed even by the more advanced user. Additionally, the use of a commonly known user interface facilitates system implementation and operation.

The integration of EWS tools with enterprise information system and other standard computer tools is implemented at the level of data exchange. Virtually, all computer systems allow data to exchange with MS Office applications, at least in RTF format(rich text format). Whereas, the integration of dedicated EWS tools is ensured by the mechanisms of MS Office. The concept of realization of early warning tasks in system that supports knowledge management is shown in Figure 1.

Defining the areas of observation

- Determination of potential observation areas including:
  - key safety factors
  - critical risk factors
- Observation areas selection taking account the possibility of EWS

Tools for supporting tasks: hypertext knowledge system, standard computer tools used in an enterprise

⇩

Creating the set of adversity standards

- Overview of the early warning situation standards contained in the knowledge base
- Archetypes and general early warning models refinement, mainly the dynamics system models
- Generalization of adverse situations in the past or observed in other similar businesses

Tools for supporting tasks: hypertext knowledge system, dynamic research simulation system, rule-based expert system, standard computer tools used in an enterprise

⇩

Development of the primary early warning information collection

- Acquiring information about the company and the environment in the various patterns of adversity
- Comparison of the actual situation of the company with the situation defined by the standard
- Assessment of the reality of risks and the size of potential losses

Tools for supporting tasks: hypertext knowledge system, rule-based expert system, standard computer tools used in enterprise

⇩

Verification of primary early warning information

- Checking the completeness of the information
- Formal and content verification of information:
  - examine the compatibility of information from independent sources and obtained by different methods
  - experts reliability assess

Tools for supporting tasks: hypertext knowledge system, rule-based expert system

⇩

Developing comprehensive early warning information - interpretation and distribution

- Explanation and interpretation of complex early warning information:
  - simulation research
  - presentation the complex relationships in a graphic form
- Structuring, organizing and selecting information
  - information ordering according to importance, urgency and other attributes
  - selection and compression of information
- information distribution – to determine the recipients of information

Fig. 1. The concept of realization of early warning tasks in system supporting knowledge management

In the rule expert system, the following solutions were used:

- The concept of self-organizing decision table for recording knowledge base in the form of Horn rules.
- The concept of calculating and concluding expert sheets, combining spreadsheet capacities (algebraic models) with the expert system concluding ahead (logical models).
- Technique of interactive creation of graphical representation of knowledge bases.
- Graphical method for justifying the results which involves the visualisation of inference paths.
- The use of inference in three-valued logic (True, False, lack of knowledge). Such solution ensures monotonicity of inference, as in case of developed knowledge bases (two-valued logic inference would be non-monotonic). A natural generalization of three-valued logic is the approximate logic, such as fuzzy logic. Rule-based expert system enables inference in approximate logic.
- System of simulating processes of complex logical structure. Rule-based expert system can be used in the interpretation of early warning information of complex logical structure and it can integrate different methods and concepts of early warning.

The system of interactive paired comparison supports sequencing of knowledge objects on the basis of qualitative assessment. For this system an original method for determining the relative importance of objects was developed. It involves comparing pairs combined with the current sorting of set of objects. The use of interactive methods of paired comparison often reduces the number of comparisons. The interactive paired comparison system can be used to organize early warning information.

System of dynamic test simulation is used to study the dynamics of the system. Such models refer to the concept of system diagrams Senge (see Senge, 1992) that illustrate the typical structures and behaviours of systems (archetypes). Diagrams depict the key features of the systems, especially the feedback loops. However, the level of simplification is often too high to accurately explain all the dependencies that are difficult to intuitive interpretation. The system of dynamic research simulations provides a more precise and unambiguous representation of the test system structure. In particular, it may be used in the interpretation of early warning information system with a complex structure.

For the system of dynamic research simulations, the concept of a graphical representation of system models was developed. The graphical representation of the systemic model is a sequence (table) of consecutive objects and corresponding time graphs. Objects represent the dynamic relation (integration, derivative , delay) and non-linear static relation (e.g., parabolic, exponential, sigmoidal, step). Objects can also represent external extractions controllers, especially the control size and interference. The system of dynamic research stimulators enables the creation of interactive graphical representation of system models and test simulation for different values of model parameters and various external excitations.

Conclusion

Early warning systems can be of great importance in the management of the enterprise. Particular importance of EWS is due to two reasons:

- Avoiding significant losses within the whole period of enterprise existence is a necessity to achieve different goals.
- Preventive measures which avert the losses can be economically effective. In other types of actions such high efficiency is unattainable.

Predictable processes and actions of surprise can be the source of threats.

Important reasons for surprise include:

- Omission, or neglecting available information or fail to take appropriate actions on time.
- The deficit of information about the threats and about the possibilities of response.
- Difficulties in the interpretation of complex information. These difficulties can be caused by a large number of diverse information or a high complexity of cause-and-effect relationships, such as feedbacks, dynamic effects, non-linear, complex logical structure.

Early warning information do not need to be characterized by a high degree of certainty and accuracy. The primary aim of early warning is not to develop a precise and realistic forecast, but recognize the possibility of taking action of high efficient prevention. In explaining and interpreting complex cause-and-effect relationships methods of system dynamics are very useful, in particular, research simulations carried out on simplified models that corresponds with system archetypes (see Senge, 1992). The use of computer tools that base on knowledge (knowledge based) provides flexibility of early warning system and enables its creation by means of evolutionary method. In particular, it is possible to connect the familiar methods of early warning with the experimental solutions. The actions of an experimental and research nature are important in predicting the risk of a surprise nature.

In the near perspective, the development of early warning systems using knowledge requires gradual creation of direct knowledge libraries, describing potential hazards, ways of their recognition and prevention. In the longer perspective, development of an early warning model based on deep knowledge is intentional. In studies on the deep knowledge of early warning, in addition to control theory and systems, different methods and concepts should be considered, e.g. the turbulence analysis and chaos theory. The important issues in further cognitive studies include:

- Theoretical deepening of the essence of early warning and related key ideas.
- The determination of usefulness limits of early warning methods in business management.

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The Effects of Hard Power and Soft Power on the Influence Attempts in Online Purchase Decisions

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Abstract

Recently, researchers have shown an increased interest in influential media. A fundamental property of online social networks is that people tend to have attributes similar to those of their friends. The purpose of this study is to understand the effects of social power on the influence of opinion leaders from the social power perspective. This study examined the relationships among social power, personal influence attempts, and influences on purchase decisions. A strong relationship between influence attempts and decision influence has been reported in this study. Contrary to expectations, this study did not find a significant difference between hard power and influence attempts. In this study, expert power and referent were found to cause influence attempts. In sum, by explicating the unique role of social power, this paper proposed contributions to the continued development and success of electronic commerce in general.

Keywords

social power, hard power, soft power, influence attempts, purchase decision

Introduction

A considerable amount of literature has been published on interactive society in the virtual world (Zelitchenko, 2010). There is a large volume of published studies describing the role of social power exists in online communities (Bagozzi & Dholakia, 2002; Zhou, 2011). Due to the increased social interaction within the online community, there is now more social power and influence among the community members. When the online community members have an intention to purchase, they will look for opinion help. Several studies have identified that individuals are more likely to obey powerful authority figures (Milgram, 1963) and accept the persuasive attempts of powerful individuals (Keltner, Gruenfeld, & Anderson, 2003). As people become more involved in the online community, there is an increased social relationship between the community members. Social power is a basic force in social relationships (Fiske, 1993; Kemper, 1991), the ability of one person (Busch & Wilson, 1976), and the dynamics and structure of personality (Moskowitz, 1994; Wiggins & Broughton, 1985), and these relationships all occur in the online community (Keltner, et al., 2003). Social power is also defined as the potentiality for inducing forces in other persons towards acting or changing in a given direction (Lippitt, Polansky, & Rosen, 1952). Therefore, this study argued that social power will play an important role in influencing purchase decisions in the field of electronic commerce. In 2001, Koslowsky, Schwarzwald, and Ashuri proposed a two-factor model of social power and influence where French and Raven's dimensions were divided into soft power and hard power dimensions (French & Raven, 2001; Koslowsky, Schwarzwald, & Ashuri, 2001; Shriberg, 2007). By integrating two types of social power, this study selects several important constructs which are closely related to hard and soft power to enhance the influence attempts in the online community. This study confirms the importance of social power from the perspectives of influence attempts and recommends a conceptual framework for illustrating personal influence behaviour in the electronic commerce environment.

Theoretical Background

Influence Attempts

Previous studies suggest that individuals who make stronger influence attempts tend to have greater manifest influence. The individuals' stake in the decisions is related to their influence and there is a correlation between individuals' specific self-confidence and their influence.

(McMillan, 1973; Patchen, 1974). These social influence attempts can involve a number of strategies including the use of promises, threats, warnings and recommendations (Bonoma & Johnston, 1978). High risk and reward are likely to motivate an individual to make stronger influence attempts (Anderson & Chambers, 1985) which will lead to greater manifest influence. In general, therefore, the stronger the influence attempts, the greater the manifest influence. This study thus formally proposes the follow hypothesis:

H1: Stronger influence attempts will positively enhance the manifest influence of purchase decisions in the online community.

Soft and Hard Power

Social influence occurs when an individual's thoughts, feelings or actions are affected by others (Divakaran, 2012; Wong, 2012). Social power comes from interactions between the participants and makes people change their will and actions. Previous researches divide social power into soft and hard power (Nye Jr, 1990). In the online community, the rules make the leaders have hard power, and the other members have soft power. Hard power includes rewards, coercion and legitimate power, while soft power refers to referent power and expert power (Nye, 2004). Previous studies indicated that more active social power used will enhance the influence attempts (Flurry & Burns, 2005). In the next section, this study proposes hypotheses to explain the phenomenon of the relationship between social power and influence attempts.

Legitimate power

Legitimate power is the authority granted from the formal position in an organization and the power of an accepted authority (Kirchler, Hoelzl, & Wahl, 2008; You, 2011). It refers to the ability to induce in others feelings of task-related responsibility and obligation (Mossholder, Bennett, Kemery, & Wesolowski, 1998). For example, once a person has been selected as a supervisor, most employees accept that they are obligated to follow his/her direction with respect to work activities. Followers accept the legitimate rights of formal leaders to set goals, make decisions, and direct activities. Certain rights, responsibilities, and prerogatives accrue to anyone holding a formal leadership position. Legitimate power is formal authority delegated to the holder of the position. Therefore, legitimate power is also called positional power. Legitimate power is the power of an individual because of the relative position and duties of the holder of the position within an organization. It is usually accompanied by various attributes of power, such as uniforms, offices, etc. This is the most obvious and also most important kind of power. Legitimate power increases compliance because social norms endow uniformed leaders with the authority to constrain members' behavioural options; therefore, the leader will be more motivated to influence others (Barbuto Jr, 2000). This study thus formally proposes the follow hypothesis:

H2a: Stronger legitimate power will positively enhance influence attempts in the online community.

Reward Power

Power that comes from the authority to give rewards to others is called reward power. Reward power refers to the leader's perception that the members can administer positive rewards for desired behaviours (Wagner & Hess, 1997), such as salary increases, performance ratings, promotion, developmental funds, and interesting work assignments (Gemmill & Wilemon, 1972). These leaders may have access to grant rewards, directly or formally. Sometimes, organizations allocate huge amounts of resources downward from the top leaders. Leaders control the resources and their distribution. Community members and followers depend on the leaders for the financial and physical resources to perform their tasks. Therefore, leaders with reward power can use rewards to influence other members' behaviour. The strength of the reward power depends on the influenced one's perception of the actual ability of the powerful one to provide the reward and it is modified by the perception of the legitimacy of the reward (Hallenbeck, 1966). As the reward power increases, the attraction of members to the relation increases, as does the cohesiveness to it; in turn the leader will have a greater motivation to influence (Molm, 1989). This study thus formally proposes the follow hypothesis:

H2b: Stronger reward power will positively enhance influence attempts in the online community.

Coercive Power

The opposite of reward power is coercive power, which refers to the members' perceptions of the leader's ability to punish them or recommend punishment if they fail to comply with his or her requests (Paulsel, Chory-Assad, & Dunleavy, 2005). Community leaders have coercive power as they have the right to fire or demote subordinates, criticize them, or withdraw their pay increases. For example, if a community member fails to perform as well as expected, the leader has the coercive power to criticize him, reprimand him, put a negative letter in his file, and damage his chances of a raise. Coercive power is also the negative side of legitimate and reward power. Coercive power is based on fear. A leader high in coercive power is seen as inducing compliance because a failure to comply will lead to punishment, such as undesirable work assignments and reprimands (Hersey, Blanchard, & Natemeyer, 1979). As a leader's coercive power increases, the likelihood that other members will tend toward target compliance also increases (Barbuto Jr, 2000), so the leader will have more motivation to influence. This study thus formally proposes the follow hypothesis:

H2c: Stronger coercive power will positively enhance influence attempts in the online community.

Expert Power

Expert power refers to one’s influence over another because one possesses superior skills, or special knowledge or skills regarding the tasks performed by followers (Kahn, 1984). As a leader is a true expert, subordinates go along with his/her recommendations because of his/her superior knowledge. Expert power is limited to the area in which the leader has special knowledge or skills (Busch & Wilson, 1976). Expert power comes from the belief that the leaders know what is best, and therefore others follow their opinions because they are viewed as likely to be correct. People throughout the organization with expertise and knowledge can use this to influence or place limits on the decisions made by those above them in the organization. Self-perceived expert power increases as position level increases while, in the participative situation, the leader will enhance the motivation to influence others (Dieterly & Schneider, 1974). This study thus formally proposes the follow hypothesis:

H3a: Stronger expert power will positively enhance influence attempts in the online community.

Referent Power

Referent power is the power or ability of individuals to attract others and build loyalty. It is based on the charisma and interpersonal skills of the power holder. Referent power refers to other members and participants meeting a leader's request because they are, for some reason or other, personally attracted to him/her and value both their relationship with him/her and his/her opinion of them (Wilemon & Gemmill, 1971). Referent power comes from the leader’s personality characteristics. Referent power influences the identification, respect, and admiration of the community member so they want to emulate the leader. When members admire a leader because of the way he/she deals with them, the influence is based on referent power. Referent power depends on the leader’s personal characteristics rather than on a formal title or position and is especially visible in the area of charismatic leadership. A person may be admired because of a specific personal trait, and this admiration creates the opportunity for influence attempts. Here the person under power desires to identify with these personal qualities, and gains satisfaction from being an accepted follower. As referent power increases to a high level, the leaders' normative influence may extend well beyond this sphere to encompass other aspects of lifestyle, and therefore they will have a higher motivation to influence others (Janis, 2012). This study thus formally proposes the follow hypothesis:

H3b: Stronger referent power will positively enhance influence attempts in the online community.

Research Methodology

Research Model

In this study, we focus on how opinion leaders in the online community exert their social power which will have further effects on the purchase decision of other members. The research design selected for this research was an online survey with random sampling. The research model proposed aims to understand the different characteristics of hard and soft power. The research model, composed of two social power dimensions, soft (referent power and expert power) and hard power (reward, coercive and legitimate powers), could effectively explain the causes of influence attempts which, in turn, have a great influence on purchase decisions.

Measurement Development and Data Collection

Decision influence and influence attempts were measured with items adapted from Kohli (1989) to fit the context of online communities. The measurement scales of social power, including referent power, expert power, reward power, coercive power, and legitimate power, were adapted from Venkatesh et al. (1995). The respondents were asked to assess the extent of their agreement with each item by using a seven-point Likert scale with anchors from strongly disagree/low (1) to strongly agree/high (7). The research data were collected from members of various online communities via the Internet in December 2012. In order to target online users, a web-based survey was employed. Among the 196 valid respondents, about 51.5% were male. Most of them were aged from 21 to 30 (71.9%) and have received a college or university education (65.8%). Almost half of our respondents had been contacted with an opinion leader. Most online communities have one to five opinion leaders.

Research Result

A partial least squares (PLS) analysis was used to perform the data analysis. Our data analysis consisted of the following steps. First, confirmatory factor analysis (CFA) was applied to assess the validity and reliability of the research instrument. Then, the structural model was performed to examine the relationships among the research constructs. Third, a further mediation analysis was conducted to examine the mediation role of influence attempts.

Measurement model

CFA was conducted to assess the construct validity of six constructs at the individual-level. The following criteria, suggested by Hair et al. (1998), were applied to assess the construct validity: (1) the standardized indicator loading for certain constructs should exceed .50; (2) the average variance extracted (AVE) should exceed .50; (3) the square root of the AVE should be greater than the correlation between the construct and other constructs; and (4) the construct reliability should exceed .70. All of the loadings were above the threshold. The AVE values were above .50, ranging from .60 to .80. All of the square roots of the AVE were greater than the correlations among the constructs, which revealed good convergent validity and discriminant validity. The composite reliability (CR) of the research constructs ranged from .88 to .94, while their Cronbach's α ranged from .85 to .92. The results indicate that our research scales have sufficient reliability. Tables 1 present the results of the measurement validation. In addition, the multicollinearity was further checked by calculating the variance inflation factor (VIF). The VIF values are below the cut-off threshold of ten suggested by Hair et al. (1998) and range from 1.38 to 3.39. Then, we followed the suggestion of Podsakoff et al. (2003) and conducted a Harman's one-factor test to assess the severity of the common method bias. No general factor emerged and six factors were produced after performing an unrotated factor analysis. The first factor accounted for 40.56% of the variance. The results indicated that collinearity does not seem to pose a serious problem and that all of the constructs used in this study are acceptable and reliable.

Table 1. Composite Reliability, AVE and Correlations

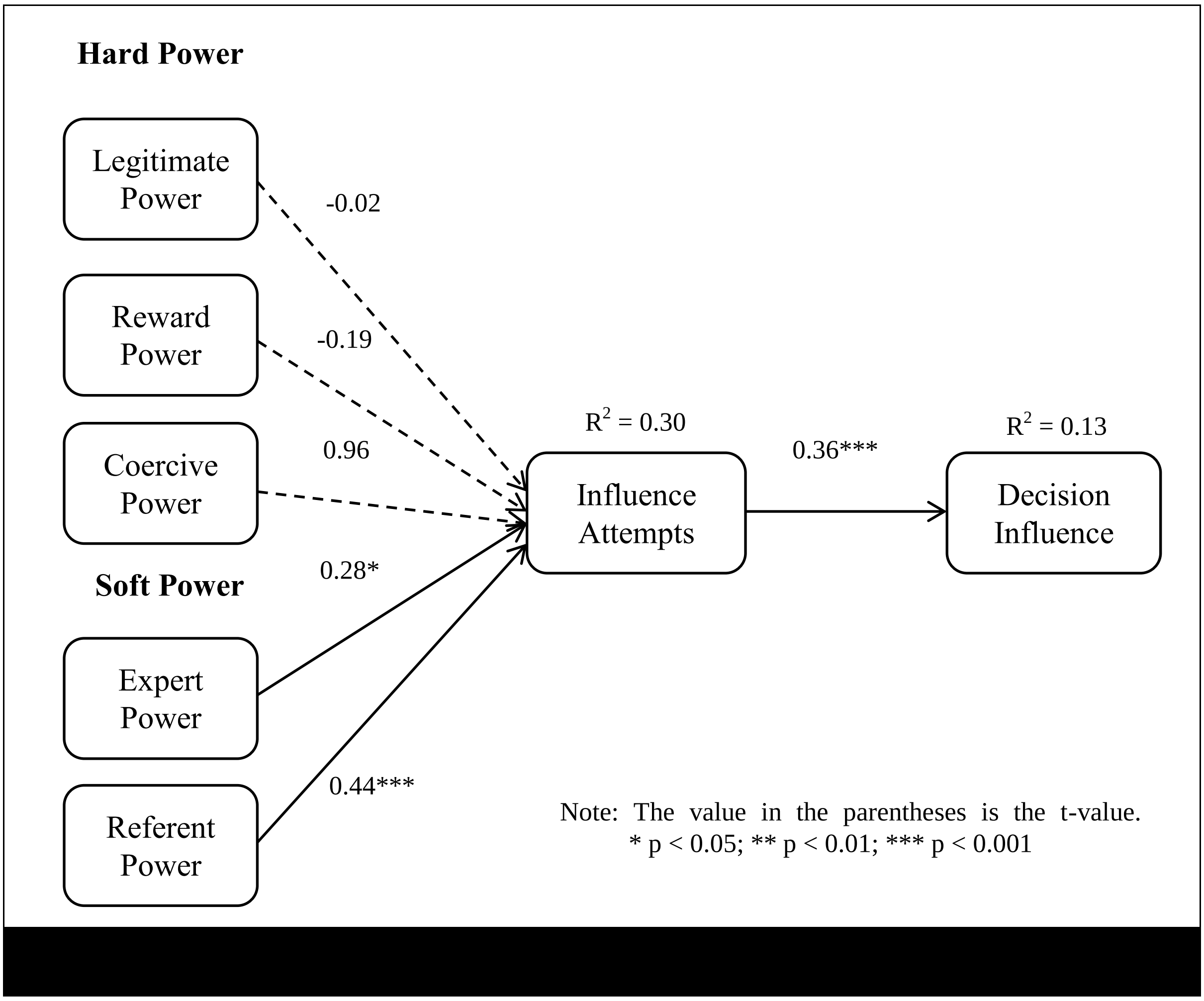
	AVE	CR	DI	IA	LP	WP	CP	EP	RP
DI	0.74	0.93	0.86						
IA	0.76	0.93	0.36	0.87					
LP	0.80	0.94	0.55	0.28	0.89				
WP	0.60	0.88	0.63	0.29	0.68	0.77			
CP	0.76	0.94	0.94	0.07	0.31	0.43	0.87		
EP	0.66	0.91	0.59	0.45	0.57	0.67	0.12	0.81	
RP	0.75	0.94	0.69	0.51	0.56	0.65	0.15	0.69	0.87
	VIF		-	1.41	2.28	3.39	1.38	2.48	2.59

Note: VIF = variance inflation factor; The shaded numbers in the diagonal row are the square root of the average variance extracted.

Structural model

In order to test the research model, the bootstrap re-sampling procedure was conducted to examine the statistical significance of the research hypotheses. The model explains a substantial amount of the variance in influence attempts (R^2 = 0.30) and decision influence (R^2 = 0.13). The results provide support for the significance of three research hypotheses. Influence attempts (β = 0.36 $p < 0.001$) is significantly related to decision influence, providing support for H1. In contrast to our assumption, all three hard power constructs are not significant. Expert power (β = 0.28, $p < 0.05$) and referent power (β = 0.44, $p < 0.001$)

positively contribute to influence attempts. Thus, H3a and H3b are supported. Figure 1 presents the results of the analysis.



Conclusion

Several studies indicate that social influence plays an important role in electronic commerce (Bhattacherjee, 2000; Gefen, 2000; Hsu & Lu, 2004; Lu, Yao, & Yu, 2005). This study provided evidence to help marketing managers to improve the intention to purchase and to connect customers more effectively. The purpose of this study is to understand the effects of social power on the influence of opinion leaders from the social power perspective. This study discusses the development or disappearance of social power in the online community. This study also investigated the reasons for increasing individual influence among the community members. Finally, the findings of the study, by establishing a link between influence attempts and purchase decision, has given support to communities through hard and soft power for electronic commerce. This study successfully examined the relationships among social power, personal influence attempts, and influences on purchase decisions. A strong relationship between influence attempts and decision influence has been reported in this study. Contrary to expectations, this study did not find a significant difference between hard power and influence attempts. In this study, expert power and referent were found to cause influence attempts. In sum, by explicating the unique role of social power, this paper proposed contributions to the continued development and success of electronic commerce in general.

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Appendix: Questionnaire

Constructs	Measurement Items	References
Decision Influence (DI)	1. How much weight did the committee members give to my suggestions? 2. How much impact did I have on the thinking of the other members? 3. To what extent did I influence the criteria used for making the final purchase decision? 4. To what extent did my participation influence the purchase decision eventually reached? 5. To what extent did the final purchase decision reflect my views?	(Kohli, 1989)
Influence Attempts (IA)	1. I spent more time to impress my views on the committee members. 2. I tried harder to shape the thinking of others. 3. I spent more energy to make sure my opinions were taken into account. 4. I made weaker attempts to influence the evaluation process. 5. I exerted more effort to make sure the final decision reflected my views.	(Kohli, 1989)
Referent Power (RP)	1. They liked me as a person. 2. They thought highly of my personality. 3. They shared my personal values. 4. They identified with me as a person. 5. They had high regard for my personal qualities.	(Venkatesh, Kohli, & Zaltman, 1995)
Expert Power (EP)	1. They felt I am knowledgeable about the company's needs with respect to the product to be procured. 2. They felt I am competent to make an assessment of the various options. 3. They felt I knew exactly how the product would be used. 4. They felt I had the expertise to make the best decision.	(Venkatesh, et al., 1995)
Reward Power (WP)	1. They believed I am capable of getting them pay raises. 2. They felt I could help them improve their standing in the organization. 3. They felt it was desirable to be approved of by me. 4. They valued receiving recognition from me. 5. They felt I could arrange desirable assignments for them.	(Venkatesh, et al., 1995)

Coercive Power (CP)	1. They believed I am capable of interfering with their promotions. 2. They felt I could take them to task. 3. They felt I could make life difficult for them. 4. They thought I could block their salary increases. 5. They believed I could arrange for them to be assigned to unpleasant tasks.	(Venkatesh, et al., 1995)
Legitimate Power (LP)	1. They felt I had the authority to ask for their compliance." 2. They felt someone in my position had a legitimate right to influence the purchase decision. 3. They felt obligated to comply with me because of his or her formal position in the organization. 4. They felt the purchase decision should reflect my preferences because I had more at stake than others. 5. They felt they ought to comply with me because the purchase decision would affect me more than others.	(Venkatesh, et al., 1995)

The MinK Framework: Developing Metrics for the Measurement of Individual Knowledge

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Abstract

Knowledge is the currency of the current economy and a vital resource for the sustainability of performance quality in today's knowledge intensive business environment. To avoid the detrimental consequences of knowledge loss, managers are urged to identify where knowledge stocks exist and how knowledge flows within their organisations, by keying out wellsprings of knowledge among their employees. Although some studies have attempted to measure knowledge on an organisational level using different methods, very few studies have addressed the individual knowledge carrier. Moving from a critical literature review of the existing approaches to knowledge measurement, this paper proposes a novel framework that enables organisations to measure individual knowledge in a business context using a set of metrics. The metrics are subsequently validated through a series of in-depth interviews with senior managers. A summary of the managers' views on individual knowledge measurement is presented. Reflections regarding the industry application and recommendations for the proposed framework are also discussed.

Keywords

measurement, knowledge stocks and flows, knowledge management tools, performance management.

Introduction

Knowledge is recognised as a foundation of sustainable quality and competitive advantage in the current complex and dynamic business era (Tullawat and Vichita Vathanophas, 2012). The ability of organisations to create value is no longer solely dependent on their financial and physical capital, but rather on their capacity to acquire, create and utilise knowledge (Carmeli and Tishler, 2004). Asserting that knowledge is the main value driver in today's businesses, the management of knowledge as a strategic resource gave rise to the rapidly growing field of Knowledge Management (KM), which has been growing exponentially in the last decade (Serenko et al., 2010). However, based on the saying "*if you can't measure it, you can't manage it*," the need to measure knowledge resources within an organisation emerged as a key area of interest for both researchers and practitioners within the KM domain (Skyrme, 2003).

Despite being one of the most challenging activities in KM (Chen et al., 2009), the need to measure knowledge arises to achieve two organisational objectives: internal monitoring and external presentation. From an internal perspective, managers may be oblivious of the knowledge that exists within their own organisations, as once stated by the CEO of Hewlett-Packard in his famous quote, "if only HP knew what HP knew, we would be three times as profitable" (Davenport and Prusak, 2000). In such cases, knowledge measurement is essential to expose "hidden" knowledge resources, leading to more effective KM (Edvinsson and Malone, 1997). Furthermore, knowledge measurement remains crucial during the implementation of KM initiatives to evaluate the effect of KM on organisational knowledge and to provide managers with convincing justifications for the substantial costs associated with KM implementation (Liebowitz and Suen, 2000, Khalifa et al., 2008). From an external perspective, the mounting gap between book values and market values of companies has led to the widespread view that a company's "true" value could only be expressed if intangible assets are also evaluated (Boda and Szlavik, 2007). In this regard, the value of a company is viewed as the summation of its financial capital and its intellectual capital (IC). IC (Galbraith, 1969) is a term that refers to "packaged useful knowledge" (Stewart, 1998). In the traditional conceptualisation where organisational knowledge is envisaged as a series of "stocks and flows," IC refers to the stock of knowledge within an organisation at a certain time, while KM is concerned with the flows, namely knowledge acquisition and sharing (Bontis et al., 1999, Al-Laham et al., 2011).

The need to measure knowledge to enhance its management and evaluate companies has impelled researchers to propose a number of knowledge measurement frameworks. However, it is observed that the majority of models attempted to measure knowledge at a company level with very few efforts directed towards measuring the knowledge of individual employees, although they are the actual source of all knowledge within any organisation (Kannan and Aulbur, 2004). In their classic work two decades ago, Nonaka and Takeuchi (1995) stated, "*knowledge is created only by individuals. An organisation cannot create knowledge on its own," "organisational knowledge creation should be understood as a process that organisationally amplifies the knowledge created by individuals*." Viewing knowledge in isolation from *the knowers who own it* is among Fahey and Prusak's (1998) list of gravest mistakes in KM where they state "*there is no knowledge without someone knowing it*." Since knowledge identification is a core activity of the KM process (Heisig, 2009), the success of KM would be largely dependent upon an organisation's ability to identify individual knowledge carriers and creators before striving to implement other KM activities including knowledge sharing and knowledge utilisation. This identification should contribute to the reduction of knowledge loss, since managers would take measures to ensure knowledge holders remain within the organisation through proper compensation, longer contracts and loyalty programmes. Despite its cardinal importance, the measurement of individual knowledge remains a fundamental, yet comparatively unexplored, subdomain of knowledge measurement and KM.

This study presents an attempt to fill this gap by proposing a new framework, referred to as *MinK*, an acronym for *Measuring Individual Knowledge*. The ultimate objective of *MinK* is to provide managers with a comprehensive tool which allows them to assess individual knowledge, given the complexities surrounding the process. In an attempt to achieve the stated objective, a succinct critical review of the different existing methods used to measure knowledge in the KM literature was conducted, along with a discussion of the main frameworks used by each method. The development of *MinK* is then described and the model's structure is presented. A pilot study aimed at the preliminary validation of *MinK* is introduced followed by the findings and future work recommendations.

Literature Review

The literature offers a diverse array of knowledge measurement methods in which researchers have applied different methods to assess organisational knowledge (Skyrme, 2005). Three main approaches are identified: Financial Methods, IC Components Methods, and Performance Methods.

Financial Methods

In the first approach, IC is computed in financial terms by using data from a company's financial results and records. The most widely cited models and their respective knowledge valuation methodologies are listed in Table 1.

Table 6: Financial knowledge measurement methods

Model	Methodology
Tobin's Q (Tobin, 1969)	Measures knowledge as the ratio between a company's market value and its book value. A Q higher than one is an indicator of the ability to create value by utilising knowledge.
Economic Value Added (Stewart, 1994)	Applying 164 adjustments to traditional balance sheets to account for intangibles after which EVA is calculated by deducting the cost of capital from operating profit (Weaver, 2001).
Human Resource Accounting (HRA) (Hermanson, 1964)	Uses three types of models: *Cost models*- Value human capital comprising knowledge as the cost of acquiring human assets. *Market models* - Equate knowledge with the cost of buying an individual's services from the market. *Income models*- Use the present value of the revenues an employee is expected to generate while working for a company as a measure of knowledge (Flamholtz et al., 1993).
Value Creation Intellectual Coefficient (Pulic, 2000)	Calculates how efficiently financial and intellectual capital are utilised to generate value for the company using financial data.

IC Components Methods

Within the second approach, IC is divided into different components, and each component is measured individually (Luthy, 1998). Most IC methods tend to apply a minimum of the first two of the following four steps:

Classification: IC is broken down into components, usually Human Capital (HC) and Structural Capital (SC), where HC refers to the combined knowledge of employees, while SC refers to "*knowledge that doesn't go home at night*" including the company's supportive infrastructure, business processes, IT systems and customer relations (Ranjit, 2004). SC may be divided further into Organisational Capital and Customer Capital (Edvinsson, 1997).

Metric Development: Metrics are selected to measure each IC component.

Aggregation: IC measures are aggregated into one numerical figure using such methods as averages, weighted averages or other methods. The outcome of this step should be one number that reflects a company's IC.

Financial Valuation: A financial value of IC may be computed and presented in monetary terms, or a correlation may be established between the IC value and a financial indicator. Widely cited IC frameworks in the KM literature are summarised in Table 2.

Table 7: IC Component measurement models

Framework	IC Classification	Metric Development	Aggregation	Financial Valuation
Skandia Navigator (Edvinsson and Malone, 1997)	Human Capital Structural Capital Customer Capital Organisational Capital Process Capital Innovation Capital	Developed 112 metrics that cover five components of IC.	Combines all financial indicators into a single monetary value *C*. Converts all the remaining metrics into ratios then aggregates them into an efficiency indicator ***I***.	The overall financial value of IC is equal to *I* multiplied by *C*.
IC Index (Roos et al., 1998)	Human Capital (*thinking part*) Competence Attitude Intellectual Agility Structural Capital (*non-thinking part*) Relationships Organisation Renewal and Development	Does not propose specific metrics. Provides a framework by which every organisation would set its own metrics in light of its strategy, characteristics and the surrounding environment.	Metrics must be expressed as a dimensionless numbers. Metrics are assigned weights to reflect their relative importance, and are aggregated into a single index using a weighted average.	Indicates the behaviour of a correctly designed IC Index should be correlated to financial value of the company.
Intangible Assets Monitor (Sveiby, 1997, Sveiby, 1993)	Internal Structure External Structure Human Competence	Proposes indices to measure each IC component from three perspectives: Growth and renewal Efficiency Stability	Visually presents IC components' strengths and weaknesses in an aggregated tabular form, but provides no numerical aggregation.	No financial valuation.
IC Rating (Jacobsen et al., 2005)	Human Capital Management Employees Organisational Capital Process Intellectual Properties Relational Capital Network Brand Customers Business Recipe	Evaluates 200 parameters through in-depth interviews with internal and external stakeholders. Assesses IC components from the perspectives of: Effectiveness Risk Renewal	Results are presented using a letter grading system ranging from 'AAA' to 'D' in one diagram, but no numerical aggregation is conducted.	No financial valuation.

Knowledge Assets Map (Marr et al., 2004)	Stakeholder Resources Stakeholder Relationships Human Resources Structural Resources Human Resources Physical Infrastructure Virtual Infrastructure (Culture, routines, and IP)	Does not propose specific metrics and states that metrics should be identified by top management according to their organisation's unique competencies and strategy.	No numerical aggregation is suggested, however, managers have the flexibility to present their selected indicators in the manner they find most appropriate to evaluate their company's knowledge assets.	No financial valuation.
Technology Broker (IC Audit) (Brooking, 1996)	Market assets Human-centred assets Intellectual property assets Infrastructure assets	IC components are audited using: - Surveys - Interviews - Quantitative analysis - Market research - Documents auditing - Evaluation of return on investment Each aspect is compared with the optimal state and is rated with an index score from 1 to 5.	Results are visually represented on a target diagram/bull's-eye chart (Wickham, 2008) to depict the score, importance and trend of each aspect. No numerical aggregation.	Uses cost, market or income valuation methods (as described in HRA).

Performance Methods

While a number of researchers designed models to measure knowledge, others adopted the view that knowledge could not be measured, due to its fluid and complex nature, and that only the *effects* or *outcomes* of utilising knowledge are measureable (Liebowitz and Wright, 1999). Therefore, research within the third knowledge measurement approach directs its efforts towards the measurement of the impact of applying knowledge with the objective of establishing a link between KM and improvement in organisational performance, a link that according to the literature remains nebulous (Petra and Annelies, 2012). This is achieved by the comparison of an organisation's performance before a KM process is instated and after its implementation, to identify the effect KM has had on performance. To this end, studies vary in their methodology of evaluating organisational performance, mostly adopting either a quantitative or qualitative approach (Huang et al., 2007). To measure performance, quantitative methods use financial indicators such as profitability or return investment, or non-financial indicators such as cycle time or number of complaints On the other hand, qualitative methods rely on surveys, questionnaires or interviews to obtain feedback on the effect of KM on performance Finally, some KM researchers assess performance using *The Balanced Scorecard*; one of the most popular and comprehensive performance measurement tools that comprises quantitative, qualitative, financial and non-financial measures (Kaplan and Norton, 1996).

In summary, review of the literature reveals three main approaches to knowledge measurement. Financial models provide a concise unbiased overview of a company's IC and may be beneficial in investment decisions and benchmarking. However, they do not elucidate where KM problems exist, nor do they suggest what decisions should be taken to improve knowledge creation, sharing and utilisation (Kannan and Aulbur, 2004). IC Components models offer more vivid insights about each element of IC and where corrective action is required. However, they are criticised because they provide a "snapshot" evaluation of knowledge, by only reflecting static knowledge stocks without considering the dynamism of organisational knowledge present in knowledge flows (Lerro et al., 2012, Bontis, 2001). Finally, performance methods provide some correlation between KM and performance. However, they are built on the inaccurate assumption that changes in organisational performance are solely due to KM, disregarding a number of other endogenous and exogenous performance factors (Yu et al., 2007).

The *MinK* Framework

The authors endeavoured to benefit from the existing mass of knowledge measurement literature when developing a new individual measurement model. First, the authors adopted the view that the absolute "*quantity"* of knowledge an individual holds could never be measured with a direct formula because knowledge is both intangible and contextual. However, the assessment of certain *attributes* and *actions* of individuals could provide a good indication of the knowledge they hold, acquire and share. Thus, instead of attempting to measure knowledge *itself*, characteristics that indicate knowledge is present within an individual would be identified and assessed. Accordingly, ten *Individual Knowledge Indicators (IKI)* are suggested in *MinK*, where each indicator implies that an individual possesses certain knowledge that is of value to his/her organisation or is actively acquiring and sharing knowledge. In light of the literature review, the authors preferred not to rely on a single approach when developing IKIs, but amalgamated a number of perspectives to propose IKIs that reflect individual knowledge components, knowledge stocks and flows and knowledge utilisation outcomes (i.e. effects on performance), in addition to financial IKIs.

The ten IKIs are:

1. *Education* - The formal education an individual has received from academic institutions (e.g. BSc, MBA, PhD...etc.)
2. *Training* - Training courses and internships the individual has attended during their career.
3. *Experience* - The individual’s years of professional experience.
4. *IT Literacy* - An individual’s ability to use IT tools (software and hardware) in business to acquire, create and share knowledge.
5. *Business Communications* - The nature, rate and patterns of an individual’s internal business communications (with managers, colleagues, subordinates) and external communications (with customers, suppliers, regulators) using different means (meeting, phone calls, emails).
6. *Business Process Interactions* - The interaction of the individual with business processes internal and external to the organisation.
7. *Personal Network* - The size and quality of the network of business contacts the individual interacts with.
8. *Performance* - The individual’s performance at work and contribution to their organisation.
9. *Creativity/Innovation* - The ability of the individual to generate new ideas and solutions to existing problems.
10. *Financial Indicators* - The financial value of the individual on the job market (e.g. recruitment cost, training cost, salary) and their monetary contribution to the organisation (e.g. sales, cost-savings, funds acquired).

The first four IKIs (education, training, experience, IT literacy) are *knowledge stock indicators*. These are background measures that reflect an individual’s knowledge based on their history and background and provide static measures of a person’s knowledge stock (Bolisani and Oltramari, 2012). The next three IKIs (business communications, business process interactions, personal network) are *knowledge flow indicators,* which reflect the exposure of individuals to knowledge flows and their corresponding roles in knowledge acquisition and sharing (Malhotra, 2003). The following two IKIs (performance and creativity) are *knowledge utilisation indicators,* which, as output indicators, reflect the effect an individual’s knowledge has had on the outcomes of their work and their performance. The inclusion of this perspective is essential because an employee’s knowledge would be of value to his/her organisation only if it is used to sustain quality, improve performance, and gain competitive advantage (Baron, 2011). Finally, analogous to financial methods in the literature, the last indicator uses financial figures associated with the individual as measures of their knowledge.

The subsequent step is the development of metrics to assess each IKI. Metrics are measurement units which describe the properties of each indicator (Lerro et al., 2012). They may be direct counts, monetary values or ratios/percentages when used to measure quantitative attributes, or numerical scale-based ratings when used to quantify qualitative attributes. Proposed metrics for each indicator are shown in Table 3 along with their corresponding units of measurement, where "#" is a number, "%" is a percentage,"$" is a monetary value and "*r*" is a rating

Table 8: Metrics for each individual knowledge indicator

Knowledge Stock Indicators			
Education	Experience	Training	IT Literacy
• Level of education *(r)* • Grades *(%)* • Relevance of education to job *(r)*	• Professional years *(#)* • Years in industry *(#)* • Years in function *(#)* (e.g. finance) • Years in the company *(#)*	• Professional Qualifications*(r)* • Training hours*(#)* • Training expense*($)* • Internships*(n)*	• General IT Literacy *(r)* *(Windows, Office, Internet)* • Specific IT literacy *(r)(Function specific software)*

Knowledge Flow Indicators		
Business Communication	Business Process Interactions	Personal Network
• Meetings attended per week*(#)* • Meetings with managers per week*(#)* • Meetings with subordinates per week*(#)* • Meetings with per week with external stakeholders*(#)* • Communications sent per week*(#)* (*phone/email/memo/report*) • Communications received per week*(#)*	• Processes utilised*(#)* • Processes supervised*(#)* • Processes reviewed/audited*(#)* • Process improvement Suggestions*(#)* •Process improvement suggestions implemented*(#)* • Business process quality systems involvement (e.g. ISO)*(r)* • Contribution to information systems*(r)*	• Contacts*(#)* • Relevance of contacts to business*(r)* •No. of social media connections*(#)* • Percentage of external contacts*(%)* • Percentage of international contacts*(%)* • Percentage of "VIP" contacts*(%)* • New contacts acquired/month*(#)* • Business contacts retention*(r)*

Knowledge Utilisation Indicators	
Performance	Creativity/ Innovation
• Performance Appraisal *(r)* • Cost Savings*($)* • Income generated/Sales*($)* • Productivity*(r)* • Percentage of Target(s) Achieved*(%)*	• New ideas suggested *(#)* • New ideas implemented *(#)* • Patents *(#)*

Financial Indicators
• Compensation *($)* • Recruitment / Replacement costs *($)* • Market cost of equivalent services *($)* • Investment in Training *($)*

Preliminary Validation Study

Before proceeding to the second phase of this research, preliminary validation was required to examine the validity of the proposed indicators and metrics as measures of individual knowledge. A study was conducted through semi-structured interviews of a sample of eleven senior managers and directors representing small, medium and large corporations from eight different industries and located in six countries (Table 4). Respondents were selected from diverse backgrounds to examine the generalisability of *MinK* across different disciplines, company sizes and countries.

Table 9: Pilot study respondents' profiles

Respondent No.	***Position***	***Company Description***	***Number of Employees***	***Country***
1	Managing Director	Marketing consulting company	6	Egypt
2	HR Consultant	Training and HR consulting company	9	South Africa
3	Chief Scientist	Software research company	9	USA
4	Business Development Manager	Healthcare development contractor	25	Lebanon
5	Sales Lead	Multinational Pharmaceutical Company	150	Dubai
6	Associate Professor	Private college	174	USA
7	Business Development Advisor	Medical equipment supplier	300	Egypt
8	Managing Director	Private equity and investment advisory	400	Egypt/Qatar
9	Vice-President for Quality Assurance	Private university	1000	Egypt
10	Channel Marketing Manager	Multinational consumer goods manufacturer	1800	Egypt
11	Supply Planning Manager	Multinational food manufacturer	70000	Saudi Arabia

Interviews started with background information about knowledge measurement and a brief explanation of *MinK*. The first few questions examined the awareness of knowledge management and measurement in respondents' organisations and the KM challenges they are currently confronted with. Participants were then asked to complete an evaluation questionnaire to assess the relevance of the proposed indicators and metrics to individual knowledge measurement using a five-point Likert scale (Likert, 1932) ranging from 1 (highly irrelevant) to 5 (highly relevant). The questionnaire was then discussed and the managers provided insights related to their answers, in addition to their reflections and opinions regarding the *MinK* framework.

Findings and Feedback

During initial discussions participants seemed familiar with KM, and most of their organisations implemented some sort of KM activity, of which the most interesting was a virtual interactive knowledge marketplace, mentioned by respondent number 10, which employees were encouraged to use by "selling" knowledge to their colleagues from their "kiosks" in return for virtual "stars". However, most respondents indicated that their organisations were still suffering from knowledge loss primarily due to staff turnover. When introduced to *MinK*, all respondents emphasised the value of individual knowledge and expressed interest in the idea of individual knowledge measurement. Six out of the eleven participants stated their organisations attempt to measure individual knowledge mostly by performance appraisals or subjective assessments by managers.

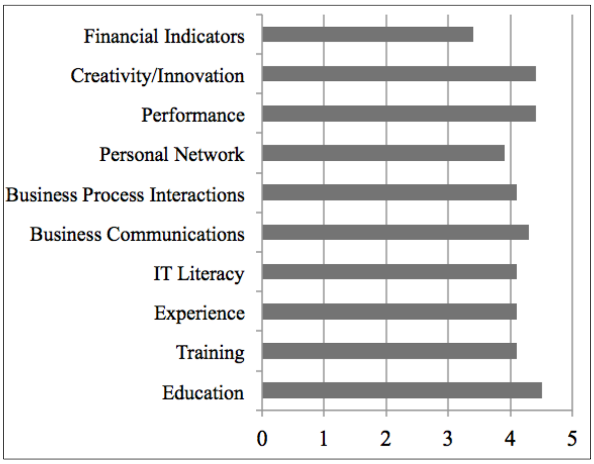

Figure 4: Indicators evaluation questionnaire results

Analysis of the questionnaire results regarding the evaluation of IKIs revealed that the *MinK* framework was highly regarded, where nine out of ten indicators had an average rating higher than 4. Having the lowest average rating of 3.4, financial indicators were viewed as the least relevant IKI. Five respondents questioned the relationship between compensation and knowledge since it is common for knowledgeable employees to be underpaid and, in some cases, less knowledgeable ones could be overpaid. On the other hand, two participants offered an interesting suggestion by recommending a new IKI to represent "*interpersonal skills*" or "*the ability to convey knowledge*" as an additional measure of knowledge flow. Nevertheless, the overall outcome of IKI evaluation was highly positive as interviewees unanimously agreed that *Mink*'s indicators collectively provide "a good indication of individual knowledge."

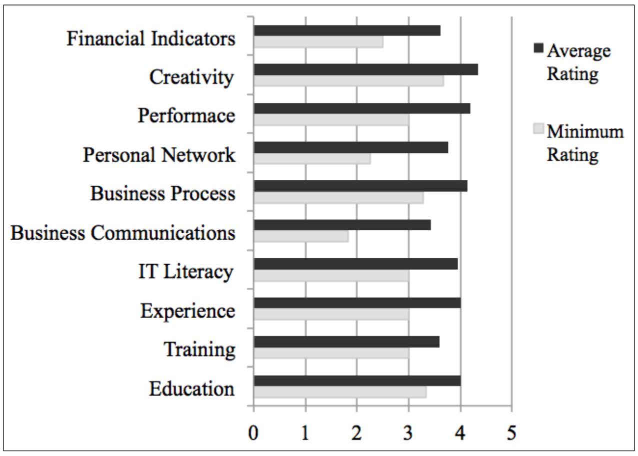

Figure 5: Metrics evaluation questionnaire results

When evaluating metrics, the metrics for six indicators received an average rating of 4 or higher (Figure 2). It was observed that participants who found financial indicators to be irrelevant also gave low ratings to financial metrics. Some respondents found that metrics under the *Business Communications* and *Personal Network* IKIs that were based on direct counts (e.g. number of contacts, number of emails per day) were not very relevant to their corresponding IKIs because they measured the "quantity" and not the "quality." As one manager stated, "*an employee can attend tens of meetings and receive hundreds of emails per day only for bureaucratic tasks that would have limited effect on her or his individual knowledge*." Likewise, a large number of participants found that training expenses were highly irrelevant to the value of the knowledge acquired during training. Such comments by managers were found to offer valuable feedback that would be used to improve *MinK*.

Conclusion and Future Work

This study presented the first phase in the development of *MinK*, a framework designed to measure individual knowledge in a business context, to fill an existing gap in the literature and, more importantly, help organisations manage knowledge more effectively by identifying knowledge holders. Ten indicators that denote individual knowledge were selected, and metrics were developed to assess each metric individually. As a means of preliminary validation, a study was conducted though semi-structured interviews with managers from different industries. The framework was rated high and managers who contributed in the study provided useful insights and recommendations that will be considered in the final version of *MinK*.

The main limitation of the preliminary validation stage is the sample size. The subsequent phase is therefore planning to include more companies and a larger scale of contribution from top management in the targeted organisations. The framework will then be modified to incorporate the valid suggestions that emerged from the preliminary validation and the subsequent validation phase.

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The Quality of Doctoral Degree Awarding: Perspective of Self-regulation Mode

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Abstract

The responsibility of the doctoral school to maintain a certain quality level of doctoral studies is a subject of autonomy of a higher education institution. From the perspective of research policy, autonomy could be analysed as a self-regulation mode, when fulfilment of the standards is under supervision of the self-organized body. For the process of doctoral degree awarding (DDA), peer review is used as a major formal procedure implemented via committees formed of researchers. We have analysed the practice of the DDA process in Lithuania and reconstructed the committee structure in terms of social network analysis aiming to measure impact of self-regulation on the DDA process. Empirical evidences let us discuss the hypothesis that the space completely comprised by a self-regulation mode is less competitive and has tendencies to work in a more closed environment and could be critical for peer review process and biased in favour of colleges and close partners.

Keywords

quality, peer review, self-regulation, new researchers, doctoral degree, social network analysis, research policy.

Introduction

Research excellence as a policy target is highly complicated to describe. It is rarely defined in political documents in detail and is even more rarely measured directly (Tijssen, 2003, Taylor, 2011). However, discussions about excellence are never-ending in the research policy arena and have different images such as “quality”, “excellence” or ”best practice”. All these issues concerning the quality of research and scientific activity become the content of autonomy of higher education institution assuming that autonomy guarantees certain level of quality. From the perspective of research policy, state regulation is stepping back for self-regulation sake when the supervision of quality of research output is transferred to the internal institutional practice of doing research. This way the state regulation works in self-regulation mode seeking to strengthen the research quality achievements. However the perfect alignment condition between external regulation and internal self-regulation could become an issue of concern for research policy makers. Furthermore, it would be advisable to distinguish one set of indicators which could be regulated and another set of indicators that left for supervision of self-regulation. However this task is rather complicate to accomplish since quality indicators are controversial (for instance, tension between qualitative and quantitative research output assessment) and very difficult to find research quality element being totally free from one of two possible regulations. It could be an explanation why it still lacks such empirical research. It is more realistic to estimate impact of one of the mode of regulation instead of tracing particular quality indicator. These difficulties could be partially solved if the quality element is achievable by particular mode of regulation. We have chosen self-regulation for further investigation, since this mode could be interesting for policy makers when higher autonomy is granted. Policy makers take into account what the boundaries of self-regulation are and how deep one can rely on it.

Searching for quality element which is free of state regulation, doctoral training in Lithuania has been chosen for deeper investigation. Doctoral training quality is based mainly on doctoral school supervision. While Government stipulates specific rules for process recommendation and introduces some control elements concerning the requirements for the researchers that could be nominated to evaluate the doctoral student achievements. Meanwhile the decision, which particular researcher will be invited to evaluate the final doctoral student output – doctoral thesis, is made by local doctoral school and it is purely attributed to self-regulation mode. So the rationality is based on the assumption that most prominent researchers acting as peers in doctoral degree awarding (DDA) committee would recognise quality of thesis in the best way and guarantees necessary doctoral education quality level.

So the DDA process has been carefully scrutinised and the research purpose was set to evaluate self-regulation mode via analysis of network of DDA committee members. Our research question is: who takes part in committees and how tight network members are bound with each other. The research presumption is that random distribution of members in DDA committees is a trace of similar perception of doctoral training quality in different doctoral schools. For such kind of purpose, the social network analysis was employed.

Presumably this investigation should lead us towards testing an alternative evaluation methodology necessary to tackle operational quality of the self-regulation mode.

Doctoral degree acknowledgment: reflection of research quality regulation

Apparently a doctoral degree is the first stage in training of researchers and a formal benchmark of their professional excellence. As a result of doctoral studies and exposure to the professional community, researchers often come out of the boundaries of the programme following certain guidelines on how to do research and how to proceed with newly acquired knowledge. These guidelines could be analysed as a basis of their professional behaviour, yet can hardly ever be measured precisely despite the fact that scholars constantly put effort into doing this (Lahenius, 2012). Difficulties concerning evaluation of the quality of doctoral studies lay down to the difficulties with research quality evaluation.

Research quality evaluation. Output measures of quantitative research performance (Everett et al, 2004) are complemented by peer reviews with the focus on the quality of outputs. This is widely recognised as a proper approach to evaluating the quality of research (Sense About Science, 2006, Bornmann et al, 2005). Methodology based on so called “informal” (Peer review) and formal (bibliometric) evaluation approach to the research quality measuring binds two contraposition concepts. There are some evidences that “peer reviews are regarded as a better absolute measure of research journal quality than citation scores” (Brinn, 2000) but bibliometric measure discloses the research picture as well. Both formal and informal techniques raise critics if they are applied solely. Peer review is inherently subjective and the bibliometric measure has other pitfalls, such as inflation of fashionable topics or popular authors, citation with critics instead of following and so on (Groot and García-Valderrama, 2006). However there are some cases where formal evaluation prioritizes higher. Formal evaluation based on citation analysis and bibliometric measure of research outputs is tightly connected with the construct of "research quality" from the perspective of research policy. This practice is used for many regulatory purposes: university and research group funding (Adam 2002; Butler 2007; Moed 2008) or for tenure and promotion in researcher carrier path (Ballas and Theoharakis, 2003). It could easily justify in the eyes of policy managers, since bibliometric measure produces a large body of knowledge about supplementary research components such as research communication infrastructure (scientific journals), research team activity and recognition. This source of knowledge could invoke the sense that it is rather simple to manage and ground new policy regulation on bibliometric data whereas it is hard to base it on peer review evaluation outputs. However "research quality is diverse, uncertain, and multidimensional" (Frey and Rost, 2010) and it is a challenging task to find a true set of indicators for formal evaluation that capture all dimensions of research. While seeking to regulate research quality, one should respect possible competition of preferences between novelty and originality of research theory with empirical research constitution. Such regulatory practice that makes preferences on peer review is functioning for DDA.

DDA regulation. In the doctoral degree acknowledgement (DDA) process, peer review is used as a major formal procedure. This procedure is carried out via committees (or some prominent researchers such as examiners in the UK) composed of researchers who have proved their competences during their research careers. DDA committees are nominated with the purpose of assessing the output of the research conducted by a candidate to evaluate new researcher's abilities to work as a researcher in the future. The way committees are set up and the way individual committee members are chosen is the responsibility of the university or a doctoral school that has established the doctoral programme (Kehm, 2005). The responsibility of the doctoral school to maintain a certain quality level of doctoral studies depends on the autonomy of an individual institution of academic education. Institutional autonomy is perceived as a sensitive safeguarding instrument of maintaining the quality of higher education at a certain level (Gvaramadze, 2008). Members of the committee have a role of peers that agreed on a certain decision regarding new PhD and the credibility of this committee becomes DDA quality assurance.

Autonomy vs self-regulation mode. From the perspective of research policy, autonomy could be analysed as a self-regulatory mode where the achievement of standards is under the supervision of a self-organised body inside the university with only certain minor regulation coming from the outside, mainly connected with the qualification requirements for committee members. Self-regulation as opposed to external governmental regulation is a mode of balance between internal commitments to endeavour for research excellence, whereas the aim of external control is to achieve the quality of training of researchers (Brookset et al, 2007). Self-regulation is emphasised as a “moral commitment from participants” affected by the use of information, education, technologies, and perhaps peer group pressure (Darren, 1997). Self-regulation is often associated with the ‘better regulation’ agenda and influence of new regulatory policies (Bartle and Vass, 2005). Research based evidences have proved that self-regulation empowers organisational members to undertake responsibility for the activities voluntary and seek for higher standards via cooperation.

However, debate what knowledge policy makers need to prove a necessary level of autonomy for good operation and how to measure the impact of self-regulation that universities are granted with are open on every policy cycle and no direct quantitative approach has been proposed or tested yet. Social network analysis being quantitative method could spot some aspects of self-regulation, even if it does not produce direct measuring. It has long been proven that networks consist of the members either similar in attributes or assimilated later after permanent interaction. Permanent networks are good source of information about values keeping network together. For DDA committee network case, such value is quality level. So application of social network analysis to DDA committee members is grounded to the main advantage of the method.

Methodology

The DDA reports issued for 2010-2011 in Lithuania were chosen for deeper investigation. Empirical data for the investigation were collected from officially issued reports about PhD thesis defences. The research input includes the following data: names of committee members, their research interest in the field of representation, the research area of the doctoral degree, the date of defending and the affiliation of the doctoral programme institutions. Data were analysed according to the research field divided into officially assigned scientific fields: biomedical science (B), social science (S), humanities (H), physical science (P) and technological science (T). The research fields have been used as attributes of committee members for network analysis.

The network substructure has been distinguished with the purpose of reconstructing hidden tendencies to recognise nodes as suitable members. Social network analysis makes it possible to analyse relations between nodes in the light of their position in the network, their geographical distribution by affiliations and their international and interdisciplinary cooperation. Such committees form a part of a larger network which was active in 2010 and 2011. Relations of the committee and a PhD candidate are perceived as a hierarchical mode (star like) network with 7 nodes (5 committee members and 2 opponents) connected with the doctoral candidate in the centre. Names included into the network repeatedly gave information about the practice of how the committee members are selected and what type of relationship they have. The network analysis and network visualisation were processed by UCINET software (Borgatti et al., 2002). The networks were drawn by NetDraw with the spring-embedding representation.

Results and discusions

The total research data set comprises 831 DDA cases and builds a network of 2711 nodes, 1880 of which represent committee members. All research fields are represented by individual networks.

Statistics. The Social network analysis (SNA) has shown that out of 1880 committee members, 56 % were involved in the DDA process once, while 42 per cent of nodes (885) represented themselves in the network 2-5 times and 8 per cent of researchers (178) were nominated as doctoral candidate recognition members more than 5 times (1 researcher participated in the process 32 times, and 2 members participated 22 and 25 times respectively). Since no special dynamics is tracked according to time, the networks were built for two years.

Density as the basic SNA parameter is usually monitored foremost. Density is a ration between actually available ties and all possible ties. Its value associates with the size of the network and the way the network is constructed. Since we constructed a star like network with a PhD student in the centre and ignored actual ties between committee members, the density value is not expected to be high. Not surprisingly, for this particular case, densities of the five networks are comparable and give a relatively low value with some moderate increase in H, T and P networks. This parameter acquires meaning in an integrated analysis including other parameters.

In the scrutiny of the statistics that SNA provided, the substantial differences are observed in centrality measures and repeated participation in the DDA committees. Centrality is a characteristic of a single actor and demonstrates how many ties a node in the network has. An out-degree is defined as a number of ties between nodes directed from the node and constitutes a characteristic of PhD students. Committee members are characterized by an in-degree defined by the ties directed from other nodes. An in-degree reflects attitudes of the doctoral school towards recognition of committee members. A higher in-degree could demonstrate that networks consist of the nodes that were invited to participate more than once and that nodes are dominating. In this respect, the network of social science demonstrates that particular committee members have been invited more often than in the network of Humanities or Biotechnologies.

Table 1. Statistics of SNA.

Analysis criteria	Science field				
	A, B	S	H	T	P
Density	0.0024	0.0028	0.0032	0.0034	0.0034
No. of Ties/Sum	1300	1465	728	916	825
Mean (participation in committees)	1.750	2.029	1.523	1.772	1.67
Max (participation in committees)	25	35	9	16	17
Centrality:					
Out-degree	0.354%	0.690%	1.151%	1.015%	1.083%
In-degree	1.569%	4.579%	1.571%	2.763%	3.116%
PhD thesis (2010)	101	104	54	79	69
PhD thesis(2011)	103	127	63	67	64

Ego networks. The social network analysis allows a possibility to observe the data that are hidden from a direct view, by minimising excess of the data. For instance, the nodes that were involved in the network once per analysed period are withdrawn from the network and the analysis is conducted with the nodes that are most dominant. Interesting results have been produced by ego network studies: the two most prominent members form independent sub-networks have no interconnections. After adding more ego networks, the separation in the network structure still remains (see Figure 1, 2, 3, 4). The formation of two clusters expresses a rather equal distribution of relations, while the division between the clusters is still clear. Surprisingly, we can see that this pattern of clustering is repeated in every individual research field. After elimination of the most prominent members from the network, no clearly recurrent structure was identified.

Such results suggest that DDA committees tend to become stuck on a stable composition without even minor changes and that changes take place mostly because of external regulation by the state (e.g., a requirement to have a member from the international community or a community other than the doctoral school). Surprisingly or not, affiliations of the repeatedly participating DDA committee members attribute to the same regulation – they represent institutions other than PhD student's doctoral school. It seems that some researchers play a safeguarding role and fit any research topic.

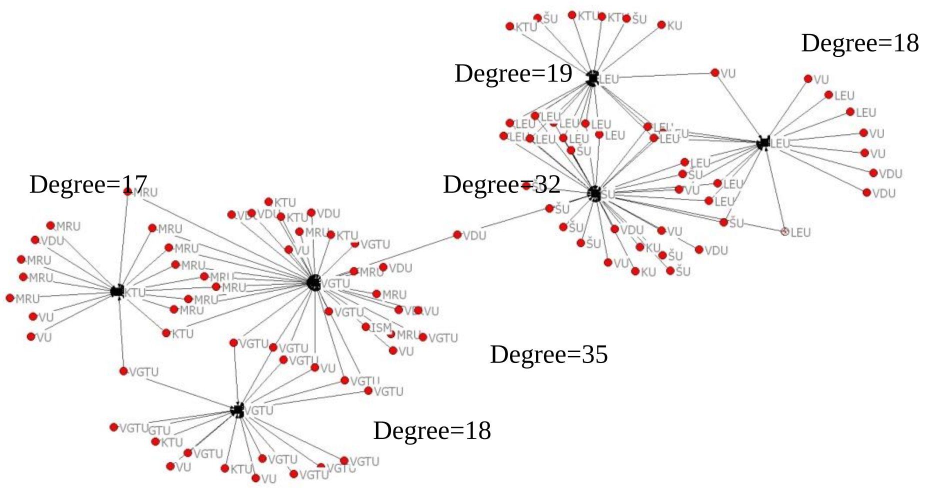

Figure 1. Fragment of DDA network in social science with the most popular committee members.

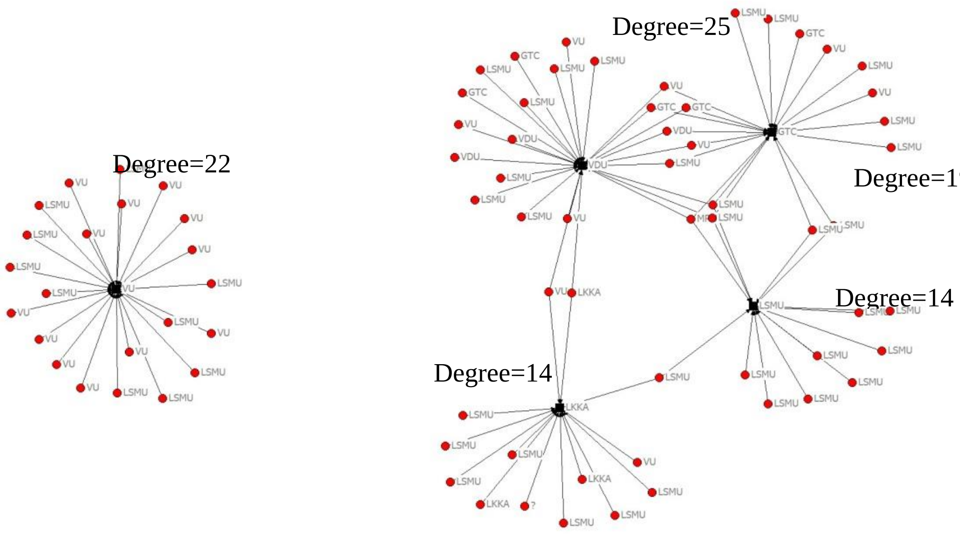

Figure 2. Fragment of DDA network in biomedical science with the most popular committee members.

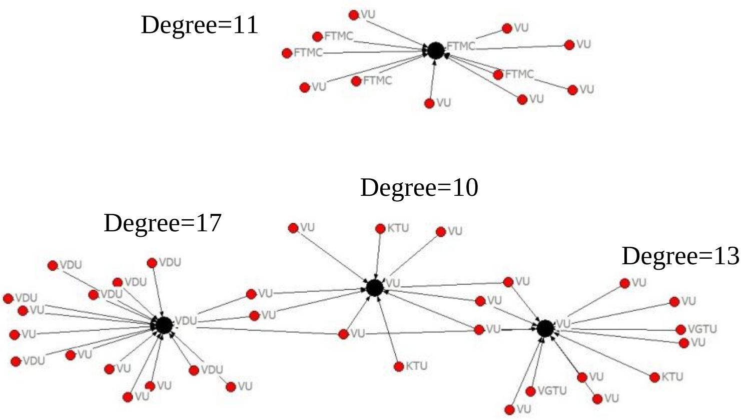

Figure 3. Fragment of DDA network in physical science with the most popular committee members.

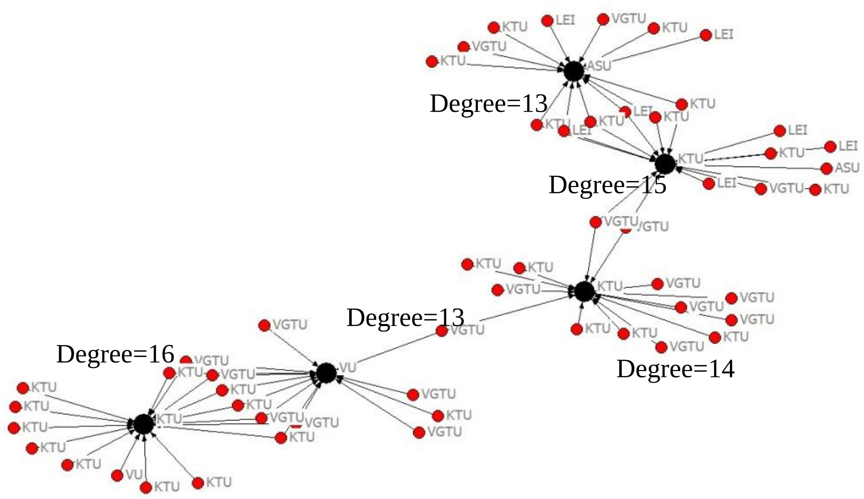

Figure 4. Fragment of DDA network in technological science with the most popular committee members.

The networks of DDA committees have demonstrated stability in their composition and some isolation when most popular members are not recognised by other doctoral schools in the field. That makes us wonder why the quality level of one doctoral school is not acceptable for another. However, with the available non changeable committee composition a doctoral school with presumably lower research quality is precluded from quality development. If we agree that the network of DDA committee members affords spotting self-regulation, we can express doubts about competitiveness of the self-regulation in this particular case. The DDA committee network demonstrates tendencies to work in a more isolated environment seeking to avoid outer influences, frequently critical to peer review and biased in favour of colleagues and close partners. Other scholars have also reported on the weak abilities of “self-steering capacity“ (Baschung, 2010).

Conclusion

In the present research of the composition of DDA committees, we have analysed a formal network of researchers that have a duty to ensure the quality of doctoral thesis. Such networks consisted of prominent researchers, which are officially nominated by the doctoral school and represent the doctoral school's appreciable level of quality. This quality level is a subject of self-regulation, when committee members are selected locally by doctoral school.

Presumably, the stable composition of the committees inviting the same members periodically reflects recognition of certain quality standards. However, the tolerance towards agreed standards has a potential to become flexible. That means that operational quality is going to be changed to a new quality stage that it is not necessarily higher than previous one, as no external and independent discussion is available.

The social network analysis of the members that participate in the DDA process lets us measure an impact of the self-regulation mode on the DDA process and make emphasis on the balance between state regulation and self-regulation modes while autonomy of the doctoral institution remains under discussion. By this research we propose additional methodology to peer review and bibliometrics, empowering to collect operational knowledge and use it for further policy regulation. The available techniques, such as peer review and bibliometric measures, produce a body of knowledge about research quality useful for research policy regulation. Knowledge from social network is additional operational knowledge that demonstrates coupling of certain policy regulation with predominant self-regulation.

Our finding has some implication for policy makers. Whereas self-regulation mode has tendency to keep doctoral education quality level at some fluctuate condition, the state regulation respecting self-regulation could take a role of stabilising of that fluctuation. Limitation of this research derives from the fundamentals of SNA and particularly from the dynamics of self-regulation. We cannot deny that self-regulation needs time to expose its impact, therefore dynamical measurement of the evolution of networks during a longer period could be helpful. A qualitative analysis of attitudes of DDA committee members towards the committee practice can shed some light on network composition and need to be planned for the further research. Qualitative data about particular reasoning why some committee members are invited ten times and others just one could add more personification to the social network data.

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Toward a Sustainable Quality of University Research: Knowledge Sharing and Leadership

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Abstract

It is claimed that by providing a sustainable environment, a university's research profile can be enhanced. The questions then arise how universities define sustainability, what criteria are used to judge sustainable quality in research and how a university can maintain sustainable research quality? This paper places emphasis on sustainable quality of research from perspectives of knowledge sharing. It is argued that effective sharing of knowledge among academics could lead to improved university research performance. It is most important that universities establish credible leadership influences on knowledge sharing. We apply Beer's Viable System Model to identify those domains of research leadership and knowledge sharing necessary for an institution to maintain sustainable quality in research. This paper considers examples of research-knowledge sharing in UK research communities, and explores a positive relationship between research leadership and research-knowledge sharing.

Keywords

sustainability; knowledge sharing; research-leadership

Introduction

The term ‘sustainability’ in relation to research suggests ability to maintain a certain rate or level of activity within higher education institutions (Oxford Dictionaries, 2013). Use of this term in HE policy discourse suggests perception of threats to continued research activity from the current political and social environment. Certainly, it can be seen in Western countries such as UK, USA and Australia that the political and economic climate is not conducive to generous funding for research. A survey in the United States revealed that 40% of respondents saw a decline in federal funding as the most important trend affecting the overall research environment (Welker and Cox, 2006). Governments may embrace the rhetoric of economic development through research and innovation, but the pot of money available to support it is limited through competition with other demands on the public purse. In this climate, competition for available funding is increasing and even traditional centres of ‘excellence’ in research must look to husband their resources. At the same time, those UK institutions deemed to be ‘research informed’ rather than ‘research led’ have difficult choices to make. While teaching is the primary source of income (HESA, 2012), it is not sufficient to secure future prosperity (EUDIS, 2011). Not only does research output generate direct income for HEIs through the Research Councils, it also enables income generating activity through knowledge transfer to industry and commerce. Research outputs form the basis of worldwide university rankings, which in turn influence an institution’s ability to market its services and attract international students. Sustainable research is thus vital to on-going financial stability. Formal acknowledgement of the need to consider sustainability can be found in policy statements. The Australian Government, for instance, began a Sustainable Research Excellence initiative in 2009-10. The issue has also been taken up by the UK research councils, e.g. ESRC invites applications for funding for Capacity Building Clusters, saying that it is vital that the UK maintains a strong supply of skilled people to enable the research base (ESRC, 2012).

Hazelkorn (2004) points out that the market for higher education is now global and that research is a core element of its mission. A focus for many institutional research strategies is therefore to ‘*Sustain academic and professional reputation in knowledge-based economy’*. Among the key challenges of research capacity building are, in her view, poor infrastructure, lack of a critical mass of researchers, staff without the necessary skills or resources, academic workload tensions and lack of research tradition. Attempts to identify ‘best practice’ have surfaced, inter alia, a need to build a ‘culture of scholarship’.

Research Culture

There is no widespread agreement as to the nature of a research culture, and it is likely that this varies between disciplines. One suggestion is offered by Pete Downes, Principal and Vice Chancellor, University of Dundee, who describes its (successful) research culture as comprising the following elements: selective recruitment to bring in high calibre researchers; collaboration to become competitive; respect and value for the contributions of all staff, including support staff; and celebration of one another’s success (Downes, 2011). He goes on to highlight the role of Universities in innovation, suggesting that this role needs to be a more active one in the future, ensuring not only that research findings are disseminated but that they are exploited through knowledge transfer partnerships. He suggests that successful research culture continues to promote ‘curiosity-driven research’ but that it needs to abandon the passivity of traditional knowledge dissemination and seek instead to capture the economic impact of investment.

Knowledge sharing appears to be a key part of a strong research culture, whether this is collaboration in interdisciplinary research, sharing ideas with a mentor or partner, or through a knowledge transfer exercise in which ideas can be shared and exploited for gain.

Knowledge Sharing in Research Culture

Of course, dissemination of results is a normal outcome of the research process. However, knowledge sharing behaviour at earlier stages in that process may be more problematic. Many have discussed the influence of extrinsic and intrinsic motivation in knowledge sharing. Hung et al. (2011) suggest that intrinsic rewards (e.g. reputation enhancement) have the strongest positive impact on research knowledge sharing (RKS) as compared to extrinsic rewards. Of course, extrinsic rewards also play a role in motivating academics to share research knowledge, e.g. adding value to individual research profiles for career development.

Investigation has shown that academics sometimes fear losing power and competitive value if they share their research knowledge, particularly at early stages in a project. Hence, they tend to hoard their research-knowledge (Mahamed Ismail, et al, 2012). This is particularly true of early career researchers who may be lacking in confidence or savoir-faire in research matters. RKS is most likely to occur when there is trust among colleagues or with research-leaders, and conversely least likely when there is fear that colleagues may steal ideas before they become developed and intellectual property (IP) is protected. Wang and Noe (2010) conclude that organisational culture is one of the key determinants of knowledge sharing. A study by Mahamed Ismail (2012) involved semi-structured interviews with both academics and research-leaders in eight UK Business Schools across the binary divide. She finds that there is a clear dichotomy between research-leadership in Pre- and Post-1992 universities. Research culture in Pre-1992 universities is more established, with strong explicit cultures, which are successful in developing, implementing and maintaining effective research policies, and strong implicit cultures around research (Mahamed Ismail, et al, 2012).

The elements found to differentiate the implicit culture in Pre- and Post-1992 universities can be summarised into four different aspects: research capability; behaviour of research-academics; engagement in research-knowledge sharing (RKS); and research-leadership. Due to the nature of the so-called ‘research-intensive’ universities, new academics are automatically exposed to knowledge sharing behaviour. RKS engagement is embedded in research-academics’ beliefs and norms. In contrast, academics in Post-1992 universities are at a disadvantaged, since they have had less exposure to RKS. In consequence, numbers of research-academics who are active in RKS are relatively small, and research savoir-faire and confidence among research colleagues may be lacking. In ‘research-intensive’ universities, every academic is aware of the need to engage in RKS: this is their raison d’être. Conversely, in Post-1992 universities, the involvement of academics in RKS is found to be primarily extrinsically-driven through policy. RKS engagement styles also differ. In Pre-1992, academics appear more independent and tend to work in isolated groups, whereas in Post-1992 universities, RKS involvement is more clustered, with an atmosphere of collectivism.

Research leadership

Perhaps most important of the four elements is research-leadership. Mahamed Ismail notes that research-leaders in Pre-1992 universities, particularly professors, use an interactive approach to support RKS among academics, giving advice and guidance continuously. In contrast, research-leaders in Post-1992 universities, particularly professors, are less likely to provide interactive leadership with their junior colleagues. RKS support is more ‘top-down’, with emphasis on developing and implementing research policies. Chawla and Joshi (2010) show how leadership plays an essential role in creating, developing, and managing organisational capabilities, by creating effective teams; building and integrating culture; promoting use of IT and other supportive infrastructures; and development of rewards and recognition systems. This suggests that, in a higher education context, research-leaders could have a significant influence on RKS engagement among research-academics.

Pre-1992 research-leaders are not only supportive of RKS through the development and implementation of research strategy, but also through daily interactions with other academics, formal or informal. Mahamed Ismail shows that research-leaders across all levels in Pre-1992 universities take positive steps to provide an encouraging atmosphere, in order to facilitate RKS among academics. Most importantly, professors in Pre-1992 universities are found to use an interactive approach to promote and motivate research-academics towards RKS engagement. The interactive relationships between professors and research-academics show no particular boundaries. In contrast, this study shows that research-leaders in Post-1992 are successful in setting up, developing, and implementing systematic research policies to enhance research performance but have overlooked the need for more specific encouragement and guidance for junior academics. Professors should act as ‘knowledge builders’, who create opportunities and processes that stimulate RKS amongst academics, take the lead in research, and form a positive influence helping to consolidate a sustainable research culture. Mahamed Ismail’s study has suggested three key enablers of knowledge sharing - people, organisation, and IT. A model of context-specific RKS was developed (see Figure 1), integrating the three enablers together. In the next section, we consider the systemic nature of HEIs and the potential usefulness of Beer’s Viable Systems Model in analysis of sustainability.

The University as a System

A university can be conceived as one particular type of organization, i.e. a complex, purposive social system created in order to bring about and maintain some desired transformation in its environment (Argyris and Schon, 1978). In the case of universities, multiple purposes/transformations are contemplated: students to graduates through education; what is unknown into ‘knowledge’ through research; uninformed to informed clientele through knowledge transfer. Organizational systems are comprised of individual members who are themselves purposeful, intentionally and collectively formulating objectives (Ackoff and Emery, 1972). However, an organization is more than just a collective. It is the interactions among members in their multiple, contextually-dependent roles that generates those perceived emergent properties that characterize a particular organization as a purposeful system (Bednar, 2007). Thus, universities have a problem in that they resource the academic systems from which new knowledge is generated, and depend upon the collective reputation of the faculty for on-going prosperity, but they never truly own either the means of production of knowledge, nor the fruits of academic labour.

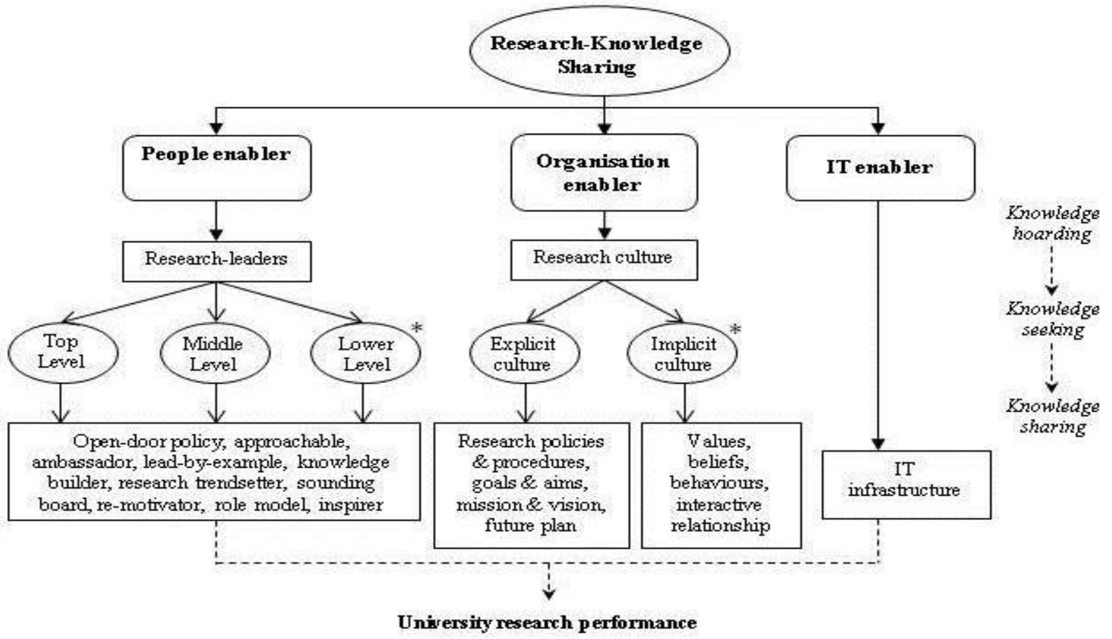

Figure 1: The impact of knowledge sharing on research performance (Mahamed Ismail, 2012)

The Viable Systems Model

A viable system is one which can maintain a stable relationship with its environment, and hence sustain its performance, through appropriate feedback. Beer (1985) derived his concept of ‘viability’ of systems through reflections upon Ashby’s (1956) Law of Requisite Variety.

This 'law' states that only variety can absorb variety (the number of discernibly different states that a dynamic system can occupy). Variety in the system as a whole must match the variety of its interactions with its environment in order for stability to be maintained over time.

Beer reflected upon the ways in which balance is achieved in the human body, through three interacting parts: first, *Operations* – the organs and the muscles which carry out all its primary functions; secondly, the co-ordinating *Metasystem* that ensures all the various operational units work together in an integrated way, achieving internal balance; and the *Environment* - those parts of the outside world which directly influence the system concerned (see Figure 2). Operational units must maintain balance with the Environment if the system is to remain viable. Many examples exist of practical application of the Viable Systems Model to real world organizations (see, e.g. Espejo and Reyes, 2011).

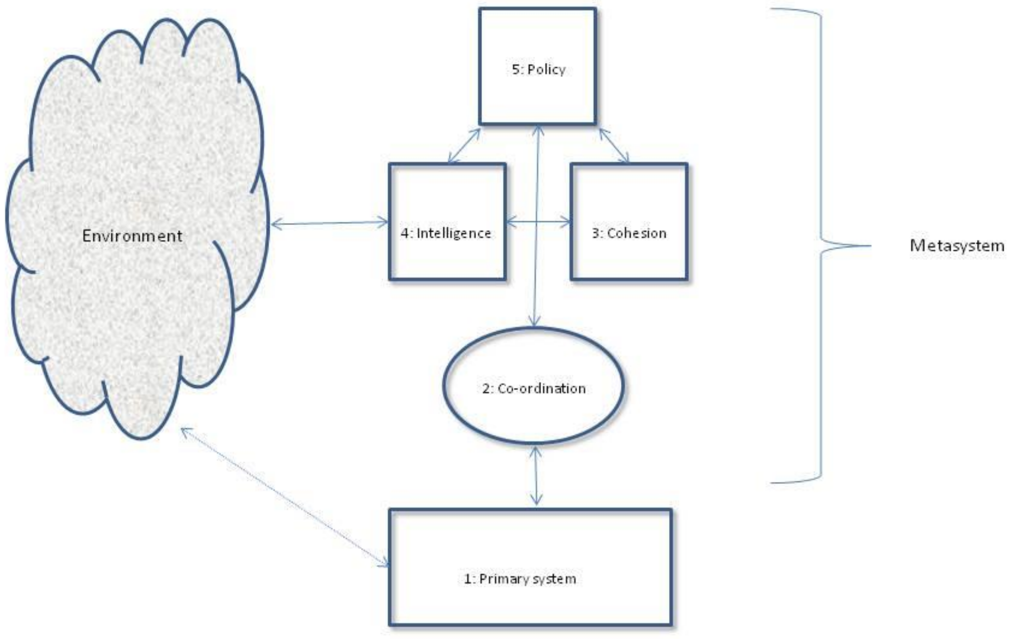

Figure 2 : Elements of the Viable Systems Model

VSM helps us to consider a system in terms of the necessary elements that can enable it to form an integrated whole capable of sustained pursuit of purposeful activity. Using the model as the basis for design, we begin by asking what operational activities the system in focus needs to perform (System 1) and what needs to be managed in order to facilitate this (the co-ordinating Metasystem). Figure 3 shows how organisational systems often appear in higher education institutions, with fragmentation of System 1 activities within separate, discipline-related silos. These may be competing for the same scarce resources. The co-ordinating system often takes the form of a remote management structure, which tends to exacerbate rather than tackling this fragmentation. Fragmentation inevitably leads to sub-optimality in the System as a whole, as each unit seeks to pursue its own objectives and to optimise its performance at the expense of the integrated whole (Bertalanffy, 1968). One major challenge for proponents of sustainable research will be to overcome this sub-optimality, either through restructuring or appropriate interventions from Systems 2 and 3. Fragmentation of activities is likely to mean result in multiple cultures of teaching, research and knowledge transfer, which Systems 2 and 3 will need to address.

System 2 is concerned with communication and co-ordination, maintaining the stability of the whole by smoothing out conflicts that arise. Shared ‘language’ and organization culture are important System 2 features (Hoverstadt, 2008, p.107). The responsibility of the communicator here goes beyond dissemination of policy, to engage in a circular process of negotiation: sender-receiver-sender, and to do this simultaneously to embrace the activities of all System 1 units, co-ordinating their actions and smoothing out conflicts. The context of UK higher education makes this a daunting task. Once stability has been achieved, the job of System 3 must be addressed: how to optimise interactions in order to achieve the aims of the whole. Rodgers (2007) points to a paradox that managers have formal authority to control business decisions but lack any control over the informal interpretations, expectations and competence of their staff (particularly applicable in HEIs). Successful management, they argue, lies in embracing this paradox rather than attempting to resolve it. System 3 takes a continuous overview of the complexities of the system, using feedback from operational units and its essential task is to regulate System 1 and ensure each unit has appropriate resources. Thus, a loose federation of work clusters might be a more effective structure than traditional departments and faculties (see Figure 4). Academics could collaborate in research and knowledge transfer, guided by professors in respect of research knowledge sharing and enterprise co-ordinators in respect of knowledge transfer. System 2/3 would need to provide a vehicle of support for attraction and distribution of funding for these core activities. If ‘curiosity-driven’ research is to be encouraged, the timescale over which success might be expected may vary considerably. Aspects of System 3 will need to be embedded within the clusters forming System 1, gaining cluster-specific knowledge but without falling into the trap of reinforcing fragmentation and sub-optimality.

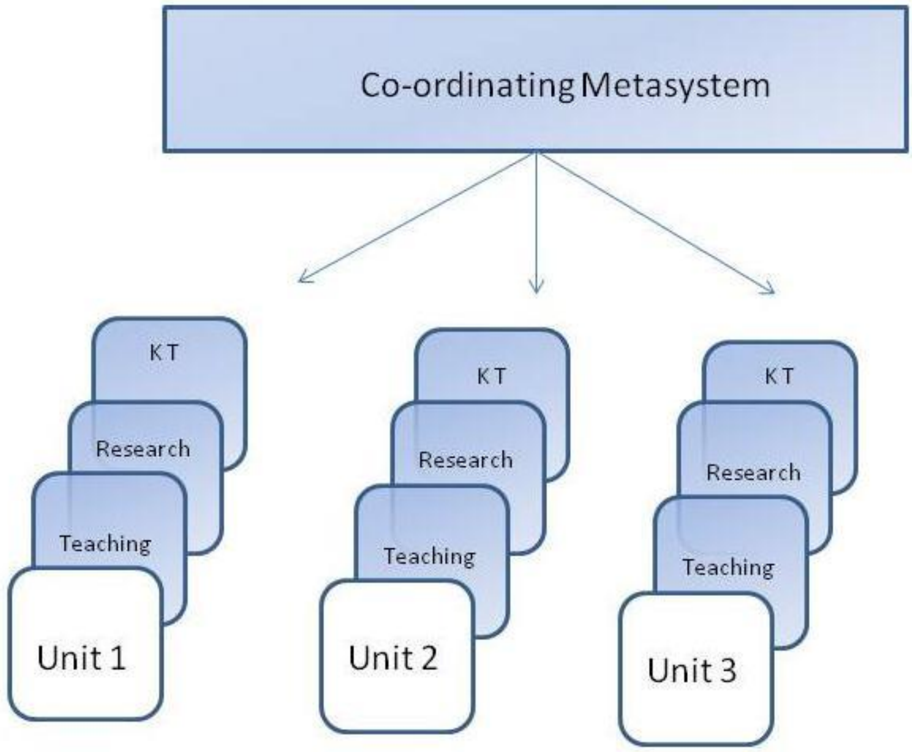

Figure 3: System 1 fragmentation in HEIs

There must be an interaction (feedback loop) between System 3 and System 2, since it will be necessary to deliberate on optimal use of scarce resources and resolve any ensuing conflicts. There is also an interaction with System 4. Future stability and/or growth require forward planning, based on interpretations of feedback from System 3, and from intelligence gathered from the *Environment*. System 4 is responsible for representing the whole as a viable system to the outside world. System 4 will also need effective means to trawl the environment for opportunities, e.g. for research funding or new KT partnerships, which will be fed back to System 3. System 4 must also be designed to (re)create the institution's public persona and provide information to System 5. System 5 addresses the achievement of overall purpose, providing ground rules for all activities of participating units, together with means for enforcing them (policy-making) but will need to be designed in conjunction with System 2. It is necessary to ensure that a model of one-way communication of policy from a remote centre is avoided. System 5’s task is not simply to declare what shall be done (or how) but to cement together a common identity which all those engaged within the system can espouse, i.e. build a *culture of sustainability*. Only if this is achieved effectively can the problems of fragmentation and lack of effective research culture be overcome. Balance must be maintained on an on-going basis between variety in the HEI system and its interactions with the environment in order for sustainability to be achieved.

System 5 depends upon communication from all the other aspects of the Metasystem in order to fulfil its role effectively. Since tacit knowledge is the key to management of variety at operational level, internal autonomy must balance. Imbalance in organisational complexity, for instance through arbitrary approaches to management, can lead to loss of effective control. Co-ordination challenges reflect the tension between autonomy of operational units and a need for synergy across the system as a whole. Identifying and removing unnecessary complexity (e.g. by streamlining processes) is clearly beneficial in this respect.

On-going development is needed to ensure a good fit is maintained between an organization and the environment within which it operates. Change is endemic in any environment and a viable system must be prepared to cope with on-going change.

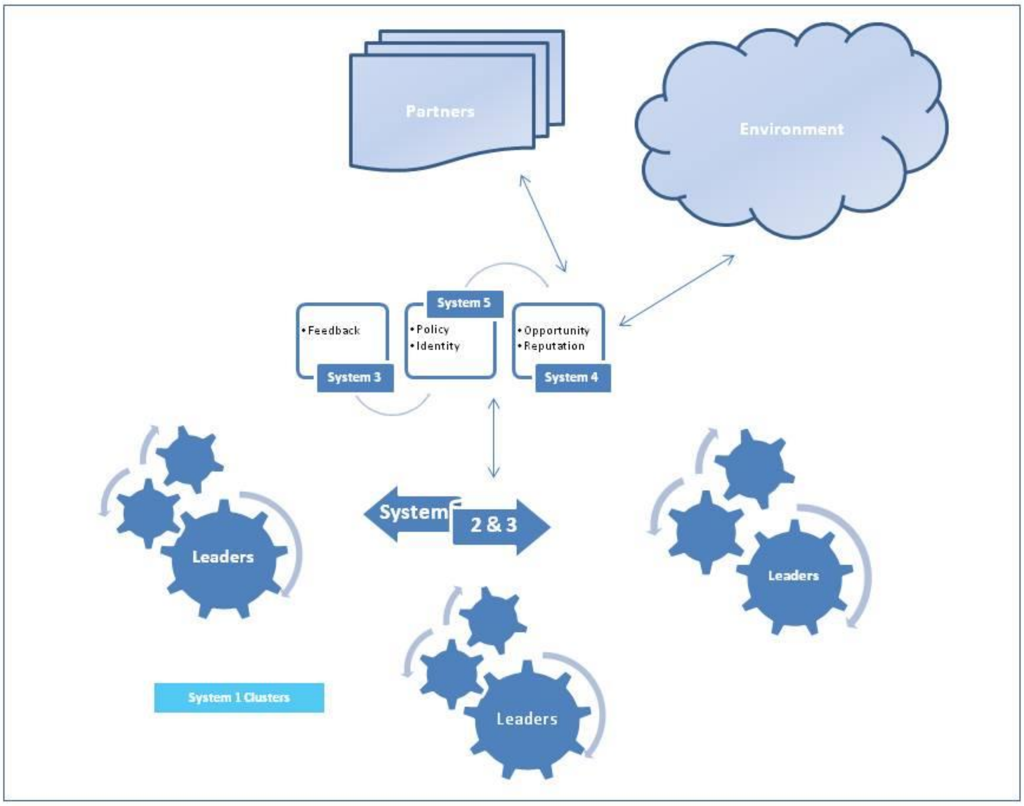

Figure 4: A sustainable system for university research?

Conclusion

This paper has examined the concept of sustainability in relation to University research and has seen that the agenda of sustainability is growing in importance in the context of financial constraints experienced in many higher education sectors around the world. It has been seen that strong research culture is positively associated with success and that many institutions and funding agencies are engaged in capacity building activities. Studies have shown that research knowledge sharing is vital to building of effective research cultures, and that attitudes to knowledge sharing can be seen to vary between the Pre- and Post-1992 Universities in the UK. Examination of the differences between these sectors reveals a crucial role for professors in providing inspirational leadership, encouraging knowledge-sharing activity and thus enhancing the confidence and savoir-faire of other academics. We suggest that the Viable Systems Model (Beer, 1985) could be a useful vehicle to examine structures and processes in HEIs in order to promote greater synergies and build stronger research cultures. Application of this model suggests, in particular, that fragmentation of operational units may lead to conflict of objectives (sub-optimality) in the system as a whole. This will mitigate against effective research knowledge sharing as a basis for sustainability.

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Towards a Quality Assessment Framework for a KMS Software: A Mapping Study

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Abstract

Evaluation of effectiveness or quality of a Knowledge Management System (KMS) is challenging. The main objective of this research is to investigate what attributes define the KMS software quality, what methods have been used to measure that quality and ultimately formulate the essential guidelines for assessing the quality of the KMS software. A systematic mapping study methodology has been used in this study to identify what topics have generally been investigated by researchers in the KMS field. The mapping study consists of three main activities: search for relevant publications, definition of a classification scheme and mapping or categorization of publications. The mapping study for this research identified 175 publications on various KMS topics and these have been grouped into 11 categories. The findings of this mapping study provide a useful baseline for further research work leading to the quality assessment framework for a KMS software.

Keywords

knowledge management systems (kms), mapping study, software quality assessment

Introduction

"Knowledge has become the key economic resource and the dominant and perhaps even the only source of competitive advantage." Peter Drucker, (Drucker, 1995)

Knowledge has become a strategic asset to any organization due to its usefulness for innovation, performance improvement and competitive advantage. This asset is embedded and flows through multiple entities within a firm, including individuals with domain expertise, specific best known methods or lessons learned from similar experiences, documents, routines, systems and methods (Kulkarni U. et al., 2007). In order to get the maximum benefit from knowledge, managing various forms of knowledge is increasingly viewed as an important aspect. There are many definitions of Knowledge Management (KM). A common definition of KM is that its objective is to identify and leverage the collective knowledge in an organization to help compete with other organizations and survive (Rosemary H. W. et al., 2002).

A Knowledge Management System (KMS) is a class of Information System (IS) that manages organizational knowledge: thus it is a system developed in order to support and enhance the processes of knowledge creation, storage, retrieval, transfer and application. KMS provide benefits to organizations for implementing mechanisms for collaboration, organizational learning, workflow management, intellectual property management and document management. KM is enabled by the integration of information technology tools, business processes, human or social capital, continuous learning and innovations (Halawi L. et al., 2005). KMS Software (KMSS) is a component of a KMS that can be used as a platform for managing various forms of knowledge in organizations. It enables organizations to locate, capture and share information seamlessly with customers, employees and key stakeholders. Other components of a KMS are people, culture, organizational practices and structures. There are more than 250 KMS software are available as commercial software (e.g. Office 365, Google Apps, Hyper Office, LotusNotes, BlackBoard/WebCT, Desire2Learn 8.1, KEWL, ANGEL, eCollege) and open source software (e.g. Moodle 1.8, Claroline 1.6, Dokeos 2.1.1, OLAT, Sakai 2.3.1, ATutor ,eFront 3.6.11). These are available as Course Management Systems (CMS), Learning Management Systems (LMS), Virtual Learning Environments (VLEs), Content Management Systems, Document Management Systems and Office Productivity Software.

Increasing the effectiveness of a KMSS has become one of the most practically and theoretically important issues. In order to measure the effectiveness of a KMSS, attention needs to be paid to identify means of measurement. Quality is considered as one of the parameter which is useful for measuring effectiveness of any system. There are many ways to explain quality of any system; “fitness for purpose”, “meeting specifications” and “satisfying customers” are some definitions for quality. It is evident that the usefulness of a KMS and its successful application derive from the quality of its various components (Lila Rao et al., 2007).

Through the literature review it is evident that there are common features of KM and e-learning. KM and e-learning are both about knowledge generation (acquisition, creation, capture and adoption), knowledge storage, knowledge distribution and knowledge application (Rosemary H. W. et al., 2002). In short, e-learning permits participants to acquire knowledge, pass it from one person to another, apply it to organizational problems/opportunities and store that knowledge for future use. In relating e-learning to KM it is evident that e-learning is cognitively a part of knowledge sharing and therefore part of KM (Peter Donker et al., 2002). Thus quality assessment can be considered as a key parameter for learning effectiveness in KM as well as e- learning. In developing the research questions, these common features in assessing the quality of both e- learning and KM were taken into account.

A number of researchers have tried to address the issues in evaluating information systems and e-learning systems (e.g. (Alkhattabi et al., 2011),(Wu and Wang, 2006),(Nevo et al., 2008), (Ounaies et al., 2008)) by considering various different factors. To our knowledge, most of these evaluation frameworks have focused the software quality rather than quality of the learning environment that is specially to be evaluated for effectiveness of learning. The main objective of this study is to find out the various approaches to quality assessment in KMS with a view to devising a quality assessment framework for KMS software. Mapping study was carried out at the initial stages of this research to gather evidence on topics that are being investigated by researchers on KMS.

Methodology

Knowledge management is a large interdisciplinary field. There are varieties of topics in KM or e-learning systems which are investigated by researchers. But it was unclear precisely what topics are being investigated on KM or e-learning systems. In order to overcome this issue, our research question one is devised to identify the topics that are being investigated by researchers on KM or e-learning systems. Guidelines on mapping study methodology which have been adopted for this investigation provided in (Kitchenham and Charters, 2007).The mapping process consists of three activities: (i) search for relevant publications, (ii) definition of classification scheme and (iii) mapping of publications.

(i) Search for Relevant Publications:

Search for relevant publications was carried out by using 5 electronic sources: Science Direct (SD), EBSCOhost (EB), Association of Computing Machinery (ACM), ISI Web of Knowledge (ISI) and Springer Link (SL). In order to search for publications key terms were identified as “knowledge management system”, “learning management system”, “on line learning”, “e-learning”, “LMS ” and “ KMS”. The search string was developed using these key terms. Search string used for automatic search from these electronic resources is ((((“knowledge” OR “learning”) AND “management”) OR “KM” OR “e-learning” OR “on line learning”) AND (“system” OR “systems”) OR “LMS” OR “KMS”). The criteria explained below have been identified in order to extract all the relevant literature and to eliminate the inclusion of publications which are not acceptable for mapping study.

Inclusion Criteria:

- Date of publication will not act as a barrier for inclusion
- Where several papers have reported the same study only the most recent paper will be included
- Relevant technical papers will be accepted if publicly accessible
- Publications on quality assessment on KMS as well as e-learning environments will be included

Exclusion Criteria:

- Publications will be excluded if the main focus is not related to the research questions

- Other articles such as unpublished reports, letters and editorials, prefaces, article summaries, interviews, news, reviews, correspondence, discussions, comments, readers' letters and summaries of tutorials, workshops, panels and poster sessions will be excluded
- Papers written in languages other than English will be excluded

List of publications included for this initial mapping study is given in Appendix A.

Initial search carried out based on title, abstract and key words include the number of publications mentioned in Table 1. By considering the subject areas in the digital libraries, a large amount of publications (28552) collected were further refined. Finally by reading titles, keywords and abstracts, 275 publications selected for this initial mapping study include Science Direct (35), EBSCOhost (31), ACM (36), ISI (105) and Springer Link (68). For this stage, as a pilot study, 175 publications were selected for categorization of publications which is explained in the next section. There are over 100 more publications from ISI Web of Science to be included at a later stage of this ongoing research.

Table 01 Publications Returned and Included for Categorization

	SD	EB	ACM	ISI	SL	Total
Publications returned	16379	9452	1667	984	70	28552
Publications included	35	31	36	105	68	275

Acronyms: SD:Science Direct, EB: EBSCOhost, ACM: Association of Computing Machine, ISI: ISI Web of Science, SL: Springer Link

(ii) Definition of The Classification Scheme:

The publications retrieved under the search terms were further analysed to categorize the topics which are being investigated by the researchers in the existing research. The main purpose of this categorization is mapping the collected publications related to Knowledge Management and e-learning systems. Publications were classified into eleven different categories. These categories were established iteratively. The criterion, properties of each category and number of publications under each category are given in Table 2.

Table 2: Categories of Publications and Properties

Category	Properties	Publications	Total
1. Guidelines for design and implementation	Standards, frameworks for development, implementation stages, educational methods, fitness for purpose, application features, lessons learned, knowledge management strategies, challenges in knowledge sharing, needs analysis, frameworks for training, weaknesses and critical success factors	[1-56]	56 (32.0%)
2. Conceptual framework	KM concepts, learner retention, KM in information systems and modelling of learners	[57-62]	6 (3.4%)
3.Quality aspects	Quality assurance, quality dimensions and best practices	[63-66]	4 (2.3%)
4.Theoretical background	users' acceptance and role of IT	[67-68]	2 (1.1%)
5.Ontology based applications	Procedures for integration, social networks, skills assessment, conceptualisation of performance and learning objects metadata	[69-77]	9 (5.1%)
6.Architectural model	Personalization, performance analysis, learning activity systems, interdisciplinary and integrative frameworks, intelligent tutoring, collaborative learning, context aware models, generic content models, blended learning and graphical based systems	[78-109]	32 (18.3%)
7. Evaluation	Success factors, perceptions outcomes, motivators, pedagogical strategies and usability	[110-122]	13 (7.4%)
8. Case study	facilitating collaborative learning, application features and KM strategies	[123-134]	12 (6.9%)
9. Technology or tool	Customization, social navigation, mobile learning, digital video, executing experimental activities, authoring, deployment and evaluation , content reusability and automated sequencing, application of mining and fuzzy techniques, usage of multi agent system and open	[135-166]	32 (18.3%)

	source systems and implications of collaborative and peer learning		
10. Literature survey	Systematic literature review , mapping studies and literature review	No publications	0 (0.0%)
11. Assessing learning effectiveness	behaviour analysis, online persistence, students' perceptions , learners' satisfaction , students' motivation, students' evaluation, disseminative capacity and students' experience	[167-175]	9 (5.1%)
Total			175(100.0%)

(iii) Mapping of Publications:

The publications selected for this initial mapping (given in Appendix A) were grouped under 11 categories identified in stage (ii). Based on title, abstract and keywords; main focus of the publication was identified and a short description on why the publication was accepted for each category was written for each publication. Publications which can be categorized under more than one category were considered only under the most relevant category identified by reading the abstract.

The mapping here gave a wide overview of research on KMS and e-learning. From the results in Table 2, it is evident that most of the research are carried out on guidelines for design and implementation (56), architectural model (32) and technology or tool (32). Out of these 56 publications under guidelines for design and implementation include 7 publications on standardization of KM and e-learning. There are 12 publications on frameworks for development of Learning Management Systems, Knowledge Management Systems and e-learning systems. Application features in various sectors such as in health, maritime, military, and education for different target groups is explained in eight publications. The publications under architectural model (32) include models for personalization, performance analysis, learning activity systems, interdisciplinary and integrative frameworks, intelligent tutoring, collaborative learning, context aware models, generic content models and blended learning. Properties of publications under the criteria technology or tool (32) are customization, social navigation, mobile learning, digital video, executing experimental activities, authoring, deployment and evaluation, content reusability and automated sequencing, application of mining and fuzzy techniques, usage of multi agent systems and open source systems, implications of collaborative and peer learning.

The number of publications under the categories conceptual framework (6), quality aspects (4), theoretical background (2) ontology based applications (9), evaluation (13), case study (12), assessing learning effectiveness (9) and literature survey (0) gave an indication on lack of research on these areas. Since the main objective of our research is devising a quality assessment framework, category number three (quality aspects), seven (evaluation), and eleven (assessing learning effectiveness) in our categorization are the baseline for our Systematic Literature Review (SLR). The publications under quality aspects (4) focus on quality assurance, quality dimensions and best practices. Properties considered under the category named as evaluation (13) are success factors, perceptions, outcomes, motivators, pedagogical strategies and usability. In categorizing publications under assessing learning effectiveness (9) the properties considered include behaviour analysis, online persistence, students’ perceptions, learners' satisfaction, students’ motivation, students' evaluation, disseminative capacity and students' experience.

Conclusion

The mapping study shows that there is a significant lack of research, particularly on the learning effectiveness and the KMS software quality. This justifies the need for further research on these key aspects of the KMS and e-learning environments. These findings will be used as a baseline for other research questions in the Systematic Literature Review (SLR), an empirical study and eventually in the formulation and development of the quality assessment framework for a KMS software.

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Appendix A

List of publications selected for initial Mapping study

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Using Self-Organizing Maps for Sentiment Analysis

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Abstract

Web 2.0 services have enabled people to express their opinions, experience and feelings in the form of user-generated content. Sentiment analysis or opinion mining involves identifying, classifying and aggregating opinions as per their positive or negative polarity. This paper investigates the efficacy of different implementations of Self-Organizing Maps (SOM) for sentiment based visualization and classification of online reviews. Specifically, this paper implements the SOM algorithm for both supervised and unsupervised learning from text documents. The unsupervised SOM algorithm is implemented for sentiment based visualization and classification tasks. For supervised sentiment analysis, a competitive learning algorithm known as Learning Vector Quantization is used. Both algorithms are also compared with their respective multi-pass implementations where a quick rough ordering pass is followed by a fine tuning pass. The experimental results on the online movie review data set show that SOMs are well suited for sentiment based classification and sentiment polarity visualization.

Keywords

sentiment analysis, self-organizing map, machine learning, text mining

Introduction

With the ever-growing popularity of Web 2.0 platforms and services, the Internet has emerged as a common medium to write reviews and share opinions for any product consumed or service received by users. Sentiment analysis, also known as opinion mining, attempts to address the problem of classifying opinionated texts (e.g. product reviews) according to their opinion polarity (positive or negative) (Pang et al, 2008). The sentiment based classification of online opinionated texts imposes several challenges which distinguishes it from topic based text classification. The variability and complexity of sentiment expressions, overlapping vocabularies, feature selection and domain dependency of sentiment features are the key issues in sentiment analysis (He et al, 2011; Bai, 2011).

This paper investigates the efficacy of Self-Organizing Maps (SOM) for sentiment based visualization and classification of online product reviews. SOM can transform high-dimensional data into two-dimensional representation and can enable automatic clustering of text documents, while preserving higher order topology. Specifically, this paper implements the unsupervised SOM algorithm to support sentiment based visualization and classification tasks. For supervised sentiment analysis, a competitive learning algorithm known as Learning Vector Quantization (LVQ) is used in this work. Both algorithms are also compared with their respective multi-pass implementations. The movie reviews dataset (Pang and Lee 2004) is used to evaluate performance of these different SOM implementations.

The rest of this paper is organized as follows: next Section presents related work on sentiment analysis, the methodology based on supervised and unsupervised SOM is described in the Section named methodology, the experimental result Section discusses our results, and the last Section concludes the paper.

Related Work

There have been a considerable number of studies on sentiment analysis and opinion mining, most of which utilize machine learning, dictionary, statistical, and semantic based approaches. Supervised machine learning classifiers like Naïve Bayes, Support Vector Machine, Maximum Entropy, Decision Tree, Centroid classifier, K-nearest neighbor, Neural Networks, winnow classifier etc., are quite popular for sentiment based classification of online reviews (Sharma et al, 2012a, 2012b; Pang et al, 2002, 2004; Tan et al, 2008).

Dictionaries of subjective words with some weighting schemes are also proposed in some studies to quantify polarities of sentiment expressing words in texts for sentiment analysis (Amati et al, 2008). Statistical approached apply statistics like Pointwise Mutual Information (PMI) based on co-occurrence of words to derive sentiment polarity of features (Turney, 2002). The Semantic approach exploits various semantic relationships between sentiment words like synonyms and antonyms, to calculate sentiment polarities for mining and summarizing customer reviews (Hu, 2004).

The machine learning approaches that belong to supervised text classification techniques have shown good accuracy. But, the performance of machine learning approaches is heavily dependent on the selected features, the quality and quantity of training data and the domain of the data. The additional learning time required by the machine learning techniques is also a prominent issue since lexicon or semantic approaches take less time.

The Naïve Bayes classifier is a probabilistic classifier based on Bayes' theorem with strong feature independence assumptions. In real life, the sentiment features are seldom independent (Pang, 2002), severely limiting its applicability. The complexity of SVM due to its convoluted training and categorizing algorithms is a major drawback. The over-fitting issues with small training sets also limits the use of SVMs in many real world applications. The k-nearest neighbor (k-NN) classifier is easy to implement but becomes computationally intensive with growing size of the training set (Han et al, 1999). The decision tree and rule induction classifiers are simple to understand and explain but their performance suffer when the number of distinguishing features is large (Quinlan, 1993).

To address the above issues, this paper implements both supervised and unsupervised SOM based approaches for sentiment based classification and compares their performances in the same domain. The findings will help gaining insight into the strengths and limitations of different SOM implementations for sentiment analysis.

Methodology

Data Pre-processing

The data pre-processing involves collecting opinionated text documents, performing initial data cleaning and transforming relevant text data into the input variables form as needed by self-organizing maps. In this study we have performed tokenization, stemming and stop word removal in data pre-processing. We have used Vector Space Model (VSM) to generate the bag of words representation for each document. In VSM, the weights represent the *tf·idf* score which is computed from term frequency (*tf*) and inverse document frequency (*idf*). The *tf·idf* weight for term *j* in document D_i is computed as

$$t_{ij} = tf_{ij} \times idf_j = \log(1 + f_{ij}) \times \log(\frac{n}{df_j}) \qquad (1)$$

Where f_{ij} is frequency of term *j* in document *I* and df_j is number of document having term *j*.

Information Gain Feature Selection

Information gain (IG) as a feature goodness criterion has shown consistent performance for sentiment-feature selection (Tan et al, 2008). A feature from large feature space is selected based on its impact on decreasing the overall entropy. Entropy is the expected information needed to classify an instance document. The attributes ranked as per high to low IG score will minimize the overall information necessary to classify instances into predefined classes. The information gain of a feature *j* over all classes is given by:

$$IG(j) = -\sum_{i=1}^{|C|} P(c_i)\log_2 P(c_i) + P(j)\sum_{i=1}^{|C|} P(c_i \mid j)\log_2 P(c_i \mid j) + P(\bar{j})\sum_{i=1}^{|C|} P(c_i \mid \bar{j})\log_2 P(c_i \mid \bar{j})$$

(2)

Where, $P(c_i)$ is the probability that a random instance document belongs to class c_i. $P(j)$ is the probability of the occurrence of the feature *j* in a randomly selected document. $P(c_i|j)$ is the probability that a randomly selected document belongs to class c_i if document has feature *j*. $P(\bar{j})$ is the probability of that *j* does not appear in a random document. $P(c_i \mid \bar{j})$ is the probability that a random document belongs to class *c* if *j* does not occur in it. The top ranked features are selected based upon information gain feature selection in this study.

Self-Organizing Maps (SOM)

The self-organizing map (SOM) is an unsupervised competitive ANN based on the winner-takes-all (WTA) principle (Kohonen, 1995). A typical SOM is made up of a vector of nodes for input (input neurons layer), an array of nodes as output map, and a matrix of connections between each output layer unit and all the input layer units. The input nodes receive vectorized input data patterns and propagate them to a set of output nodes, which are arranged according to map topology (generally two-dimensional grid) forming so called Kohonen's layer. Kohonen's principle of topographic map formation, determines how the spatial location of an output node in the topographic map corresponds to a particular feature of the input data pattern (Merkl, 1998).

Each of the output nodes j is associated with a weight vector w_j of the same dimension as the input data vectors and a position in the map space. The popular arrangement of output nodes is a regular spacing in a hexagonal or rectangular grid. The procedure for placing a vector from input data space onto the map is to first find the node with the spatially closest weight vector to the input data space vector. Once the closest node is located it is assigned the values from the vector taken from the data space. For Sentiment based classification, each vector represents an online review document, while the output node represents the sentiment category that the review is classified to.

The SOM learns through self organization of random nodes whose weights are associated to the layers of neurons. These weights are updated at every epoch during the training process. The change in weights depends upon the similarity or spatial closeness between the input data pattern and the map pattern (Michalski et al, 1999).

Let $x_i \in \mathbb{R}^M$, $1 \leq i \leq N$, be the randomly chosen training feature vector representing document i in the corpus, where M is the number of indexed features and N is the number of documents in input dataset. These vectors are used to train the map which consists of a regular spacing grid of processing units called neurons. Each neuron in the map has M connections (synapses). The synaptic weight vector w_j is associated with the jth neuron in the map having J neurons where, $w_j = \{w_{jm} | 1 \leq m \leq M\}$, $1 \leq j \leq J$. The SOM learning algorithm used in this paper includes the following steps:

Step 1. Initialize weights of neurons in map.

Step 2. Randomly select a training vector x_i from the corpus.

Step 3. Determine the neuron c, having the highest activity level with respect to x_i.

The activity level of a neuron is represented by the Euclidean distance between the input pattern and that neuron's weight vector. The neuron having the highest activity level is referred as best matching unit (BMU). Hence, the selection of BMU may be written as:

$$c: \| x_i(t) - w_c(t) \| = \min_j (\| x_i(t) - w_j(t) \|) \qquad (3)$$

The operator $\| \cdot \|$ denotes Euclidean vector norm as the neuron j with synaptic weights w_j is closest to x_i. The discrete time notation t denotes the current training iteration.

Step 4. Update the synaptic weights of the BMU and its neighbors in order to move the BMU closer to the input vector.

The map adapts to the input pattern in all iterations of learning, and adaption is performed as a gradual reduction of the spatial distance between the input vector and BMU's weight vector. The learning rate parameter $\alpha(t)$ controls the amount of adaptation that gradually decreases during the course of training.

A neighborhood kernel function is used to determine the spatial range of neurons around the BMU that are subject to adaptation. Based upon the spatial distance between BMU and neighboring neurons, the neighborhood function determines the width of the adaptation kernel. This ensures that neurons spatially close to the BMU are adapted more strongly than neurons further away. A Gaussian function (Eq. (4)) can serve as the neighborhood function with r_i representing the two-dimensional vector pointing to the location of neuron j within the map, and $\| r_j - r_c \|$ denoting the distance between neuron j and BMU (i.e., c) in terms of the output space.

$$h_{c(x_i),j} = e^{-\| r_j - r_c \|^2 / 2\sigma^2(t)} \qquad (4)$$

The time-varying parameter σ guides spatial width of adaptation in such a way that a wide area of the output space is subject to adaptation at the beginning of training. The number of neighboring neurons affected by adaptation is reduced gradually during the training process. The learning rule for any output neuron j can be represented as

$$w_j(t+1) = w_j(t) + \alpha(t) h_{c(x_i),j}(t) \cdot \left[x_i(t) - w_j(t) \right] \qquad (5)$$

Step 5. Increase time stamp *t* representing training iteration. If t reaches the preset maximum training time *T*, stop the training process; otherwise decrease $\alpha(t)$ ($0< \alpha(t) <1$), and the neighborhood size, and go to Step 2.

The current study has implemented SOM algorithm as a baseline model and its multi-pass implementation for sentiment analysis. The multi-pass SOM is recommended for better results where two passes are executed on the same underlying model. The first pass is executed as a rough ordering pass with large neighborhood, learning rate and small training time. The second pass is performed as the fine tuning pass that has a longer training time, small initial neighborhood and smaller initial learning rate (Kohonen et al, 1996).

SOM have two advantages over other clustering methods: non-linear projection of the input space and cluster topology preservation. Thus, SOM can extract inherent non-linear relationships amongst documents, and similar clusters of documents are mapped close to each other revealing higher level (i.e. emergent structures) (Ultsch et al, 2005). In Emergent Self Organizing Maps (ESOM) the cluster boundaries are ‘indistinct’, the degree of separation between ‘regions’ of the map (i.e. clusters) being depicted by ‘gradients’ (Ultsch et al, 2005). These attractive features of SOM have prompted researchers to use SOM for text clustering and visualization (Yen et al, 2008; Feng et al, 2010; Dey, 2010).

Learning Vector Quantization (LVQ)

The Learning Vector Quantization (LVQ) algorithm is the supervised version of the Kohonen’s SOM model designed for pattern classification tasks (Kohonen, 1995). The application of the LVQ algorithm to sentiment classification of user generated text has not been explored so far.

The LVQ algorithm is based on neural competitive learning, which enables defining a group of class labels on the input data space using reinforced learning. LVQ also transforms high dimensional input data into a two-dimensional map like SOM, but without taking into consideration the topology of input data. For this transformation, LVQ utilizes pre assigned class labels to documents, thus minimizing the average expected misclassification probability. Hence, unlike the SOM, where clusters are generated by unsupervised manner based on feature-vector similarities, the LVQ categories are predefined.

LVQ is a single-layer network where, the number of output neurons is equal to number of predefined classes (e.g., J=2 for binary sentiment classification). The weight vectors associated with each output neuron are called codebook vectors. Each class of input space is represented by its own set of codebook vectors and one codebook vector per class is used for classification. Any output neuron j, whose weight vector matches the input pattern x_i as per a spatial distance definition is the winning unit (BMU), and its weights are updated during training (Goren-Bar et al, 2005).

The LVQ algorithm is a competitive one, as for each input training vector output neurons compete among themselves in order to find the BMU as per Euclidean distance. The LVQ learning rule modifies weights of only the BMU, as it has the smallest Euclidean distance with regard to the input vector. The LVQ algorithm implemented in this paper includes the following steps:

Step 1. Initialize the codebook vectors w_i.

Step 2. Randomly select a training vector x_i from the corpus.

Step 3. Determine the BMU (winner unit) closest to the input vector. The codebook vector w_c associated with BMU has the smallest Euclidean distance with regard to the input vector x_i.

$$c: \| x_i(t) - w_c(t) \| = \min_j (\| x_i(t) - w_j(t) \|) \qquad (6)$$

Step 4. Update the synaptic weights of the BMU.

For correction classification (i.e. if codebook vector w_c and input vector x_i belong to the same class)

$$w_j(t+1) = w_j(t) + \alpha(t)\left[x_i(t) - w_j(t) \right] \qquad (7)$$

For incorrect classification (i.e. if codebook vector w_c and input vector x_i belong to different class)

$$w_j(t+1) = w_j(t) - \alpha(t)\left[x_i(t) - w_j(t) \right] \qquad (8)$$

Step 5. Increase time stamp t representing training iteration and reduce the learning rate α. Repeat from step 2 until the neural network is stabilized or until a fixed number of iterations have been carried out.

The current study has implemented LVQ1 with single BMU selection, Optimized LVQ1 (OLVQ1) with separate learning rate for each codebook vector and Multi-Pass LVQ. Multi-Pass LVQ implements two passes where, a quick rough pass is made on the model using OLVQ1, then a long fine tuning pass is made on the model with LVQ1 (Kohonen, 1990).

Experimental Evaluation

Datasets and Performance Evaluations

To evaluate the performance of SOM and LVQ for sentiment classification, this paper experiments with a data set of classified movie reviews (Pang and Lee, 2004). The data set contains 1,000 positive and 1,000 negative reviews and is a benchmark dataset for sentiment analysis tasks. This work has adopted classification accuracy, precision, recall and $F1$ Score to evaluate the performance of sentiment classification.

Experimental Results

We attempted to test the effectiveness of ESOM in visualizing sentiment polarity in classified movie reviews data set. Input features were selected using Information Gain criteria, and experiments were conducted with 50 to 1000 selected features.

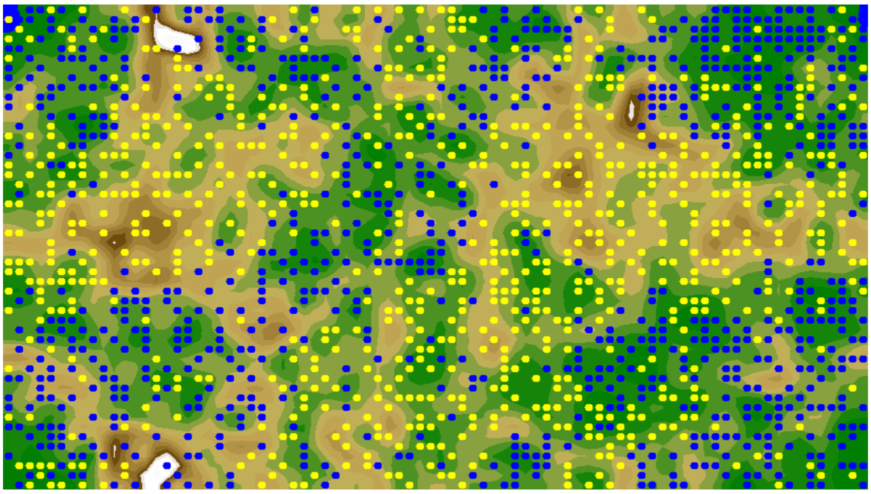
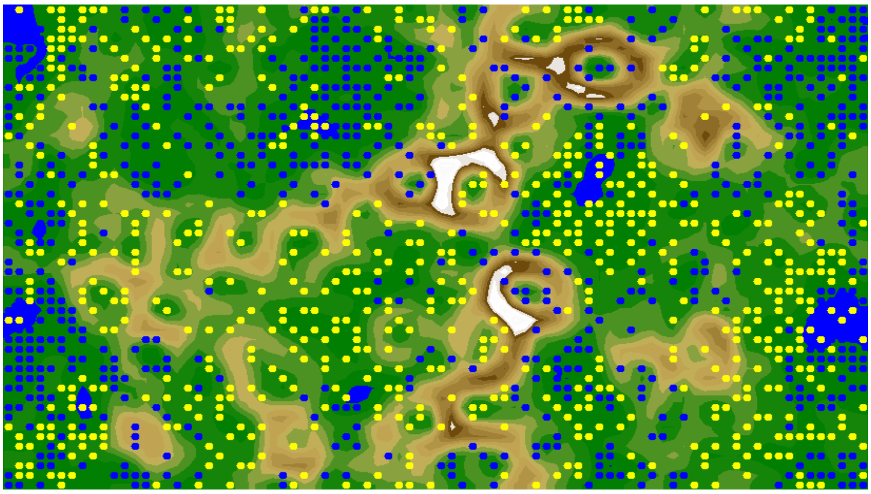


Fig. 1. ESOM of Vectors with 100 Features



Fig, 2. ESOM of Vectors with 700 Features

The resulting visualization maps for 100 and 700 features are shown in Figures 1 and 2 respectively. In the maps, the *Blue* dots represent positive polarity and *Yellow* dots represent negative polarity reviews (as classed in the movie reviews dataset). It can be observed from Figures 1 and 2 that SOMs are able to distinguish between reviews with positive and negative sentiment in the form of clusters. It is also seen that more distinct and well separated clusters are formed when vectors with 700 features are used to represent the reviews.

Java based implementations on Microsoft Windows platform were used to implement all the versions of SOM and LVQ algorithms. The number of indexed terms N to be used in input document vector was selected from 50 to 1000. All the algorithms were experimented with taking random training data, proportional initialization mode with linear decay learning function. For SOM, this paper has used Gaussian function as the neighborhood function with neighborhood size 8 for a hexagonal map topology as suggested in (Kohonen, 1995). The learning rate, α was selected 0.3 for SOM, LVQ1, OLVQ1 and for the first pass of multi-pass SOM and multi-pass LVQ. For second pass, the learning rate was kept as small as 0.05. The number of iteration was varied from 1000 to 10000 to obtain a training map. All experiments were validated using 10-fold cross validation.

Figures 3, 4, 5, and 6 shows comparison of both SOM and LVQ implementations on accuracy, precision, recall, and $F1$ score of sentiment based classification on movie reviews dataset. The Multi-Pass LVQ performed best among all algorithms with 89.1% overall accuracy. The (classic Kohonen's) SOM was the worst performer among all.

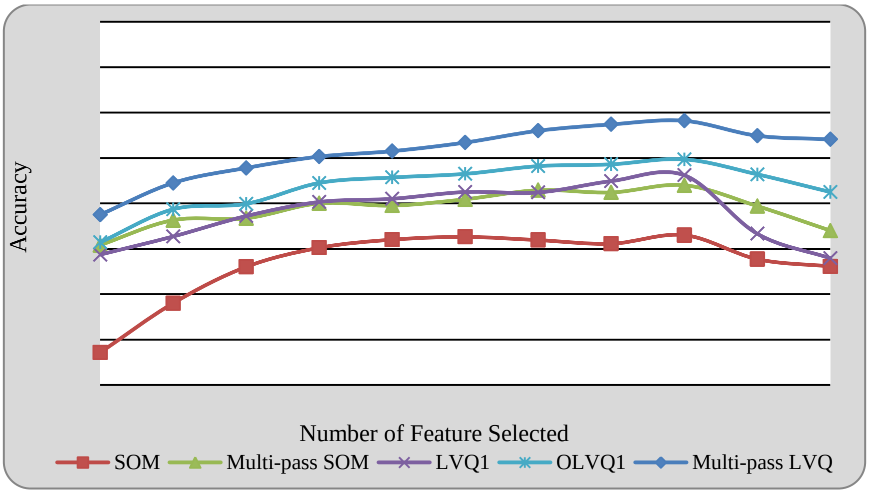


Fig. 3. Performance Comparison on Accuracy

Almost all implementations of SOM and LVQ the best performances were obtained for 700-800 selected features. These results are consistent with previous studies related to sentiment analysis, as a few sentiment bearing features can express enough polarity for the whole document to be classified (Turney, 2002). Degradation in the performance of sentiment based classification can be seen beyond 900 features as the feature matrix becomes sparse, affecting the organization of maps. The same algorithms with larger number of features (i.e. 2000 to 10000) were also executed in this study and it was observed that performance of the classifier degraded significantly due to high dimensionality of the input space.

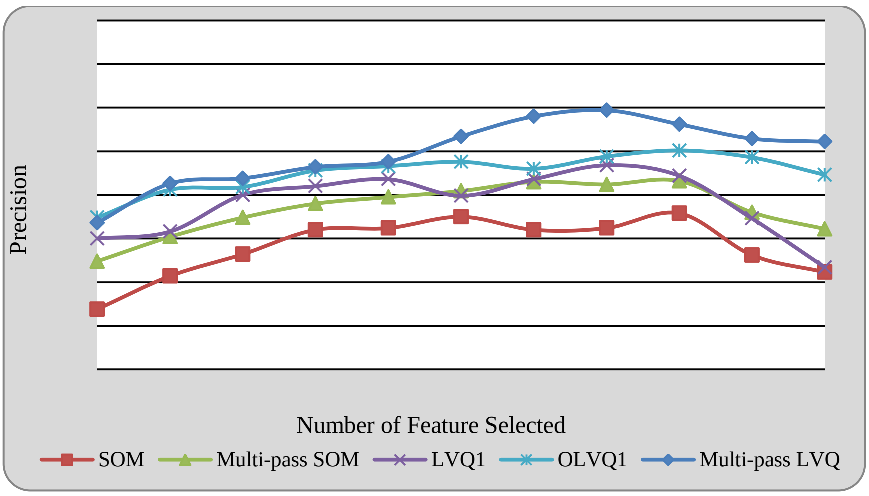


Fig. 4. Performance Comparison on Precision

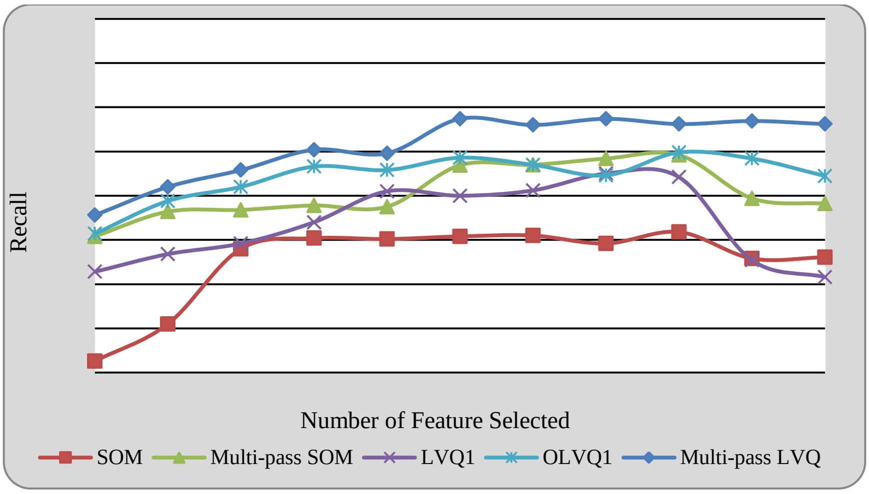


Fig. 5. Performance Comparison on Recall

As such, with respect to learning methods, LVQ and SOM are all suitable for sentiment analysis as their best performance results are comparable with other studies using other machine learning classifiers (Pang et al, 2004) and other unsupervised learning methods (Turney, 2002). The time and computation resources sacrificed to execute the two passes in multi-pass implementations are justified as they have shown better performance as compared to their respective single-pass implementations. The OLVQ1 has worked well with 84.9% best overall accuracy, which has ranked it as the second best algorithm among all in this study. Though this study did not compare the execution time of all the algorithms but it is worth noting that OLVQ1 was the quickest among all in convergence.

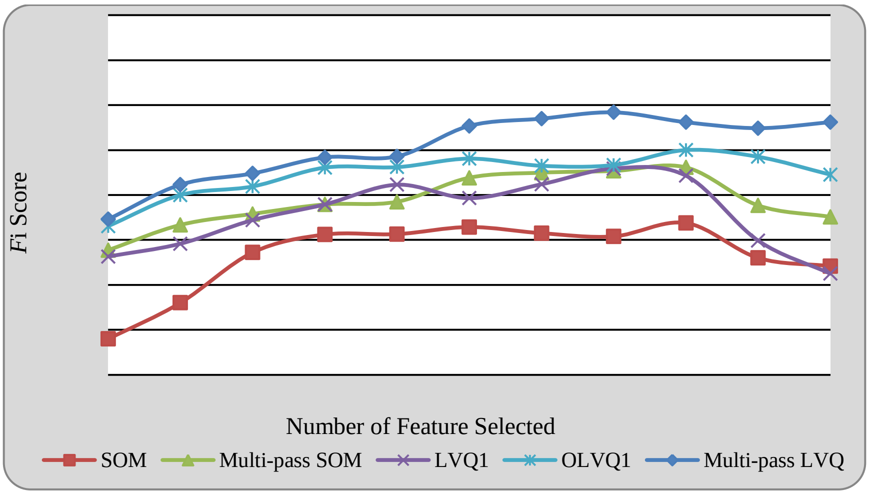


Fig. 6. Performance Comparison on *F*1 Score

Conclusion

This paper proposes a sentiment classification model using SOM and LVQ algorithms. Specifically, this paper investigates performance of different implementations of SOM for sentiment based visualization and classification of online product reviews. The supervised learning algorithms (LVQ, OLVQ1, and Multi-pass LVQ) have been found to perform better than unsupervised learning algorithm for sentiment analysis purpose. Experiments have been performed to support sentiment based visualization and classification tasks. Both SOM and LVQ algorithms have also been compared with multi-pass implementations, which performed better than their respective single-pass implementations. The experimental results on the online movie review data set show that SOMs are well suited for sentiment based classification and sentiment polarity visualization.

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What Have we Learned so Far? The Development and Application of an Organisational Learning Narratives

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Abstract

The use of narratives and stories has been growing in popularity in the field of knowledge management. Narratives may be used as useful vehicles for several knowledge-based activities within organisational (and other) contexts. These include acquiring and sharing knowledge in the form of personal experiences; the storage of explicit knowledge; and significantly, the development of personal knowledge and understanding through the use of narratives for sense making. This paper presents research into the development and application of a method for the construction of an adapted 'learning narrative': an organisational narrative developed for the specific purpose of sharing experiential knowledge. The paper presents a rationale for the use of narratives within knowledge management; details a methodological approach for the development of learning narratives; and highlights a number of benefits of the use of learning narratives, notably their use in sustaining and enhancing the quality of project-based work.

Keywords

narrative approaches; sensemaking; knowledge sharing; learning.

Introduction

This paper presents methodological approach developed and utilised within a research project, the aim of which was to develop and apply an adapted form of learning narrative within the context of a case study organisation, a multi-national energy company. The purpose of developing this technique was to explore the potential for the application of such a tool both by researchers seeking to apply narrative techniques for data capture, analysis and presentation, and by practitioners in the field of action research who may benefit through the use of a novel method of structuring and sharing knowledge.

The role of narratives in knowledge management

Over the last ten years or so, there has been a growing body of work examining the relationships and importance of narratives and knowledge management. Work in this area acknowledges the importance of enabling individuals to share knowledge in the form of narratives, and also the role of narratives as sense making tools for complex contexts (e.g. Denning, 2000; Boje, 2001; Snowden, 2001; Friedman and Prusak, 2008). The reason for this interest may be closely related to the move from highly technological to more socially embedded knowledge-based perspectives and practices, as Lang suggests 'the social construction of knowledge occurs largely through narrative' (2001, p.55). In addition to this, narratives present an important opportunity for generative learning within organisations '…where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together' (Senge, 1990, p.13). Clearly, narratives are key tools for supporting knowledge-based activities (notably knowledge sharing). However, a critical issue which this research seeks to acknowledge (which had to date not been considered in detail in the knowledge management canon of research) is, how can multiple perspectives be unified within a narrative context? This research suggests that one such method may be to construct learning narratives by adapting the learning history methodology.

The Learning History

Introduction

The learning history genre of narrative research was originally developed in the 1990s (Amidon, 2007). Roth (2000. p.71) defines it thus: 'Learning Histories are typically 50 to 100 pages long, providing a jointly told, retrospective account of significant events in an organisation's recent past'.

The aim of learning histories is to use first hand stories (told by participants and accompanied by researcher commentary) to document past experiences in order to inform the future direction of the organisation. A key element in their use is that no one person or group of people dominates the telling of the story: all views are assessed on their own merit for inclusion in the learning history (Kleiner & Roth, 1996), and thus present a valuable opportunity to unify multiple perspectives placing the voice of the participants on centre stage.

Methodology

The learning history methodology has evolved with the number of steps varying between four (Bradbury & Mainemelis, 2011) and nine (Roth, 2000). In his analysis of twelve learning histories Amidon (2008, p.465) identifies six common steps (discussed in more detail below):

- Stage 1: Planning
- Stage 2: Data collection
- Stage 3: Data distillation
- Stage 4: Validation
- Stage 5: Revision
- Stage 6: Dissemination

Presentation

Of the twelve learning histories analysed by Amidon (2007) seven used the presentation format of the 'jointly-told tales in multiple narratives' described by Roth (1996, p.16). The core of this format is a two-column section. In the right hand column the verbatim comments of participants are listed, along with some indication of their identity. Andrews (2007) writes about the dilemmas faced when deciding on the use or non-use of real names, and the external constraints that may limit the choice. Where possible comments by different participants are shown, allowing either support of a statement or contradiction. The left hand column contains comments made by the researcher relating to the participant content. This can include items such as questions posed, clarifications, interpretation, generalizations and context (Roth, 1996). Full width text may be used at certain points in the learning history, particularly to provide introductory and/or concluding statements to each section of two column text. The learning history genre does not prescribe the format, but the two columns encourage readers to view the information presented in new ways (Roth, 1996). Amidon (2007) points out that all but one of the twelve learning histories examined include a section that describes the purpose and use of a learning history for readers who may be unfamiliar with the format. An example of this is the statement by Househower (1999, p. v): ‘The learning history is designed to spark constructive conversation by presenting first-hand interview and review comments on the same page and in two columns’.

Methodology in practice

Planning

The activities in this stage were shared between the researchers and employees of the client. The researchers had four tasks:

1. To conduct a review of the literature. This revealed background information on learning histories but surprisingly little about how to actually conduct one (although a field manual written by Kleiner & Roth (1996) was subsequently discovered in the online archives of the Massachusetts Institute of Technology).
2. To create a Gantt chart to fit the study steps into the time available.
3. To obtain resources required in order to perform the participant interviews, in particular recording devices and the availability of a transcription service to create a written record of the interviews.
4. To devise interview questions. These had to be rather general due to the lack of background information provided by the client on their project (and in fact were little used during the interviews).

The main planning tasks undertaken by client’s employees were:

1. To identify suitable interviewees.
2. To arrange times for them to be available for interview.
3. To organise venues for the interviews to take place.

Data collection

The data presented in the learning narrative was collected through interviews with client employees who had a significant involvement with the project. Nine employees were interviewed: four face-to-face, three by videoconference, and two by telephone. Seven of the participants were in the UK at the time of their interview, one in the USA, and one in Azerbaijan.

Data distillation

Grounded theory (Corbin & Strauss, 2008) was used to convert the data into the final participant text, with open and axial coding employed to produce the final product. While the actual process of distilling the data was iterative and non-linear, six discrete steps were identified:

1. Examine each transcript to identify and note the main themes raised by participants. Themes common to multiple participants were of particular interest
2. Refine the identified themes to a suitable number, combining sub-themes into a higher level one where necessary; a total of six high level themes were identified and used as chapter headings in the learning narrative. Sub-themes were used in step 6 to assist in deciding on the order of extracts.
3. Mark passages in each transcript to show where a theme has been used, noting that a passage may contain more than one theme.
4. Copy relevant passages into a separate document for each theme, retaining identification of the interviewee. If appropriate also include questions asked by the researcher.
5. Re-examine the raw text in the thematic documents to identify the key parts relating to the theme, and extract these to separate documents.
6. Put the extracts into a suitable order in the right hand column, where possible ending on a positive note.

Once the participant data was placed into the learning narrative format, researcher comments were added in the left hand column at appropriate points. An introductory statement was produced for each chapter. As explained below, the standard presentation format was extended to address client requirements. It should be noted that Kleiner & Roth (1996, p. 1-10) list “Writing: production of a transitional object” as a separate methodological step between Distillation and Validation, although Amidon (2008) includes writing as part of the distillation process.

Validation

Generally a two part process (Roth & Kleiner, 1998), individual contributions were returned to the participants to allow them to confirm what had been written was indeed what they said, and to correct any errors. Secondly, representatives of the organisation reviewed a draft of the document.

Revision

Following the validation stage, the researchers made appropriate changes arising from the reviews, and repeated the second part of the validation to ensure the amendments were now correct.

Dissemination

The conduct of this step was determined largely by the commissioning organisation, as it had the infrastructure to make the learning narrative available, and made the decision as to who the audience would be. This stage was discussed with the client and it was decided that the learning narrative would initially be distributed via email to the participants, and made available to other relevant groups of employees via the company's intranet.

Extension of the Standard Presentation

The two column jointly-told tale format was extended to include a third column to the right of the participant narrative. This was used to place a marker indicating that the participant text alongside it contained a 'learning point'. The specific text was underlined to show its location. The inclusion of learning points within the learning narrative makes an explicit link to existing knowledge management processes, and seeks to continually improve the ongoing quality of the project by avoiding previously encountered problems, and recognising potential solutions. Garon (2006, p.103) suggests that 'Lessons learned (LLs) are a key element of knowledge management.' However, before lessons may be learned they must be identified. Learning points are parts of the learning narrative text which identify key areas for learning within the project's history. The learning points identified in the document were indicative rather than exhaustive, and readers were encouraged to add their own as appropriate.

Results

Themes/chapter headings

The first two steps in the data distillation process resulted in the identification of six major themes, which were used as chapter headings in the learning history. Each of these themes was derived from the contributions of at least five participants, demonstrating their commonality across a range of job roles. The six themes and the chapter contents are listed in Table 1.

Table 10. Major themes

Theme	Content description
Standardisation	▪ Underlying need for the programme is the drive for global standardisation ▪ Examine origins of standardisation and efforts to define standards and the behavioural changes needed to meet them ▪ Business issues posed by standardisation and implementation concerns ▪ Benefits already seen and expected from standardisation
Change	▪ Historical perspective on the programme ▪ Analysis of need for business change ▪ Project team and business co-operative working ▪ Issues caused by change and opportunities arising
Leadership	▪ Events leading to leadership support ▪ Efforts made to ensure leadership remains throughout the life of the programme ▪ Problems caused by weak leadership ▪ Benefits of leadership engagement
Sharing	▪ Early recognition of the need to share ▪ Encouragement of collaborative effort ▪ Challenges and benefits of co-operation ▪ Review training requirements, successes and failures
Resourcing	▪ Problems in obtaining resources and managing their utilisation ▪ Impact of the programme on business resources
Deployment	▪ Examples of completed deployments and support methodologies developed ▪ Challenges in understanding deployment ▪ Help provided to business to make deployment easier ▪ Post-implementation issues and recommendations for approaches for technical and business support

Contributions

Each participant contributed to at least three of the themes, with several contributing to all six. The total number of passages of text selected for inclusion in the learning history was 145. A summary of the breakdown of contributions is shown in Table 2.

Major theme / **Participant**	**Standardisation**	**Change**	**Leadership**	**Sharing**	**Resourcing**	**Deployment**	**Total contributions**	**No. of themes**
1	4	9	-	3	1		17	4
2	4	1	4	-	-	2	11	4
3	6	2	-	3	2	9	22	5
4	1	1	4	11	1	3	21	6
5	2	4	-	4	1	3	14	5
6	2	10	2	3	1	6	24	6
7	1	4	3	3	5	3	19	6
8	1	-	2	2	2	-	7	4
9	1	3	-	-	-	6	10	3
No. of contributions	22	34	15	29	13	32	**145**	
No. of contributors	9	8	5	7	7	7		

Table 11. Summary of contributions

Learning points

A total of 52 learning points were identified. Learning point numbers varied between the different chapters, perhaps indicating that the organisation's processes and procedures were less defined in those areas with more learning points. The numbers are shown in Table 3.

Chapter	Learning Points
Standardisation	7
Change	6
Leadership	6
Sharing	14
Resourcing	5
Deployment	14
Total	**52**

Table 12. Learning points

Discussion and Conclusion

This paper has described the methodological approach utilised in the development and application of an adapted form of learning history within the context of organisational knowledge management. It has shown how multiple perspectives may be unified into one narrative, and how the narrative may be further enriched for the purposes of sensemaking through the inclusion of learning points and additional researcher commentary. It is important to reflect on a number of factors in relation to the work.

Firstly, the positive aspects of the research are considered. The people selected by the client to take part in the study were all keen to talk about their involvement in the project and to recount stories that were meaningful to them. The data collected during the study provided stories of a high quality. One of the most challenging parts of the process was deciding what content to leave out; the final document could easily have been considerably longer.

Although distillation of the data was a time consuming task, use of grounded theory allowed steady progress to be made towards the production of the final document. The three column format of the learning narrative developed by the researchers allowed for the enhancement of the participants' stories, enriching the narrative, and further enabling its use as a 'live' document, to be developed as the project it focussed on progressed.

As well as these more positive aspects of the work, a number of issues were identified which should be acknowledged by future work in this area. Additional background information on the client's project would have greatly helped the researchers to understand what was required of the study, and made the interviewing more effective. Scheduling interviews was a critical issue in terms of the project timescale. Progress on later stages of the project was impacted upon due to a necessary extension of the interview stage. A possible way forward may be for the client to identify participants and in advance to advise them of a fixed period in which interviews could take place, and build an interview schedule from that information.

Technical issues were experienced during a number of the interviews. These included delays in starting video conferences and the late unavailability of video conference facilities. As all interviews were conducted at client premises these issues were out of the control of the researchers. Recording of the interviews conducted remotely was an additional challenge, due to the need to record the participant's voice from speakers. The ability to record directly would have improved the quality of the recording.

In relation to scope for future research, several opportunities are evident. Specifically within the context of this research, the development and application of a novel methodology may allow for a greater depth of understanding of specific contexts within the energy sectors, and further may be applicable into other areas of research. An expanded study with a larger group of interviewees could be conducted to build on the existing data set. Andrews (2008) discusses the benefits and pitfalls of secondary analysis of previously collected data, either by the original team or by new researchers. While there may be issues analysing data remotely from the context in which it was gathered, a fresh perspective may bring new insights. Reissman is quoted by Andrews (2008, p. 89): "I am not saying that my third reading is 'truer' than my first or second; they are, simply, different". The passage of time, and the events that happen during that period, allow data to be looked at in new and different ways. "I have argued that historical changes, as well as changes in our individual life circumstances, provide us with opportunities to see new layers of meaning in our data." (Andrews, 2008, p. 98). An alternative to transcribing the stories told in a study is to record the spoken words of participants in a narrative (or oral history) database (Snowden, 2004). This allows enquirers to build the elements of a story for themselves through searching by "archetypes, themes, intention, emotional level and perspective" (Snowden, 2004, p. 212).

As part of its Knowledge Management procedures the client has a database in which lessons learned are captured from each of its projects. An addition to the tasks performed in this study would be to incorporate the learning points noted into the database. This is something that would have to be done collaboratively between the researchers and the client. Each learning point would have to be assessed to determine the level at which it would be added to the database, as some lessons learned are deemed applicable at a local level while others are applied regionally or globally.

As a final comment, it should be noted that the client's project on which this narrative work was based is still ongoing. As such, future work will focus on how the learning narrative has been used to share understanding, and to improve the continuing quality of the project as a whole.

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