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Ken Grant
Ryerson University, Toronto, Canada

Introduction

This is my last editorial as the Editor of the Electronic Journal of Knowledge Management. It is been a pleasure and a privilege to be the Editor of the Journal for the last four years and I have enjoyed working with the authors in the knowledge management community and helping them present the results of their research. I am stepping down as the editor because I have taken on a new editorial responsibility at Academic Conferences and Publishing International to establish a new journal, the Electronic Journal of Innovative and Entrepreneurial Practice.

I am also pleased to announce that Dr John Dumay will be taking over as the new Editor. John is a respected researcher in the knowledge management and intellectual capital field and was previously an Associate Editor of the Electronic Journal of Knowledge Management. He will be sharing his views on the Journal's future direction in the next issue.

This issue has five interesting articles.

Two provide different perspectives on the links between business intelligence and knowledge management. William McHenry draws on a case history from the past, the work of the MOSAIC Group, to make recommendations for the future on how to integrate artifacts from business intelligence, content management, knowledge management and collaboration, through the use of a "Decision-ID".

Pamela Clavier examines the high failure rate in business intelligence projects and the challenges faced in achieving the expected benefits. She proposes the use of "goods and service dominant logic" to examine the “worldview” characteristics of business intelligence. Her theoretical discussion is supported by an interpretive case study within a corporate banking group in South Africa.

Thibaut Métailier examines the links between human resource management and knowledge management in the context of technological SMEs. While recognising that KM practices within SMEs are likely to be informal and not well documented, he found that the HRM processes set up by entrepreneurs do in fact demonstrate the adoption of implicit KM practices. Using Participatory Action Research, he interviewed 10 experienced entrepreneurial leaders of technology SMEs. The study provides an interesting perspective on the interaction of the and communities of practice within the SME, recognizing that, while the role of the entrepreneur is central, it is supported by distributed expertise following implicit KM processes established through HRM practices.

The article by Richard Evans, James Gao, Sara Mahdikah, Mourad Messaadia and David Baudr examines crowdsourcing knowledge solutions within the airspace industry. Specifically they look at microblogging activities that support the product development process. They present a conceptual framework for the capture of employee knowledge and describe a validation process using a focus group of key players within a major aerospace industry player. While the findings of both benefits and perceived challenges are preliminary, their work provides an excellent foundation on how crowdsourcing can play a role in knowledge development in high-tech organizations.

Neil David and John Topping suggest that most research on knowledge sharing has followed qualitative research methods and propose a quantitative experiment. After reviewing the literature on knowledge sharing, they add consideration of the concept of expertise as being a critical element of effective knowledge sharing. They establish 18 factors that could impact the intent to share knowledge along with two latent variables related to business expertise. From this, a theoretical model of knowledge sharing types was identified and a survey intended to test the model was developed and administered. Based on 103 responses, they found some interesting preliminary results worthy of further investigation.
These five articles illustrate the continued relevance of knowledge management in a wide range of settings. Four of them combine knowledge management theory with other important management research themes -- business intelligence, entrepreneurship and creativity and crowdsourcing -- illustrating how KM continues to be relevant with current thinking and challenges in business.

I wish my successor well in continuing to develop the Electronic Journal of Knowledge Management and keep it relevant both to the KM research community and the wider society.

Ken Grant
Editor
Linking Decision Artifacts: A Means for Integrating Business Intelligence and Knowledge Management

William McHenry
Associate Professor, Dept. of Management, The University of Akron, Ohio, USA
wm@uakron.edu

Abstract: With the ability to capture ever more artifacts that trigger, substantiate, and document decisions, it has become imperative to integrate multiple streams of information from information systems/business intelligence (BI), content management, and other collaboration and knowledge management (KM) systems. This paper argues that this can be accomplished by creating a “DECISION-ID” that links together evidence and decision at various levels of aggregation for use and reuse in subsequent decisions. Illustration of how this may work in part is based on a case study of The MOSAIC Group at The University of Arizona, which conducted research in international computing using a KM system called the AAIS. Organizations that embrace concepts of “pre-codification” and “clustering” of artifacts related to decisions may achieve superior performance in the future.

Keywords: collaborative business intelligence, Arizona Analyst Information System, knowledge artifacts, decision tracking, business process integration, decision-id

1. Introduction

At the end of the Spring, 2015 semester, a team of four MBA students made a presentation of their semester-long capstone business analytics project to executives from a major consumer goods firm in Northeastern Ohio. The presentation was so successful that the senior executive in charge made sure the students gave him all the presentation files so he could repeat parts of the presentation to his boss—he would be asking for funds to go from the current spreadsheet model (the bailiwick of essentially one analyst “Phillip”), to a deployable, visual set of models that could ultimately be used in real-time decision making. The head of enterprise analytics volunteered to put some of his people on the project when it became a reality. “Phillip” was delighted that his model was gaining increasing prominence and sophistication. The students basked in praise and high grades for the course.

Business meetings of this sort occur all the time. The question for this paper is the following: how can a firm subsequently understand how and why decisions were made? Certainly for the first few months or even years, while the same people are involved, it may not be hard to recollect why certain choices were made. But what happens a few years down the road, when the model is not functioning as well as hoped, when team members have moved on to other positions, and someone asks: why did we do it this way? If it is possible to retrieve all of the relevant artifacts, the firm may avoid a critical problem related to analytics and organizational systems more generally: business rules become embedded in models that “fall out of understanding.” The paucity of documentation makes current model users loathe to change them. Agility becomes sclerosis. “The most common obstacles to decision making at large companies are disagreements among executives over past decisions, current alternatives, and even the facts presented to support strategic plans” (Mankins and Steele, 2006: 84).

Consider the artifacts involved in this example. Some relate to traditional information systems and Business Intelligence (BI); some are the result of collaboration; some derive from analytics. They encompass not only the model files and slides at the time of the presentation. They go all the way back to the initial email correspondence about the project, which includes vital details about what portions of the data had to be omitted because of third party disclosure restrictions. Further caveats were made orally during the presentation, as the team explained why they chose to focus only on the largest (by dollar value) segment of the model. If the project goes ahead, there will be numerous emails, minutes of meetings, project proposals, new versions of the model files, ETL routines to pull additional data from the data warehouse, acquisitions of third party data streams, and more. Artifacts will be stored in various places, and may be effectively lost unless they have been put into a repository such as a SharePoint site.

This paper makes a contribution to the KM literature by proposing an audacious means of integrating BI, content management, collaboration and KM in order to track decisions. “DECISION-IDs” should be established and related to the artifacts in a way that cuts across major artifact types without impeding day-to-day work. Such a solution addresses one of the central paradoxes of KM: storage of knowledge in repositories (codification) is indispensable, but mastery of that knowledge for reconsideration and reuse by other individuals often requires awareness of context and tacit knowledge that cannot easily be stored (von Krogh, 2002). Once knowledge is “coded” in a repository, context and the “dynamics of ‘tacitness’” may be lost (Hatami and Galliers, 2005:76).
To investigate how DECISION-IDs might work, this article recounts a case study of a KM system that was created to facilitate the work of the MOSAIC Group (McHenry, Lynch, and Goodman, 1988; Goodman, Mehrer, Lynch, and Roche, 1990; Lynch, Snyder, Vogel and McHenry, 1990). This work took place in a collaborative environment built around a minicomputer, slow modems, limited storage space, and “green screen” CRTs. However, we contend that some of the KM ideas realized in this limited environment have now come of age given pervasive and much more powerful technology. We argue that the MOSAIC experience points the way towards a new understanding of how to integrate BI, content management, collaboration, and KM.

This paper uses a method of participant observation, as the author was one of the principle researchers and designers of the MOSAIC Group system (AAIS). It is laid out as follows. Section 2 examines the streams of information that knowledge workers must integrate. Section 3 is about the AAIS. Section 4 puts forth lessons learned from the AAIS experience and how they point towards DECISION-IDs as a way forward for KM.

2. What Needs to be Integrated

In making decisions, knowledge workers typically must integrate multiple streams of information from information/business intelligence (BI), content management, and other collaboration and Knowledge Management (KM) systems (Imhoff and White, 2013).

2.1 Business Intelligence and Content Management

First, numerous corporations have collectively spent billions of dollars on traditional information systems that produce structured, numerical information (now commonly called BI) (Watson, 2009). BI combines data from transaction systems, usually stored in a data warehouse, with graphics, dashboards, alerts, and drill-down capabilities. When it comes to decision making, the BI system may or may not suffice—the only way the executive or knowledge worker will see any data or information derived from it is if someone figured out in advance that the data had to be collected (termed the “hierarchical” approach by Dennis and Vessey (2005)). With traditional BI, once knowledge workers and decision makers receive their reports, the process of subsequent decision making may go largely unrecorded (Devlin, 2012). While Western Digital’s BI environment, for example, provided for several levels of near real-time alerts, it did not provide for a ready means to capture the thinking that went along with the decisions made (Houghton, et al., 2004). It was up to the user to put these streams together herself, if indeed the systems made this remotely possible.

A second stream, falling under the rubric of “content management,” has to do with managing core documents used to run the business. Paper invoices may be scanned, data from them extracted, and their contents attached to other transactions. RFPs, RFQs, contracts, invoices, other legal documents, etc. all must be maintained and managed (Smith and McKeen, 2003). Web-site content also falls generally under content management. Although the documents themselves may only be semi-structured, they arise within a well-understood context that permits the documents to be related to transactions and/or other artifacts. Both BI and content management generally relate to and support operational business processes in which decisions are repeatable and well-understood.

2.2 Knowledge Management

A third stream arose in the 1990s under the rubric of Knowledge Management (Alavi and Leidner, 2001). The goal here was to capture personal and organizational knowledge and represent it in a way that it could be retrieved and reused. At one end of a spectrum of approaches was codification (Zack, 1999), i.e. recording and summarizing knowledge in written forms such as “lessons learned” documents. Knowledge sources were not highly structured; they comprised specific artifacts such as documents, presentations, and more recently, video clips. Markus (2001) foresaw the wide variety of artifact types; her research underscored the difficulty of creating and maintaining different types of information for users with different levels of experience and needs (see also Chen et al., 1994).

In some cases, firms tried to use interviews, videos, and other means to create repositories of expert knowledge in the hope that at some point this knowledge would be useful (for example, see Coffey and Hoffman (2003)). Because of the vast amount of knowledge this could entail, the difficulty of eliciting and representing tacit knowledge, and the labor intensiveness of the knowledge engineering and maintenance involved, this approach fell somewhat out of favor. With baby-boomer retirements occurring more frequently, the problem itself has intensified over the past few years and is receiving renewed attention (Leonard-Barton, Swap, and Barton, 2015). But a core obstacle remains: it is difficult to be motivated to codify knowledge when it is hard to predict to what extent it will be useful in the future. Trying to capture the amount of context necessary for re-use also makes this task onerous (Hatami and Galliers, 2005).
At the other KM extreme (an approach known as “personalization”) were directories of experts to facilitate finding the right people to ask and with whom to work (Zack, 1999). Personalization was most aligned with the idea of creating new knowledge, and this knowledge development often took place in communities of practice or purpose (Verburg and Andriessen, 2011; Yamklin and Igel, 2012). However, the results of these interactions were not necessarily in machine readable form at all, or if they were, they required a lot of work to put them in any form that could be reused. Again, without sufficient context, it was hard to understand these exchanges. Many firms used personalization effectively, but did not necessarily capture the generated knowledge for reuse (e.g., Cross, et al., 2006).

Means to bridge these extremes are being developed. Text analytics (e.g. Lahl, 2011) is widely used to understand sentiment, and multimedia analytics (Chinchor, et al., 2010) is facilitating (for example) automated classification of video. Artificial Intelligence research, with applications across many domains (such as machine-learning techniques to work with peta- and exascale data, natural language processing, use of ontologies and the Semantic Web to enhance search, and “Discovery Informatics”), is opening powerful new means of finding and making sense of all kinds of data, in massive amounts (Gil, et al., 2014; Russell and Norvig, 2009). IBM’s Watson (Kroeker, 2011) represents a cognitive computing approach that combines a number of these technologies. These techniques can be used to process the unstructured byproducts of personalization in ways that can then be stored, analyzed, and reused.

Nevertheless, the problem of how to capture the results of collaborative decision-making remains. Watson’s “overlords”—to borrow the comment made by Ken Jenkins at the end of the famous Jeopardy! Round (Siegel, 2013)—envision Watson only in an advisory role. Delen and Al-Hawamdeh (2009) propose a “holistic” KM environment that integrates data and text mining tools, search mechanisms, and directories of experts—so that queries are answered first from existing codified knowledge and then by personal interactions with experts. Once these interactions end, what happens to the knowledge that has (briefly) been assembled for decision-making?

2.3 Collaborative BI

Taking the perspective of an executive or a knowledge worker, it is easy to see why these streams, when functioning separately, fell far short of an overarching concept of “business intelligence.” “Decision making” ranges from reaching a consensus about the true value and interpretation of information to action plans of varying scope. As we have seen, the decision-making logic exists only in the organizational memory represented by those involved in the process, or by artifacts that (partially) reflect the decision-making process such as emails.

And decision making is an iterative process. At any given point in time, decisions rely upon amalgamations of old and new information, layered on top of the decisions made in the past. Freedman (2013), speaking about strategy here, is also making a more universal point about the nature of decisions: “a strategy could never really be considered a settled product, a fixed reference point for all decision making, but rather a continuing activity, with important moments of decision. Such moments could not settle matters once and for all but provided the basis for moving on until the next decision. In this respect, strategy was the basis for getting from one state of affairs to another, hopefully better state of affairs” (Freedman, 2013: 541).

While a discussion of decision making per se is beyond the scope of this paper, the approach in this paper is fundamentally based in ideas of “rational” decision making, which “enables individuals to learn information deliberately, to develop ideas, and to engage in analyses in an attentive manner” (Dane and Pratt, 2007: 36). The “rational actor” model has been a foundation of the decision support systems field since its inception (Huber, 1981). Decisions may be based in organizational politics or routines (Kuwashima, 2014), and decision makers may limit themselves to a few choices because of “bounded rationality” (Kahneman, 2013). Other decisions are experiential and may stem from intuition, a concept whereby “individuals ... reach perceptions of knowing without conscious attention” (Dane and Pratt, 2007: 37).

According to the garbage can theory, it is not necessarily clear until later that a decision has actually been made (Cohen, March, and Olsen, 1972). This theory, which has recently been called by Padgett (2013) “as arresting and radical a vision of organizations today as it was forty years ago (p. 473),” “focused less on theorizing how people behave in their situations than on how those transient ‘definitions of choice’ were constructed through temporal intersections of fluid people, issues, and alternatives” (Padgett, 2013: 473). In this case the emphasis is on “patterns of simultaneity in time, not patterns of authority in networks, or patterns of consequentiality in causation” (Padgett, 2013: 473).
In this paper we argue that a user should be able to “drill down” into the thinking that informed previous decisions to enhance his or her ability to make new ones. This perspective applies regardless of which theory of decision making is most prevalent in any given circumstances. A true BI system should provide collaboration tools that allow for the capture and reuse of knowledge that is created in the process of collaboration, with links to any and all supporting materials that were used in making the decision.

Figure 1 shows an integrated conception of what Imhoff and White (2013) call “Collaborative BI.” In their original formulation, they show how BI results in the discovery, access, integration, and management of information. This information is then published and analyzed, and used by workgroups in a collaborative process to make decisions. However, they left out the feedback loop at the bottom of Figure 1 for storing back into the data warehouse analysis, publishing details, collaboration records, and information about decisions and actions taken.

We contend that this data warehouse must now be able to store self-referential artifacts. Search mechanisms must be expanded so that knowledge workers can join a “decision stream” at any point and understand what came before it and after it. And, the repository should include a robust directory of experts to facilitate personalization. In the next section we examine an example of a Collaborative BI environment set up to do what might be termed “competitive intelligence” on the country level. (Evgeniou and Cartwright (2005) describe a similar case study, using multiple streams of quantitative and qualitative information combined to achieve “information intelligence” for market research about competitors.) The means in which this group incorporated self-referential artifacts points towards the proposed solution for moving Collaborative BI forward.

![Figure 1](https://example.com/figure1.png)

3. **Case Study: The Arizona Analyst Information System**

Under the direction of Professor Seymour Goodman at the University of Arizona, the MOSAIC group studied computing in the USSR, Japan, China, and other countries from about 1980 to approximately 1994. It can be argued that this group was responsible for providing a great deal of the openly-available knowledge in the US about Soviet computing at a time when the Soviets did not particularly want that knowledge to be widely known (McHenry, Snyder and Lynch, 1990).

Central to the research efforts of the Mosaic Group was the Arizona Analyst Information System (AAIS), which was built by Mosaic Group members and continually enhanced in the 1982-1993 timeframe. Databases were created covering international technology trends and policy analysis, emerging information technologies, Soviet science and education, groupware and related technologies, and the AAIS itself. The largest of these (on international computing)
William McHenry

had over 40,000 entries from 20,000 sources, and served over 50 researchers. AAIS databases supported seven dissertations, well over 50 journal and conference papers, at least 19 chapters in books, and numerous other unpublished manuscripts and technical reports. AAIS databases were used to support research ranging from ad-hoc, time critical questions to long term policy analyses. At its peak, the MOSAIC group received about $500,000 per year in external funding. The AAIS led to a great deal of collaborative work. From 1983-1991, there were 15 co-authorship relationships which concerned topics tracked in the database, accounting for 26 coauthored works and 36 instances of coauthor pairs.

The genesis of the AAIS was the need to fill in templates for structured, quantitative information about each model of Soviet and Japanese computer as part of “The World Computing Database (WCDB)” (funded by a consortium of US government agencies). For example, a question was whether the USSR was building an indigenous computer that could perform 1 Million operations per second. (Current readers may not realize that the Soviets actually designed and produced indigenous computers, or that there was intense interest in finding out about them in the West (see, for example Crowe and Goodman, 1994; Davis and Goodman, 1978; Goodman, 1979; McHenry, 1985; McHenry and Goodman, 1986; and Goodman and McHenry, 1991).

Since information from multiple sources did not agree, this single task prefigured many of the requirements of the system: to be able to record the history of coming to decisions about these parameters in such a way that the evidence used (and the persons involved) could be traced back as far as necessary when new information arrived, necessitating updates or revisions. We also had to affix confidence levels to each value, leading to more decisions and revisions. The careful tracking of all sources was imperative.

The process of sifting and refining data that went into our judgments for the WCDB is represented in the nomenclature of Figure 1 as follows. Information in the form of “text atoms” from “other data sources” was recorded in the “master data store.” These sources could be as mundane as an article in a scientific journal, or as exciting as interviews done with defectors, refugees, Soviet citizens abroad or in-country, and other experts.

Raw information was entered in text atoms (Figure 2). We employed a system of unique “REFIDS,” ensuring that they were created, along with bibliographical information, before any other information could be entered. A text atom was about as much information as could fit on a green-screen, character-based CRT (27 lines). Text atoms were indexed with keywords, organization names, names of places, names of people, and bibliographical information, resulting in 14 different ways to retrieve the information.

Any text atom could be associated with files, which were in a typical hierarchy, storing the quantitative WCDB templates. Initially these files only dealt with various models of computers, but soon the idea of a file hierarchy caught on for other research topics of interest (including abstract topics such as “poor use of MIS”). One analyst would flag a text atom of potential interest to another analyst by sending it to that analyst’s “hot file,” who would then decide about any subsequent classification and analysis. Analysts could also make comments on the information in a text atom as part of that same text atom (after “[AN:]”), and could even index the commentary. About 10% of the more than 22,000 text atoms entered in the original MOSAIC database contained this form of commentary by the analyst (McHenry, Lynch and Goodman, 1988).

Individual text atoms and text atoms associated in these virtual files were then analyzed, sometimes in a collaborative process, sometimes by individual analysts. In the sense that any qualified analyst could make updates, there was always an asynchronous conversation going on between the members of the group. These analyses resulted in updating or entering new numerical values for all the characteristic WCDB parameters being tracked for a computer (amount of RAM, disk storage, speed in MIPS or FLOPS, etc.). We can think of the WCDB as the data warehouse from which reports could be derived. Every conclusion that we reached about numerical values, such as MIPS, were backed up by REFIDS. Here we were codifying our knowledge in the form of numerical values. It was quite simple in the AAIS to retrieve all the old text atoms used to determine a field’s value for comparison with new information that had just arrived. We delivered updates of the WCDB data warehouse to the sponsors on a regular basis. For them, and for ourselves, we populated the Operational BI portion of the system with numerical values. In our system, these values could then be used to qualify any types of queries (for example: show me any text atoms involving computers with speeds greater than 1 Million operations/second produced outside of Moscow).
Other analysis was done to produce newsletters, research reports, scientific papers, and even dissertations. In this case the output was written text. Sometimes these texts were published, sometimes they were delivered to sponsors. Here we were codifying our knowledge in the form of written analyses.

Later we realized we wanted to know not only what raw information we had captured about a computer, network, or information system (for example), but also what judgments we had made (i.e. what we had written about it later) on the basis of this evidence. For example, we might reach a conclusion that “The Soviet nuclear power industry relied exclusively on Soviet-made computers for its SCADA (supervisory control and data acquisition) systems, and these computers had a mean-time-to-failure that was well below their Western counterparts.” Such a judgment could rely on numerous sources (one example is shown in Figure 2), and its rationale could be explained in the paragraphs leading up to this sentence. Our solution on how to be able to query the judgments we made was to enter our reports, papers, etc. back into the MOSAIC database as a series of text atoms which could be queried in the same manner as the primary text atoms. Linkage to the original sources was organic because we used the very same REFIDS in our papers as we used in the database.

We incorporated business process integration by providing bibliographic tools that allowed the automated construction of lists of references cited from the text of the paper itself. The system would read the text of the paper, extract all references in brackets, and automatically construct the bibliography needed. This was quite handy for the longest dissertation written with the system (McHenry, 1985) when the 1000+ reference list was constructed from over 700 pages of text. The dissertation was then “chunkified” and fed back into the “data warehouse” for use in future analyses.

Figure 3 shows the analysis hierarchy we created. It was possible in a crude manner to drill up from a specific source or to drill down from a specific report.
Of course we faced limitations. We could not easily capture all artifacts. Although trip reports documented the contents of many interviews and research-oriented conversations with subjects, we did not always document our internal face-to-face conversations. From time to time email messages with substantive ideas would be entered as text atoms, but we certainly missed a good deal of them. The DEC VAX VM operating system provided a real-time chat capability, and later in the project the “Sovset” network allowed for bulletin boards (Thatcher, 1989). Chat was rarely used, and BBS discussions were rarely entered into the database. In addition, we faced inconsistencies in the way novice and experienced users tagged information (Carmel, McHenry and Cohen, 1989; Chen, et al., 1994). Current technologies can fill many of these holes.

Eventually the Soviet Union broke up, research funding dried up, and the AAIS was shut down. One copy of all of the text atoms and bibliographical information was preserved on an IBM PC, though not in a system that could be called “the AAIS.” (In 1998-1999, this author was asked to evaluate whether any indigenous Soviet computers were still in use, and if so, whether vulnerabilities to the Y2K problem might lead to disasters such as a nuclear power plant malfunction (McHenry and Malkov, 1999). Some MOSAIC Group data was still relevant, underscoring the fact that it is never clear exactly for how long knowledge should be preserved.)

By the late 1990s, the remaining members of the MOSAIC group now turned their attention to the global diffusion of the Internet (Wolcott, et al., 2001). The group continued to employ a hybrid BI-KM method: the status of the Internet in a given country was defined by levels assigned to six dimensions, including, for example, pervasiveness of use. Country studies tracked changes in these levels over time. A great deal of work was put into thinking about the drivers of Internet diffusion, particularly what seemed to be unique to certain countries and what seemed to be more universal in nature. By this time each country study was written separately. Researchers reverted back to a variety of personal means of storing the information they collected, and used traditional tools to construct bibliographies. Without a central system to link all the artifacts together, it became much more difficult to collaboratively address overarching questions that cut across many countries.

4. Discussion

The experience of the MOSAIC group with the AAIS encompasses a vision of what a modern day KM/Collaborative BI system can become. If you take away the topic area of international computing, and the limits of the technology of the times, what remains is a set of business processes that encompasses those in Figure 1: ENHANCE, INTERACT, and DECIDE. Reaching an evidence-based conclusion that a computer can do 1 million operations/second is, in principle, no different from reaching a conclusion that inflation will be about 3% next year—requiring a revision in a financial strategy—, or reaching a conclusion that the competition is about to launch a new version of a “killer” product. We assert, based on the MOSAIC group experience, that linking decisions over time with the structured, semi-structured, and unstructured data used to make them, may be a cornerstone of superior team performance. The challenge for any decision-making team will still be to record the means by which the decision was made, and the evidence used to make it, in a way that can be retrieved, analyzed, and reused in the future. Some researchers are beginning to propose such systems (Devlin, 2012). Van Heesch, Avgerioua and Hilliard (2012) describe an ISO standard for documenting decisions (in their case, for the architecture of software systems). Lewis (2006) describes a knowledge-level decision support system that is based on creating sets of interacting model components that embed problem-solving techniques used throughout the enterprise. This is one way of capturing decisions in a form of rules that can be reapplied. Part of this “collaborative modeling” approach is forcing those who make any changes in assumptions in the models to document and time-stamp the rationales for those changes (Lewis, 2012). This approach goes a long way towards providing the capabilities described here, but seems to be limited to specific decisions that are subject to specific modeling. (In this regard a great deal of knowledge codification is necessary to set up the
system.) Also, it is not clear how final decisions are documented and whether they are stored in the data warehouse for further querying.

The MOSAIC Group approach was “heavy,” as is the approach of Lewis (2012). Because a great deal of additional human activity is necessary to make it work, it is unrealistic to think it could be applied widely. But new technologies may make it possible to automate enough aspects of the process to make it feasible.

In the multi-level structurization of knowledge employed by the MOSAIC group, the REFID drew all the evidence and analyses together. In the modern context of collaborative BI, it will be necessary to take a snapshot of the state of the relevant data from the data warehouse when the decision was made, capture relevant inputs from external sources on the web (social bookmarking, tagging), capture analyses done with the data (such as spreadsheets, visualizations, predictive models, etc.), capture “chatter” related to that decision (emails, instant messages, chats, voice and text messages), and capture conversations about it (which may involve asking individuals to record their ideas at the time of the decision being made, and/or capturing audio/video of meetings, web conferences, etc.). In other words, any portion of the processes in Figure 1 can give rise to artifacts. Decision-tracking technologies will have to be integrated into the business processes of the decision makers, just as they were in the MOSAIC group. All of these separate artifacts involved will need to be tied together with some form of unique “DECISION-ID” that is similar to the REFID in AAIS.

Since these technologies largely exist and have existed for some time, why haven’t we seen DECISION-IDs already? The challenges of trying to institute a DECISION-ID are formidable. Part of the problem is a technical one; i.e. re-engineering software systems to allow for tagging materials used in decision making with a single identifier (ARTIFACT-IDs). The process of stamping relevant artifacts will have to be hidden and seamless. The INTERACT portion also raises issues about granularity. A decision-tracking system should be able to “chunkify” portions of larger artifacts so that only relevant portions are (initially) accessed. It should still be possible to widen the net at any time to look for contextual cues as necessary.

The next step would be to associate these ARTIFACT-IDs with specific DECISION-IDs. Reviewing all the sources of artifacts raises questions about how and when an automated DECISION-ID would be assigned. An email written today may or may not become relevant to a decision made months later. As we noted above, it may not be possible at a given time to say that a decision is actually being made (Padgett, 2013).

It is easier to imagine how this would work when decisions are overt. Certainly at the point of a presentation (e.g. the example at the beginning of this paper), the analysts making the presentation can already tie together a strong set of artifacts into a bundle that represents the analysis they have already done, i.e. a provisional assignment of a DECISION-ID can already be made. Given the chaos that sometimes arises even within a project team about versions of files, location of important items, etc., project members are likely to welcome such a capability. Once it is clear that a decision was made, a more formal bundle of artifacts can be created.

In this approach, participants themselves may overtly assign artifacts to DECISION-IDs (or signal a system to do so). Note how different this is from typical demands of KM systems, where the participants are asked to codify their knowledge for insertion into a repository after the project ends. With a DECISION-ID system, they are simply asked to assign the artifacts to bundles; codification may or may not take place depending on whether it proves to be necessary. We may call this a “pre-codification” approach. (Also note that if there are lessons learned recorded after the project, these artifacts will also be part of the DECISION-ID bundle.)

An example: when IBM Fellow Grady Booch wanted to document and develop a deep understanding of the architecture of IBM’s Watson software, he needed to immerse himself in artifacts that documented its design. Multiple engineers he contacted gave him a “hundred or so documents, ranging from drafts of papers to PowerPoint decks to spreadsheets” (Booch, 2011: 10). Imagine if these were already linked by ARTIFACT- and DECISION-IDs, and Booch could have “pulled the string” of pre-codified materials himself. He then performed interviews, filled in holes, created UML models, and completed the loop by testing his understanding with others (Booch, 2011). Again, imagine that all of these artifacts were linked in the same chain! Clearly, with an agent like Booch involved, tagging the relevant artifacts would certainly be possible.

The pre-codification approach could be used widely by knowledge workers, but would not suffice because of the indeterminate nature of some decisions. A second type of approach (“clustering”) would try to leverage all available forms of analytics to proactively assign DECISION-IDs to clusters of artifacts. This could work in the background, with
or without manual intervention or adjustment. Any artifacts could be provisionally assigned to a number of potential
groups, and then when it became clearer that they belonged together, the groups could either be promoted to a more
permanent status or discarded. Furthermore, there would need to be some sort of threshold of significance, below
which decisions would not be tracked. (For example, documentation of who decided to get anchovies on the pizza is
not needed.) As the MOSAIC Group experience shows, maintenance of KM systems over time is difficult; the more
that background analytics can automate parts of the process, the more likely the system is the survive and flourish.

Experience teaches that the biggest obstacle will be cultural. Many barriers to knowledge sharing are well-
documented (Wang and Noe, 2010). Do decision-makers want to expose to others how they actually did make
decisions? A system like this may be perceived as intrusive, leading to an unacceptable level of surveillance. Results
reported by Peng (2013) suggest that knowledge workers who are already inclined to hide knowledge might be less
willing to directly mark or opt in to indirect marking of artifacts.

Hence, it will probably be necessary to provide some sort of electronic “cone of silence” that will allow temporary
opting out of tracking. (Or it may be possible to turn tracking off and on, as in changes tracking in text editing.) Ideally,
this can be accompanied by training about security, intellectual property, and appropriate topics for various types of
media. Boundaries across which intellectual property cannot be shared and legal requirements must be respected.
Pre-codification and clustering are not mutually exclusive, and decision-makers will likely embrace a system that
incorporates automated suggestions for assignment of artifacts to decisions, while preserving the final say for
themselves. In this regard, the MOSAIC experience is again relevant: because participants made sure the quality of the
information stored was high, incentives to continue using the system also remained high.

5. Conclusion

In this paper we have proposed an audacious way to integrate BI, content management, collaboration, and KM. By
linking together artifacts with a DECISION-ID, and allowing artifacts at multiple stages of a decision process to be
linked, it will become possible for analysts to drill down into, and recover, a great deal of the context that existed at
the time of specific decisions. The ensuing process of internalization (Sheffield and Lau, 2007) will permit the analyst
to understand the decisions much better than if he or she were just using a single document from a repository that
recounted the information, if indeed such a document had even been prepared. Given that all sorts of extraneous
things can influence decision-makers (Thaler and Tucker, 2013), including the tendency to rely on the most recently
accessed information (Tversky and Khaneman, 1974), we need long threads like this to provide all this necessary
context.

The movement towards business analytics may prove decisive in persuading organizations to embrace such a system.
Organization after organization is realizing the benefits of “evidence-based” management (McAfee and Brynjolfsson,
2012; Davenport, 2013; Rosenbush and Totty, 2013; Seigel, 2013). Sooner or later leading organizations will see the
advantages of marrying all these streams of KM, gaining a great advantage in the process. In fact, in the era of bigger
and bigger data, it is becoming essential. The experience of Caesar’s CEO and renowned champion of evidence-base
decision making Gary Loveman is instructive. In 2006 Loveman had to decide whether to invest in a gambling
concession in Macau, China. Based on running “the numbers,” he declined to bid. Loveman called this a “big mistake.”
Indeed, as of 2013, Caesar’s had been shut out of a critical, lucrative market (Kiron, Ferguson and Prentice, 2013), and
as of this writing, is navigating bankruptcy (e.g. Rzemsky and Checkler, 2015). It is possible that a BI tool that unified all
streams of knowledge within a collaborative framework could have helped Loveman make the right decision.

Companies that can track decisions in this manner will not only strengthen their decision-making process in general,
but will open up entirely new prospects for applying analytical tools to the decision-making process itself. In either
pre-codification or clustering, it would be necessary to be able to assign multiple DECISION-IDs to single artifacts.
Patterns that emerged over time could show which artifacts had more value, leading to the use of a whole new level of
analytics applied to organization effectiveness and performance. Studying emergent patterns could yield important
insights about the strength and health of social networks.

Now imagine that several years have passed at the consumer goods firm mentioned at the beginning of this paper.
“Phillip” has taken a position with a rival firm. Though the forecasting model is performing fairly well, questions have
been raised by a newly hired data scientist as to why the team decided to use a Gaussian No Overlay (GNO) approach.
During the original presentation it was noted that the effectiveness of this approach was evaluated using Mean
Absolute Percent Error (MAPE), but just for the months in which the firm provided data about actual results. This
caveat could be in a PowerPoint presentation, in documentation provided by the student team, in notes taken in
electronic form by one or more of the participants, in an audio or video recording of the meeting, buried in the code used in the model, or in an email sent about the presentation. If many of these artifacts were linked by a DECISION-ID, the data scientist could now review why the GNO model was chosen, and what would be the implications, given current knowledge, of changing it. Since this knowledge was “pre-codified” by the assignment of the DECISION-ID, codification can now take place as the analyst reaches a new decision about the model. This decision is then stored with the original materials in the same data warehouse, waiting to be accessed, if necessary, when the model is reconsidered in the future.

Although implementation of these ideas will undoubtedly be very difficult, the technologies needed do exist. Firms that embrace them will give themselves an enhanced capability to take full advantage of the knowledge that is often embedded in organizations in a way that cannot be accessed easily. Large-scale integration is the way forward for Collaborative BI and KM in the 21st Century.

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Understanding Business Intelligence Understanding: Through Goods-and Service-Dominant Logic Lenses

Pamela Clavier
pam@pamclavier.com

Abstract: Business Intelligence (BI) project failure rates are high and expected benefits are not always achieved when implementing a BI solution in an organization. Failure is characterized by recurring challenges that remain largely unresolved. Could a better understanding of BI and its challenges emerge by taking a step back to examine how BI is understood? To answer this overarching research question, this paper presents a philosophical perspective to understand BI understanding as a means to understand the understanding from where BI challenges stem and, ultimately, overcome challenges to realize expected benefits more consistently. BI understanding its model of reality or worldview is examined using a worldview framework, derived from a literature study. Worldview characteristics are identified through a study of how BI is explained in the literature and perceived by those who practise BI as a profession. Goods and Service Dominant Logic are then used as philosophical lenses through which to examine both the worldview characteristics of BI and the challenges experienced when implementing a BI solution. This answers further research questions. First: what are the characteristics of the model of reality or worldview of BI as a discipline? Second: is it plausible that the model of reality held about BI by BI practitioners and academics influences and even represses the realization of benefit? Research is supported through a literature study and an interpretive case study. This paper’s main contribution is the exploration of new avenues to overcome recurring challenges through a unique analysis of BI understanding through G D and S D Logic lenses using the framework of a worldview.

Keywords: Business intelligence; worldview; goods-dominant logic; service-dominant logic; service science

1. Introduction

Business Intelligence (BI) is identified as the most essential technology for the organization to purchase [8]. However, organizations struggle to realize significant business value from their BI investments: over 50% of BI projects fail [32]. Existing solutions to address BI failure and challenges are largely ineffective [9], highlighting the need for a new approach.

This paper responds with a new approach, in two specific ways. The model of reality that exists of BI is examined by answering key questions to build an understanding of how BI is perceived and understood – identifying a dominant worldview of BI held by BI practitioners and academics. In other words: understanding the understanding of BI. Then through an interdisciplinary approach whereby concepts from the Service Science Management and Engineering (SSME) (also referred to as Service Science) discipline are applied as a fresh new lens through which to examine the identified BI worldview. This provides a new approach to better understand BI that can, ultimately lead to increased BI project success allowing organizations to realize more significant business value from their BI investments than is currently consistently the case. This paper highlights the potential of this new approach as a means to overcome specific BI challenges that emerge in the study.

Service-ecosystems theory (the theoretical foundation for Service Science) is complemented with Service-Dominant (S-D) Logic (the philosophical foundation for Service Science) [56] by examining BI as a service-ecosystem through Goods-Dominant (G-D) Logic and S-D Logic lenses. The point of departure for this paper is that, firstly, a theoretical base for core Service Science concepts is established within the discipline of SSME. Secondly, that the SSME discipline is positioned towards expansion through contributions from interdisciplinary fields such as BI, Management Information Systems (MIS), Knowledge Management, etc. [63]. This makes it unnecessary to redefine service concepts in this paper, aside from where these concepts are briefly defined where clarity is needed in terms of BI.

BI – a specialized type of Information System (IS) [5] – is positioned conceptually as a service-ecosystem. BI is examined at an abstract level, as the broad series of exchange activities performed with the ultimate purpose of providing actionable information and/or intelligence for use in decision-making [27]. BI is contextualized in terms of exchange as it is identified that there are various exchange activities performed throughout the BI process, i.e. processes to transform raw data into useful information for insights and decision-making [12]. Understanding BI as an exchange process offers opportunities to understand the various socio-technical relationships (e.g. between BI customer, BI provider, systems, processes, information), interactions, handovers, checkpoints and the end-to-end flow that takes place from when data is sourced until it is used (in another form, e.g. intelligence).
This paper presents context and findings from the literature, supported with results from an interpretive IS case study of the BI exchange process. A recommendation then follows, consolidating key findings and revisiting research questions.

2. Literature

2.1 Using a Worldview Framework to Understand Views of Reality

A worldview is a view of reality that affects behavior [26]. It can be held by an individual or collectively by a group. Scott M. Peck, author and psychologist, contextualizes the concept of an individual’s worldview eloquently by explaining that it is a view of reality that is built up and expanded, gradually over an individual’s lifetime that is like a map with which to negotiate the terrain of life [43]. In the same way, there are worldviews of business, economy, IT, ISs – and even BI.

A “cognitive map” of what constitutes BI, how it works, what it aims to achieve, etc. has been formed by participants in and observers of BI over time. Like the map or worldview of the individual, BI’s worldview is constantly revised, redefined and shaped by its environment. It also constantly shapes values and behavior or actions of those who operate within the BI environment [18]. Not only do the actors involved in BI exchange have perceptions of BI but they also engage in actions that shape their interactions and relationships and the various BI exchange processes that they are involved in [11]. By analyzing these perceptions and actions, typical characteristics and common assumptions that are shared amongst many of BI’s actors are identified. These are seen to guide the understanding of the nature of BI, organize what is known about BI and make sense of new information that emerges on BI – thereby forming a common BI worldview [33].

While unlikely that there is a single BI worldview, or a single set of characteristics and common assumptions shared amongst BI actors, the literature and case study analysis reveals distinct, recurring characteristics and assumptions shared amongst BI actors. This points towards a dominating BI worldview that distinctly drives and influences BI at this point in time. Characteristics and assumptions identified in the literature and case study in this regard are summarized in Table 4, structured according key worldview elements within a framework, which is discussed next. Literature and case study findings are consolidated for comparative purposes and to avoid repetition.

2.2 Using a Worldview Framework to Understand BI Understanding

Study of the work of various authors [2][26][59][18] conversant on the topic of worldviews, guided the compilation of a framework to analyze BI, as shown in Table 1. The case study investigation is grounded in this framework. Table 3 reflects questions and supporting artifacts used in the case study based on this framework.

Table 1: Worldview Framework

<table>
<thead>
<tr>
<th>Element</th>
<th>Ontology</th>
<th>Explanation</th>
<th>Prediction</th>
<th>Axiology</th>
<th>Praxeology</th>
<th>Epistemology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What is? What is the nature of our world? How is it structured and how does it function?</td>
<td>Where does it come from? Why is it this way?</td>
<td>Where are we going? What is expected?</td>
<td>What is right/wrong? What should we strive for?</td>
<td>How should we act? What should guide us?</td>
<td>What is true/false? How is knowledge obtained? What are the limitations?</td>
</tr>
<tr>
<td></td>
<td>Model of reality (what is/what’s perceived) as a whole</td>
<td>Model of the past. Explanation of how and why phenomena arose</td>
<td>Model of the future (always with uncertainties)</td>
<td>Theory of values. Provides direction, purpose, goals to guide actions, measure of value</td>
<td>Theory of actions. General principles according to which actions should be organized</td>
<td>Theory of knowledge. Source of knowledge</td>
</tr>
</tbody>
</table>

Individuals and groups sense, think and act (and thereby cause responses) in reaction to stimuli (e.g. internal and external environment), intuition, revelation and knowledge formulated in a worldview [18]. Philosophers [30] explain...
that there is a correlation between worldview, values, actions and behaviour. Actions and behavior lead to outcomes, such as challenges and failure on the one hand, and opportunities and successes, on the other – as reflected in Figure 1 – and in terms of the relationship between the worldview elements and the emergent challenges that result from a particular worldview in Figure 2. As an example within BI, an individual BI professional (e.g. an analyst) reacts to stimuli (e.g. factual data) compiling it into meaningful information (e.g. a BI dashboard) that they can read and interpret (formulating knowledge) – all based on and influenced on their worldview. This results in specific actions (e.g. a decision to go to market with a certain product) and outcomes (profit or loss from the product).

Figure 1: Worldview in context of understanding challenges (adapted from Funk, 2001 [18])

Figure 2: Worldview Elements in Relation

2.3 The Service-ecosystem

Nascent research [35] introduces a service-ecosystems perspective based on S-D logic. A service-ecosystem is defined as a “relatively self-contained, self-adjusting system of resource-integrating actors that are connected by shared institutional logics and mutual value creation through service exchange” [35]. Actors are connected through shared social contexts and are either enabled or constrained by social structures. They integrate operand and operant resources and exchange services to mutually co-create phenomenological value [53]. Operand resources are static resources that must be transformed to cause an effect or provide value [35], e.g. raw materials, data, etc. Operant resources are dynamic and capable of acting on other resources to create value, e.g. knowledge and skills used in value-creating acts [35]. Phenomenological value refers to value that is uniquely and independently measured by the beneficiary, e.g. information received by an executive may or may not constitute timely and actionable intelligence.

2.4 BI as a Service-ecosystem

Consider BI at a conceptual level as the broad series of exchange activities performed with the ultimate purpose of providing actionable information and/or intelligence for use in decision-making [29]. At its core, BI is a resource-integrating system that consists of a series of exchange activities performed by configurations of actors – people, IT, organizations, processes – and shared information connected through exchanges to co-create value (enabling decision-making). This aligns with the definition of a service-ecosystem, as per section 2.4 [41] [35].

Understanding BI as a service-ecosystem provides the opportunity to understand where disputes arise between service-ecosystem entities (actors, agents, resource integrators) involved in these relationships and interactions where these entities do not see value created as intended when a BI product (e.g. information, a report) is delivered or a new BI system is deployed [63]. BI service system entities may include, for example: BI customer; BI provider; the operant resources they create (e.g. insight/intelligence); the operand resources they use (e.g. raw data) and; other organizations they interact with. BI customers are seen as entities demanding benefit (e.g. the ability to use actionable information/intelligence for decision-making [46] in exchange for reward, reimbursement or payment, through
relationships they engage in with BI providers (as their suppliers). BI providers are seen as entities seeking reward, reimbursement or payment and aim to supply the BI customer with benefit.

2.5 G-D and S-D Logic

G-D and S-D Logic are lenses, worldviews or philosophies to view “exchange” [57]. Exchange is the act of giving and receiving [28], which also applies to economic or social acts of giving (e.g. selling, leasing, lending) and receiving (e.g. buying, renting, borrowing). Exchange is concerned with relationships and interactions [49]. The aim of exchange is to give the provider and customer (and others who may potentially be involved) access to resources that provide them with benefit [7].

Vargo and Lusch [57] have called the manufacturing-oriented [39] process of exchange “G-D Logic”. G-D Logic typically sees exchange as a linear series of activities of sourcing, producing and distributing tangible saleable goods, designed and built by a producer who embeds the goods with utility and value during the production and distribution processes with a consumer in mind [55] [15]. G-D Logic promotes value-in-exchange and a separation of producer and consumer [23][56], it focuses on the product (including its embedded features), means, producer and production [56] [15].

G-D Logic perceives exchange activities such as leasing/renting and lending/borrowing in terms of the tangible product or unit of output [31] involved. In cases where no tangible product is exchanged, e.g. having a haircut, attending a class or consulting with a lawyer, G-D Logic refers to a service, where service is the residual unit of output [31]. G-D Logic sees service as unproductive and, although not useless or non-essential, as failing to contribute to the creation of wealth [57][57].

S-D Logic is significantly broader than the traditional view of service [52]. S-D Logic questions G-D Logic’s traditional views of service and recognizes traditional service as “direct service” and goods as “indirect service” [31]. It recognizes the service that is inherent in goods and, conversely to G-D Logic, defines goods in terms of service. Service is seen as the application of competences (skills and knowledge) through deeds, processes and performances for the benefit of another entity or the entity itself [54]. Skills and knowledge are seen to be embedded in goods, where goods are the transport mechanism for distributing these skills and knowledge [55].

S-D Logic’s central tenet is that service is the basis of all exchange [55]. Its primary definition being that service is the application of competences for the benefit of another entity [55]. It sees exchange (including the exchange of goods) as a flow of service where customer and provider collaboratively interact with each other and other economic and social actors to co-create value, which is phenomenologically measured by the customer (and not upfront by the provider) [40]. S-D Logic represents a shift from G-D Logic to a focus on use, the customer, the process, the intangible, the relationship and the doing [37].

2.6 Application of G-D and S-D Logic to BI

This paper examines BI as a series of exchange activities through G-D and S-D Logic lenses. First consider BI through an S-D Logic lens: BI represents an integration point for many capabilities that may exist independently (e.g. in other systems) or may not even currently exist [21] and may still need to be created. For integration to take place, BI relies on various resources (e.g. data, applications, etc.) and actors (e.g. IT, business, BI) to engage in collaborative activities with the purpose of achieving their own interests. For example, a user must interact with data and a BI application to access information to create the intelligence to be able to make a decision. Various actors – BI, IT, the user, the business product/customer/competitor from where the data comes, etc. – and operand/t resources (e.g. data, knowledge) are involved in this. As such, BI represents a highly networked and complex world where a broad range of role players’ interests need to be consolidated.

Lusch and Webster [37] argue that S-D Logic is especially useful in such a context. S-D Logic is especially useful for BI as a complex and adaptive environment: it offers a multidimensional view of all of BI’s role players, resources, relationships and integration points. It views all social and economic actors as resource integrators [52], broadening the view that BI is all about technology [25].

With this in mind, consider the application of the S-D Logic Foundational Premises (FPs) to BI in Table 2. This is based on a similar example from Schultz and Gnoth [49] who apply S-D Logic FPs to the organization.
Table 2: Foundational Premises: S-D Logic and BI

<table>
<thead>
<tr>
<th>S-D Logic FP</th>
<th>BI FP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Service is the fundamental basis of exchange</td>
<td>Service (exchange) is the fundamental basis of BI</td>
</tr>
<tr>
<td>2 Indirect exchange masks the fundamental basis of exchange</td>
<td>Indirect exchange of BI technology products masks the fundamental</td>
</tr>
<tr>
<td></td>
<td>basis of BI exchange</td>
</tr>
<tr>
<td>3 Goods are distribution mechanisms for service provision</td>
<td>BI products are distribution mechanisms for service provision</td>
</tr>
<tr>
<td>4 Operant resources are the fundamental source of competitive advantage</td>
<td>Operant resources – such as intelligence and insight (which are hard</td>
</tr>
<tr>
<td></td>
<td>to copy) – are the fundamental basis of competing using BI</td>
</tr>
<tr>
<td>5 All economies are service economies</td>
<td>BI is a service economy consisting of service flows through which</td>
</tr>
<tr>
<td></td>
<td>exchange takes place</td>
</tr>
<tr>
<td>6 The customer is always co-creator of value</td>
<td>The BI customer is always co-creator of value</td>
</tr>
<tr>
<td>7 The organization cannot deliver value, but can only offer value propositions</td>
<td>The BI provider cannot deliver value, but can only offer value</td>
</tr>
<tr>
<td></td>
<td>propositions</td>
</tr>
<tr>
<td>8 A service-centered view is inherently customer oriented and relational</td>
<td>A service-centered view is inherently oriented towards the oscillating</td>
</tr>
<tr>
<td></td>
<td>BI customer-provider relationship, including all entities involved</td>
</tr>
<tr>
<td></td>
<td>therein</td>
</tr>
<tr>
<td>9 All social and economic actors are resource integrators</td>
<td>All social, economic and technical actors are integrators of BI</td>
</tr>
<tr>
<td></td>
<td>resources</td>
</tr>
<tr>
<td>10 Value is always uniquely and phenomenologically determined by the beneficiary</td>
<td>Value is always uniquely and phenomenologically determined by the</td>
</tr>
<tr>
<td></td>
<td>BI customer (e.g. end-user, sponsor, bank customer, organization)</td>
</tr>
</tbody>
</table>

Second, consider the G-D Logic characteristics of BI. The upcoming case study demonstrates inherent G-D Logic characteristics within BI and establishes that BI tends to follow a G-D rather than an S-D Logic approach – despite the applicability of S-D Logic, as described above. This is also represented in Figure 3 in terms of a typical G-D Logic exchange process. Figure 3 also reflects the typical BI exchange activities (with G-D Logic characteristics highlighted), juxtaposed against the typical G-D Logic supply chain.

For example, instead of the customer always being the co-creator of value (FP6), the customer is often a passive recipient (a G-D Logic characteristic), only getting involved in requirements gathering during a BI project. Another example is the common behavior in BI practice whereby great volumes of data are collected and processed simply because the technological capability exists, with no or limited consideration for an identified need for or use of data [60]. This mirrors G-D Logic characteristics whereby the focus is on the means, production and product [37] rather than on both production and use activities and role players.

Figure 3: Typical G-D Logic and BI Exchange Processes
2.7 Literature Conclusion

The literature study explained key concepts, positioning BI in terms thereof. These included: the worldview framework, the service-ecosystem and G-D and S-D Logic. This provides the philosophical underpinning needed to better understand BI understanding and BI challenges – to answer the overarching research question (stated in the abstract). The following sections now provide the case study methodology, results and discussion, using the literature study as a foundation. Case study results indicating characteristics of BI’s worldview and BI challenges are examined, a dominant worldview is identified and the link between BI’s challenges and worldview is explored.

3. Methodology

This research is based on an interpretive 3.5 year case study conducted within a Corporate Banking BI department in a large South African bank, hereafter referred to as Fortune Bank (FB) (A fictitious name assigned to maintain the anonymity) and FB Corporate BI (FBCBI).

The aim of the case study was to understand the interactions, relationships and conduct of BI customers and BI providers working in the BI environment to understand their worldview and what influences and shapes this. Research techniques include interviews, questionnaires and observation – allowing for qualitative data gathering, in alignment with the interpretive approach. The study provided a descriptive analysis and interpretation of the social, organizational and economic world in which the participants – BI vendors and FB – interact. As such, interviews were chosen to elicit direct qualitative answers to questions and observation to look beyond participants’ answers into their worldviews. Questionnaires included open-ended questions to gather qualitative and not only quantitative data. Questionnaires were used for BI vendors, as many were geographically spread across the country and globe.

Questions asked in interviews and questionnaires are reflected below in Table 3, alongside FBCBI artifacts used as input to the case study. The South African focus at FB was complemented with a study of international BI vendors – performed using questionnaires. Results from the international vendors were consistent with those from FB, highlighting the validity of the case study results at an international level.

Semi-structured interviews of 14 FB staff members involved in BI as either BI customers or BI providers (e.g. users/business stakeholders employed in other FB departments as BI customers of FBCBI, FBCBI as a BI provider) were performed. Interviews ranged between 1 and 2.5 hours each. Interviewees were selected based on involvement in a core BI initiative and the ability to offer insight based on knowledge and experience of BI at FB or in a similar environment (e.g. work history).

The primary researcher was a full-time employee of FB and could observe the BI environment during the full case study period. She was involved in strategic and operational work in various roles over the course of the case study performing business analysis, training, management of a team of analysts and project managers as well as change, portfolio and project management. By default, as a participant, the researcher is subjective. To mitigate her subjectivity, she noted facts and occurrences separately from judgments and reflections, enabling more neutrality. She also compared observation notes with interview and questionnaire results, finding alignment with the facts.

Interviews and observation research techniques were complemented with questionnaires to South African and international BI vendors (BI providers). Questionnaires were conducted through FB’s Request for Proposal (RFP) that was underway at the time of the case study, performing business analysis, training, management of a team of analysts and project managers as well as change, portfolio and project management. By default, as a participant, the researcher is subjective. To mitigate her subjectivity, she noted facts and occurrences separately from judgments and reflections, enabling more neutrality.

The primary researcher performed data collection and analysis concurrently in an iterative process. In addition to...
written recordings of the interviews and the actual RFP responses, engagement with FB staff members and artifacts (documentation, processes and technologies) was carried out, assimilating data and capturing field notes. Literature reviews were continuously performed, substantiating findings and deepening enquiry and data collection. Research notes were codified by flagging and highlighting insights and establishing connections between concepts that emerged in the data. Microsoft Excel tables were used for this. G-D and S-D Logic lenses were then applied to analyze the data—seeking identification of the true underlying problem and insight into potential solutions. The various perspectives that emerged in the research findings were considered, analyzed through a philosophical lens and research findings integrated with those from the literature. Although a rich data set reflecting the voices of the various participants was experienced, a checkpoint was performed after the observation period by informally contacting some of the research participants to enquire the status of the BI department. As a final step, findings and analysis were compiled into a doctoral thesis as the report.

Table 3: Questions and Supporting Artifacts

<table>
<thead>
<tr>
<th>Element: Ontology</th>
<th>Questions: Define BI/the BI process. Indicate handovers, role-players and “deliverables” (as per FBCBI and BI vendor terminology)</th>
<th>Supporting Artifacts: FBCBI process documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element: Explanation</td>
<td>Questions: What’s the history of BI? To interviewees only: How was FBCBI established? To BI vendors: How was your firm established – partner of a software/hardware firm?</td>
<td>Supporting Artifacts: FBCBI history (available in a marketing video), vendor website and marketing packs</td>
</tr>
<tr>
<td>Element: Prediction</td>
<td>Questions: What do you see for BI in the future? Explain for FB and industry/trends. What challenges or improvements do you foresee?</td>
<td>Supporting Artifacts: Brainstorming session notes from FBCBI strategic “day away” planning sessions</td>
</tr>
<tr>
<td>Element: Axiology</td>
<td>Questions: What is the purpose/benefit of BI? How is success measured? To interviewees only: What are FB organizational measures that BI supports?</td>
<td>Supporting Artifacts: FBCBI performance measures, BI project objectives and CSFs, FB vision and strategy. Vendor mission statements</td>
</tr>
<tr>
<td>Element: Praxeology</td>
<td>Questions: What methodologies or guidelines are used for BI or by your organization?</td>
<td>Supporting Artifacts: FBCBI and FB methodologies, including FBCBI’s Systems Development Lifecycle (SDLC)</td>
</tr>
<tr>
<td>Element: Epistemology</td>
<td>Questions: Education and work experience background of interviewees. Vendor history (e.g. established as part of an IT organization or purely BI focused, etc.)</td>
<td>Supporting Artifacts: FBCBI history (available in a marketing video), vendor website and marketing packs</td>
</tr>
</tbody>
</table>

Note: Questions were directed to both BI vendors and interviewees, unless otherwise indicated

4. Results and Discussion

4.1 Background and Context

Research results consisted of:
- Descriptions and diagrams gathered through responses to open-ended questions in the interviews and questionnaires.
- Field notes based on observation of FBCBI, its stakeholders and its BI vendors.
- FBCBI artifacts as indicated in Table 3.

Research results were captured in Microsoft Excel in tabular form, maintaining the structure as per Table 3 above and meta data such as the source and type of research data. Interview notes were typed up and interview diagrams scanned and notes made in the Excel tables - within a few hours of each interview. Questionnaire results were copied and pasted from electronic responses. FBCBI artifacts were examined and notes were made (in the Excel tables). Data were flagged according to recurring themes that emerged. Comparisons were then done between data sets. Data sets were also compared with the literature study. It was then possible to extract comparable results and findings, as shown in Table 4 and Table 5 below.
Research results indicate, at the time of the case study:

- Interviewees’ experience: 2.5 to 28 years’ experience in banking and IT.
- BI providers (BI vendors and FB BI departments) typically have IT, Engineering and Science backgrounds while BI customers (business stakeholders) typically have Business, Finance and Accounting backgrounds.

Interviewees were involved in strategic and operational BI work (defined in Methodology).

2 of the 8 RFP respondents are South African vendors with 50 people or less in their employ, established for five or fewer years. The remaining 6 RFP respondents operate within South Africa and internationally, each with more than 1,000 employees and over 21 years’ BI experience.

### 4.2 Key Results

Table 4 reflects a summary of the characteristics that are seen to constitute the dominant BI worldview experienced and perceived in practice by the case study participants (flagged as “CS”), alongside the dominant worldview that is reflected in the literature on BI (flagged as "LS"). Table 5 summarizes the key challenges that emerged in the case study, as experienced by the case study participants.

Results represent summaries of in-depth analysis and comparison of case study research data and are supported by Table 3, as a means to explain what was used as a basis to formulate each summarized characteristic. This paper represents case study results at a high level for comparative purposes. Supporting detailed analysis is available in the unpublished thesis that underlies this research [11]. Supporting detailed analysis includes quantitative analysis of results, e.g. 75% of respondents used technology to describe what BI is and therefore Table 4’s Ontology section reflects that BI is perceived as a technology. It also includes qualitative analysis based on direct quotations from respondents, e.g. when asked questions about challenges and frustrations experienced in his/her job, a BI provider stated “we produce so many reports, but the business forgets about them and they don’t get used”. This could be linked to challenges in use – as well as challenges in alignment between business and IT.

### Table 4: Characteristics of BI's Worldview per Worldview Element

| Ontology | 1 BI operates from an ambiguous and unstable model of reality, where BI is perceived as a: technology, process, product and capability (one or multiple of these perceptions). (LS, CS) [1][20][3][51] |
| Past | 2 BI is generally understood (by BI providers and customers) to consist of a linear series of development or data processing activities up to the point of exchange (e.g. implementation/delivery), potentially including change management. Only a few individuals define BI beyond this point, these typically are BI customers. (CS) |
| 3 No definitive explanation for uncertainty in BI perceptions. (LS, CS) [45][17] |
| 4 BI emerged from a hard (mechanistic, deterministic) systems and engineering background. (LS, CS) [1][5] |
| 5 FB BI departments were established by individuals with dominant IT backgrounds. (CS) |
| 6 BI vendors were established with an IT focus or by an IT organization. (CS) |
| Prediction | 7 Technological advances envisioned for the future. E.g. customization and improved delivery mechanisms. (LS, CS) [6][4] |
| 8 FBCBi demonstrated a renewed technology focus by changing its name to BI Technology Services (BITS). (CS) |
| 9 BI customers are concerned about future technology solution’s features and functions. (CS) |
| 10 BI providers are concerned with collecting and managing greater volumes of data, expanding their BI target market (audience) and improving delivery mechanisms. (CS) |
| 11 BI providers aim to reduce time spent on data processing to spend more time developing and automating BI technologies. (CS) |
| 12 Frustration is experienced due to customer “meddling”, but there is a desire to close the BI customer-provider gap through, e.g.: conversations in business jargon; a new type of BI resource (with expertise in business and IT); longer support periods to equip users. (CS) |
| 13 A return to focus on decision-making is expected – enabled by analytics. (LS) [4][19][32] |
| 14 Data (enabled by technology) is the new driver of BI. (LS) |
| 15 Collaboration and interconnected solutions receive attention. (LS, CS) [4][6] |
| Axiology | 16 Value is measured by the BI provider at the point of exchange of a tangible BI output. (CS) |
| 17 BI’s purpose is seen to be “inform decision-making” but value is measured according to cost, quality and schedule measures on the BI IT solution and implementation thereof. Furthermore, BI is aligned with marketing and banking strategies that target and acquire customers and markets. (LS, CS) [21][4][27] |
18 BI vendors don’t typically receive feedback on use or performance of their BI solutions. (CS)

19 FB targets customers, selling and marketing to them to bring them onboard as primary banked customers and optimizes its processes to do this as efficiently as possible. (CS)

20 BI vendors promote and value intangible benefits or features of IT solutions, assuming “customer value” is the output of their software development process that takes place upon implementation (exchange) and can be defined unilaterally by vendor, upfront. (CS)

21 BI values the BI environment and applications (neglecting use of BI). (LS, CS) [49]

22 BI’s purposes are largely intangible, subjective and hard to measure (ROI). (LS, CS) [44]

23 BI is a top priority/value. BI is for all levels of the organization (“everyone”). (LS, CS) [32][3]

Praxeology

24 Various strategies, Critical Success Factors (CSFs), frameworks, etc. (grounded in IT) are provided by BI providers to manage, govern and guide the BI environment and its technologies. (LS, CS) [21][62]

25 BI’s guiding principles are defined and implemented unilaterally by the BI provider, without interference or influence from the BI customer. (CS)

26 BI consists of a linear series of activities in a software development process or a data warehousing process, guided by relevant IT/data methodologies. (CS)

27 The decision-making process is referred to, but not described. Focus is on delivery of BI technology solution and/or product and the activities to do this. (CS)

28 BI customers don’t typically participate in BI solution development unless required to by BI provider e.g. for requirements gathering, User Acceptance Testing (UAT), training. (CS)

29 Agile development approaches are strived towards to increase collaboration within BI departments (i.e. between data, development, analyst teams) and to increase the BI department’s productivity and deliver BI requirements at faster response rates. (CS)

Epistemology

30 BI is informed by various disciplines, science and business functions, but focuses on BI’s IT and IS aspects, causing an imbalance. (LS, CS) [1][20][3] [51]

31 BI providers (BI vendors and FB BI departments) typically have IT, Engineering and Science backgrounds while BI customers (excluding FB BI departments) typically have Business, Finance and Accounting backgrounds. (CS)

32 A limitation is identified in the gap between BI customer and provider competencies. (LS, CS) [8][9]

33 When raising challenges, BI customers and providers restrictively focus on their lack of knowledge of the other’s expertise rather than on sharing their expertise. (CS)

34 BI flows across the organization, irrespective of business function. BI providers and customers restrictively think of BI in terms of function, creating gaps where BI overlaps between business, BI and technical realm – e.g. business data ill-understood by all. (CS)

Table 5: Key Challenges Identified in the Case Study and Literature Study

1 BI use: BI is not used optimally.
   The volume of data is overwhelming. BI represents unfamiliar territory for users. There is poor or absent metadata and training. There’s a gap between the BI application or output and human decision-making.

2 Managing big data.
   The volume of data is overwhelming. Storing and accessing big data spread across the organization in various formats is difficult. Managing customer demands for data from new and unstructured resources. Gaps in ownership or responsibility for data or data quality.

3 Integrating BI across many complex technology, data and business layers.
   BI infrastructure is complex, expensive, takes time and can’t be used until most of it is complete.

4 Aligning and balancing the needs of the various role players in BI
   BI customer and provider are separated. Communication and collaboration fails. BI vendors try to bypass BI departments. Various BI departments and silos spring up in the organization.

5 Recruiting, retaining and using BI personnel and their skills effectively
   A broad skill set is required (business and technology). BI departments are forced to recruit IS and IT instead of BI experts.

6 Getting the right sponsor in place
   Absence of sponsor understanding, sponsor “mislead” by BI vendors selling tools that make BI appear a quick and easy endeavor, without taking integration or organization into consideration.

7 Realizing and measuring Return on Investment (ROI)
   BI success is measured at point of delivery of project or data process, making ROI hard to measure in the longer term.

8 Operating in an ambiguous environment
   BI is ill-defined and its environment is ambiguous. BI is treated generically the same was as a standard IT project – leading to BI-specific issues being largely overlooked. BI is perceived narrowly as an IS or even more narrowly as a data or IT solution – leading to success being measured by BI vendors’ sales volumes or data processing capabilities and recruitment of IS, IT and data professionals instead of BI experts.
4.3 Discussion of Results

Inherent G-D Logic can be identified in many of BI’s worldview characteristics. As an example, consider BI worldview characteristic 2 (Table 4). This reflects the G-D Logic characteristics whereby value is perceived in exchange rather than use [24] and a focus on means, production and producer [23][56]. Further examples are presented in Figure 4, which reflects a summarized view of BI’s dominating worldview with icons A through D representing G-D Logic characteristics. Figure 4 is based on Figure 2 (above) to show the relationship between the various worldview elements as well as the outcome in terms of the challenges. Figure 4’s key links each of these G-D Logic characteristics to BI worldview characteristic in Table 4.

Figure 4: BI’s Dominant Worldview Grounded in G-D Logic
Key:

<table>
<thead>
<tr>
<th>Ref.</th>
<th>G-D Logic Characteristic</th>
<th>Link to Table 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Value in exchange</td>
<td>2, 16-18, 20, 21, 27</td>
</tr>
<tr>
<td>B</td>
<td>Compete through goods and their features</td>
<td>2, 7-9, 11, 13-18</td>
</tr>
<tr>
<td>C</td>
<td>Separation of BI customer and BI provider</td>
<td>2, 4-6, 9-12, 16, 24, 25, 28, 30-34</td>
</tr>
<tr>
<td>D</td>
<td>Focus on means, production and producer</td>
<td>1-2, 4-8, 9, 10, 14, 16, 17, 19-21, 23-31</td>
</tr>
<tr>
<td>E</td>
<td>Focus on “services” rather than “service” and on exchange rather than on BI as a service-ecosystem informed by S-D Logic</td>
<td>1-2</td>
</tr>
</tbody>
</table>

The relationship between recurring themes of challenges and the dominant G-D Logic worldview of BI is also identified. As an example, consider challenge 1 (Table 5) which highlights how focus is on producing (discovery) rather than use, referencing back to Figure 3 where this is depicted. Table 6 provides an example and explanation, drawing from the literature and referencing the icons used above in Figure 4.
Table 6: Example of the Relationship between BI Challenges and G-D Logic Characteristics

<table>
<thead>
<tr>
<th>BI challenge</th>
<th>G-D Logic Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI is an ill-defined discipline operating in an ambiguous environment [1] [20] [3] [51]. This, and failure to consistently recognize or address this [45] [17], results in misalignment, separation and confusion. BI and BI value are then largely defined unilaterally upfront by BI providers, typically operating from a systems and engineering-centric worldview, focused primarily on BI as an IS (or data/IT solution) [45]. A dominant focus on BI technology and its features, processes, etc. overshadows other components and resources that are also needed in BI, e.g. ability to use data/IT solution, relationships, etc. [8]. This focus culminates and then dissipates at the point (or shortly thereafter) where the BI product is implemented (exchanged) [21][4][27].</td>
<td>BI is defined and scoped upfront from the provider’s point of view (neglecting and isolating the customer) [24] C This leads to passive customers and loss of knowledge of each other’s environments and context [16]. C BI providers define BI as a linear series of production activities [15][55] D that focus on BI technology (as a tool) and its features B, D – the means, production and producer [23][56]. D Value-in-exchange is perceived rather than value-in-use [24]. A</td>
</tr>
</tbody>
</table>

Based on this, it can be assessed that BI’s dominant worldview is fundamentally grounded in G-D Logic and that there is a relationship between the re-occurrence of BI challenges and the G-D Logic worldview or approach to BI.

5. Recommendation

Identification of inherent G-D Logic in the dominant BI worldview and identification how the G-D Logic characteristics can be linked to BI challenges leads to the recommendation to further explore applying S-D Logic to BI. This is recommended to determine whether implementation of a service – rather than a goods / manufacturing approach – can assist to overcome BI challenges that result from a G-D Logic approach. Based on the research presented in this paper, it is believed that this is a viable route of exploration. The following benefits of an S-D Logic approach are put forward in this regard:

- A move from focus on BI IT implementation to use of BI in decision-making
- More time spent on analysis/insight than on data processing/software development activities
- Relationship becomes a focus with BI customer and BI provider taking accountability to co-create value – reduced customer passivity/provider rigidity
- Less focus on churning out “deliverables” such as data and BI tools that may not be used/overwhelm users
- Skills and knowledge embedded in value networks result in insight that is hard for competitors to simulate

Furthermore, Table 7 reflects the proposed research agenda for the shift from G-D to S-D Logic for BI, alongside the associated BI FP.

Table 7: Summary of the G-D to S-D Logic shift for BI, based on G-D Logic characteristics identified in BI’s worldview and challenges

<table>
<thead>
<tr>
<th>Reference</th>
<th>G-D to S-D Logic shift</th>
<th>Associated S-D Logic FP</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Value-in-exchange to value-in-use</td>
<td>6, 7, 10</td>
</tr>
<tr>
<td>B</td>
<td>Compete through goods and their features to competition through operant resources embedded in value networks</td>
<td>3, 4, 7</td>
</tr>
<tr>
<td>C</td>
<td>Separation of BI customer and BI provider to a customer-oriented and relationship focus</td>
<td>2, 4, 6, 7, 8</td>
</tr>
<tr>
<td>D</td>
<td>Focus on means, production and producer to a focus on both production and use activities and role players</td>
<td>9</td>
</tr>
<tr>
<td>E</td>
<td>From “services” to “service” and BI as a service flow informed by S-D Logic</td>
<td>1, 2, 5</td>
</tr>
</tbody>
</table>

6. Concluding Remarks

In response to the overarching research question, this paper demonstrates that taking a step back to understand the
model of reality held with regard to BI can indeed lead to a better understanding of BI and its challenges. In response to the secondary questions on what BI’s worldview characteristics are and whether it is plausible that these influence or repress realization of benefits, this paper identifies that there is G-D Logic inherent in BI’s worldview and that this can be linked to recurring challenges that hinder BI success within the organization. Recommendations are made for further research to explore S-D Logic as an alternative for BI. This is a new and yet unexplored avenue of research for which this paper provides a solid point of departure. A proposed research agenda is provided above in Table 7, where each G-D to S-D Logic shift could be researched and analyzed distinctly, or as an interwoven series. Existing research [10] already provides an example of a study on the shift from production to use, which aligns with research agenda item referenced as “D” in Table 7.

References


The Role of the HRM in the Construction of KM for the Innovation in Technological SMEs

Thibaut Métailler
Aix Marseille Université, Aix en Provence, France
thibaut.metailler@hotmail.fr

Abstract: The purpose of this research is to show the link between “human resources management” and the knowledge management in practice, within technological SMEs. We show that the HRM processes set up by the entrepreneur and his experts’ collaborators in fact reveal more implicit KM practices that are deliberately integrated into the organisation through community of practices. The community of practices offers a new opportunity to assist entrepreneur in decision making to innovate by the knowledge management. The centrality of the entrepreneur is reduced for the benefit of the members of the community of practices. We used a methodology known as PAR (Participatory Action Research) strongly mobilized in the study context regarding knowledge transmission, training and recruiting. This methodology allows to both meet the organization’s expectations in terms of management and knowledge transfer, and data production based on a scientific method.

Keywords: Knowledge Management, HRM, communities of practices, Expert, Hightec SMEs

1. Introduction

In France, the industrial policy of encouraging technological innovation is supported by HRM services such as the formalized management of competences, recruitment and training. These kinds of services are influenced by the HRM norms (Pichault and Nizet, 2001) and strategy of large companies or bureaucratized organizations (Mintzberg, 1987). The aim is to identify and make explicit the required competences in specific jobs and providing the associated recruitment and training in accordance with the strategy (Pichault, 2007). If knowledge is considered as the competitive advantage of SMEs (Sparrow, 2001), this orientation of the Human Ressources to technological SMEs then raises the question of their articulation with Knowledge Management (KM) in practice and in theory. KM is defined here as a strategy for managing organizational knowledge, supporting decision-making, building up competitiveness and improving creative and innovative capacities (Zyngier et al., 2004). Whereas in large companies the HRM process and the design of its tools are separated from the KM process (Sparrow, 2001; Macpherson, 2005), this is not generally the case in SMEs where the entrepreneur integrates these two functions in practice (De Souza and Awazu, 2006). It is still less the case in technological SMEs (Gourlay, 2001). Under the influence of his own technological knowledge acquired through experience and learning, the entrepreneur develops the HRM practice in an implicit KM (Hutchinson and Quintas, 2008; Macpherson and Holt, 2007). This approach implies to consider the role of HRM processes in KM (Sveitlik and Costea, 2007) in technological SMEs.

By focusing on specificities of KM in technological SMEs, we thus consider two questions in this research 1/ How does the entrepreneur use HRM process to create KM flows in order to innovate in technological SMEs? 2/ In the practice, how does the implementation of the link between RH and KM take shape?

The data collection methodology is that of Participatory Action Research (PAR) (Kindon, Pain and Kesby, 2010), conducted over a three-year period in an optics and photonics cluster. Our job is to combine a Research and Development approach with operational function to offering HRM services to support innovation in young SMEs (less than ten years old, where the founder is still in place). With the PAR, we collected data by scientific initiatives (interviews, observations) integrated into the operational practice. We processed the data via the software Nvivo which allowed us to analyze according to codes previously established.

After presenting and establishing the theoretical framework of the approach based on specific link between KM and HR in technological SMEs, we shall set out the PAR methodology and then the results of this study. The originality of this paper is to show that beyond the strategic dimension, the practices of human resources and Knowledge Management are deliberately created and linked by the entrepreneur to assist him in decision-making to innovate. Doing so, his objective is to develop the knowledge for the innovation in SME.

2. Theoretical approach to KM in SMEs

In technological SMEs, the organizational arrangements orchestrated by the entrepreneur play a fundamental role in innovation (Sparrow, 2001); they are at the heart of the productive activity (Atherton, 2003) and structure the knowledge flows (Tsoukas, 1996). While for some authors the design of the knowledge-flow organizing processes is
centralized and personalized by the entrepreneur (Evangelista et al., 2010), other authors stress the combination of knowledge between the entrepreneur’s expertise and that of his co-workers (Tsoukas, 1996). In technological SMEs, as in communities of practice (According to Wenger (1998), a community of practice defines itself along three dimensions: its joint enterprise, a mutual engagement, the shared repertoire of communal resources) (Lave and Wenger, 1991; Brown and Duguid, 1991), knowledge is said to be constantly produced and negotiated, dynamic and provisional (Gherardi and Nicolini, 2000). However, in technological SMEs, these knowledge flows appear inseparable from the central role and intentionality of the entrepreneur, practising a KM based on his own technological knowledge incorporated into the strategy of innovation. This type of KM, which some authors call informal (Hutchinson and Quintas, 2008) and others implicit (Nunes et al., 2006), questions the pertinence not only of KM tools but also of HRM centred on formalization of knowledge (Gourlay, 2001) and orienting recruitment and training.

In young technological SMEs, the entrepreneur’s expertise seems to combine with the knowledge flows in the community of practice to which he belongs, for an integrated conception of HRM and KM processes (Gourlay, 2001). The centralization of the management can be discussed for the benefit of a more shared approach particularly in the management of the innovation.

2.1 Personalization of KM and HRM through the expertise of SME’s entrepreneur

Both HRM and KM have been shown to be powerful factors in the success of organizations and more particularly in SMEs (Jorgensen and Keller, 2008; Clancey and Sierhuis, 1997).

Comparison of the KM cycle with HRM practices reveals many activities shared by these two approaches (Sveitlik and Costea, 2007). Knowledge acquisition is found, for example, through external recruitment of individuals who will support learning and growth as individuals and professionals (Sveitlik and Costea, 2007). Similarly, in SME studies, Wong and Aspinwall (2005) argue that training activity is a source of KM implementation.

Contrary to large companies (Scarborough, 2003), informal KM integrated with HRM processes based on socialization is regarded as a lever effect that makes it possible to achieve the strategic aims efficiently and effectively in SMEs in various sectors (Desouza and Awazu, 2006). The work of Sparrow (2001) and Scarborough (2003) show that innovation processes in SMEs are facilitated by cohesion between KM and HRM. The functional distinction between KM and HRM is rare in SMEs, because of the centrality of the manager in the organization of activity at ground level and his role in strategic decision-making (Sparrow, 2001).

In the case of technological SMEs, this centrality is based on the technical and scientific expertise more than managerial expertise (Starbuck, 1992). This expertise is at the origin of the innovation (Carter et al., 2003) and comes from the experience of highly qualified entrepreneur (engineer, researcher). In the definition of the expert, Tynjälä, (1999) shows that the nature of the expert is to mobilize all these knowledge to identify, acquire, manage and develop these knowledge (Tynjälä, 1999). This natural characteristic of the expert is called metacognitive activity (Tynjälä, 1999). In fact, the entrepreneur does not centralize the management but he throws practices and process from these mental models (Jonhson and Laird, 1983) for the innovation in technological SME. This argument would explain KM strategies centred on personalization rather than codification (Zanjani and al., 2009) in technological SMEs, beyond the pursuit of efficiency. To Zanjani and al. (2009), “personalization is a strategy to manage the knowledge that is produced by human interaction”.

So the socialization of Desouza and Awazu (2006) is not the only way to the KM technological SMEs and the embedding of KM flows is achieved through the metacognitive (Metacognition is an activity of reflection on one’s own knowledge and sharing ) activity of the entrepreneur who develops his own approach (Norris and Krueger, 2007) of knowledge management. Indeed, Sparrow (2001) suggests that SMEs develop their own understanding of KM. He thus concurs with other authors whose results show that even if they do not have an explicit KM strategy, technological SMEs have implicit strategies and guidelines for KM issues (Nunes et al., 2006). KM integrates procedures and management with work organization in the company (Nunes et al., 2006) such as HRM process. KM is based on informal way to renewal constantly the technological and even scientific knowledge that is the source of innovations (Nunes et al., 2006).

Atherton (2003) even argues that successful development of an SME depends on its ability to work in and with learning, which converges with the expert entrepreneur’s metacognition through the KM cycle (Nonaka and Takeuchi, 1995) (acquisition, creation, transfer). Acquisition corresponds to the search for knowledge and information from different sources, knowledge creation corresponds to the development and expansion of the base of new knowledge, transfer corresponds to distribution and sharing (Svetlik and Costea, 2007, p. 200-201).
The structuring of knowledge creation (Von Krogh, 1998) within technological SMEs is different from other organisations (Quintas et al., 1997) and it would seem that the functioning of this type of company would then be very close to that of an intentionally created community of practice (Ackerman et al., 2008).

2.2 KM in decision-making to innovate, the role of community of practice

Argyris and Schon (1996) presented “communities of practice” (CoPs) as the intermediary that makes possible individual learning based on a collective validation of knowledge. Communities of practice have been found to support knowledge creation by knowledge sharing among experts in firms (Wolf et al., 2011). They are “groups of people informally bound together by shared experience and passion for a joint enterprise” (Wenger and Snyder, 2000, p. 139). Knowledge sharing then takes place in a situated dimension (Lave and Wenger, 1991; Clancey and Sierhuis, 1997) of the everyday life of the “community” or work collective (Brown and Duguid, 1991). A CoP brings stable collective references into individuals’ identity and cognitive construction, and enables them and the group to learn knowledge sharing processes (Lave and Wenger, 1991) and represent a favourable context (Nonaka and Konno, 1998) to create opportunities for innovation (Cook and Brown, 1999).

When these communities are supported and remain oriented by the task for which they were created, they facilitate knowledge use, development, management and storage (Snowden, 1997) and knowledge transfer (Macpherson and Holt, 2007). Gourlay (2001) even argues that knowledge is “better” managed in this type of group than by a formal KM and HRM processes devised outside the community. Nicolini et Gherardi (2000) also argue in this direction when they explain the rules of work inculcated in training programmes offered by management are not appropriated by the members of a CoP: this is governed by its own working rules which are constitutive of individual identity and social membership of a group. HRM processes that consist in identifying and making explicit the skills in jobs so as to be able to plan the recruitment and training would present a problem in the presence of a work collective close to communities (Legge, 1989; Pichault 2007).

These approaches converge on analyses of the role of organization in the structuring of technological SMEs (Quintas et al., 1997; Von Krogh, 1998).

In their analysis of innovative SMEs in clusters, McAdam and Keogh (2004) approach CoPs in SMEs as a form of structural innovation to support innovation. They mediate the strategy and support processes of innovation and creativity by making employees feel responsible and committed. Sparrow (2001) shows that the adoption of consultative processes and “learning by doing” approaches are indeed developed within SME communities of practice. McAdam and Koegh (2004), stress the strategic role of the ability of employees belonging to CoPs in SMEs. It is then clear why individualization rather than institutionalization of KM is predominant in technological SMEs as a KM tactic (Zanjani et al., 2009). Indeed, according to Zanjani et al. (2009), whereas institutionalization is based on the formal aspect validated and recognized by the collective in socialization, (for example, giving a young recruit a collectively validated information and introduction guide is a form of institutionalization) individualization emphasizes the informal aspect in small groups supporting knowledge sharing at the individual level:

“Individualized tactics allow knowledge sharing to take place using an informal and decentralized approach so in small organizations, individual tactics may serve the knowledge sharing needs of the organization adequately as employees frequently meet each other in the hallways” (Zanjani et al., 2009, p. 372).

We then assume that this perception of KM reinforces the positioning of the CoP within knowledge acquisition, creation and transfer processes.

The question of the SME entrepreneur role was not addressed in this approach. Nevertheless the traditional literature (Torres, 2004; Evangelista et al., 2010) highlights the centrality of management by the entrepreneur in SME more prescriptive. The entrepreneur creates an “egoform” (Torres, 2004) and seems to be alone in the decision-making process. In technological SME, the concept of community of practice allows to discuss this centrality. Clancey and Sierhus (1997) explain that communities of practices are created by legitimated people. In technological SME, we saw entrepreneur is an expert and he creates a community of practice with experts to share the knowledge and secure the “best” decision. Since the nature of an expert is to discuss his knowledge with his peers, we suggest that the centrality of the entrepreneur role can be reduced for the benefit of a scientific collective process of knowledge validation: Communities of Practice
2.3 The entrepreneur connects KM and HRM to innovate

In large companies, the question of the governance of the CoP brings out the complexity of the relationship between the hierarchical authority of the entrepreneur in his management and the authority of the CoP (Pattinson and Preece, 2013). Clancey and Sierhuis, (1997) show that CoPs in the case of SMEs are produced by the permission of individuals legitimate within the organization. In technological SMEs, technological knowledge of the entrepreneur and his expert's position support his authority in the community (Métailler, 2015).

Jorgensen and Keller (2008), argue that the condition for the creation of knowledge within the CoP comes from the alignment of such KM with the practices of management and the activities of the firm. HRM practices would be then directly involved in the knowledge cycle.

The entrepreneur does indeed occupy a hybrid position, as one among peers within CoP and in a position of authority through the employment contract, which implies a position of subordination in the organization and performance of work. The expertise of the entrepreneur in the choice of HR processes materializing the knowledge stemming from his expertise is re-configured by the knowledge of the CoP, which has an authority of its own.

We then suggest that, in the presence of a CoP, the entrepreneur of a technological SME has no choice but make his expert knowledge dialogue with that of the other experts in his community to organize the KM flows in the HRM processes.

The notion of “distributed expertise” (Hatchuel; 1996) in technological and scientific knowledge then makes it possible to relativize the idea of centralization of the strategic decisions orienting the knowledge flows in this type of SME. This notion suggests a consultative role (Sparrow 2001) of CoPs though an organizational design drawn up in discussion with them (Jørgensen and Keller, 2008). The knowledge flows are thus constructed individually and collectively at the heart of a work organization by different socially recognized and encouraged practices (Nicolini and Gherardi, 1991).

The intentionality of the entrepreneur in the construction of KM flows in the SME then consists in setting up mechanisms to encourage individuals to practise behaviours of knowledge sharing and selection of this knowledge from the environment (Grant, 1996; Macpherson and Holt, 2007) such as CoP. This prescription is based on the entrepreneur’s past experience (Musyck, 2003) and his perception of the environment (Nicholls-Nixon et al., 2000); it represents a tactical solution to the quest for alternative sources of knowledge lacking in the company (Deakins et al., 2000).

Recruitment in technological SMEs would therefore follow rules close to those of the CoP. Thus, whether it is formal or not, a CoP is self-organized and its members are recruited by co-option (Wenger and Snyder, 2000). These authors stress the importance of the structuring of the community by itself and the central role of the knowledge specific to the activity in the organization of knowledge flows through recruitment.

Pattinson and Preece (2014) show that in innovative technological SMEs, everyday problem-solving with client partners favours the acquisition of individual knowledge. They then demonstrate the importance of individual learning in innovation and show how in SMEs built on scientific and technological knowledge, the CoPs, made up of experts, favour and support knowledge transfer by performing “on the job training” and development functions. CoPs thus constitute a favourable context for the transfer of tacit and informal knowledge among experts and between experts and novices (Anderson et al., 2001). By recourse to HRM processes on which he is the final arbiter, the entrepreneur is then the monitor of the KM flows in the community that he has initiated by HRM process. HRM processes create KM flows and CoP. This one allows to guide the entrepreneur through his decision-making.

3. Data and methodology

In December 2010, a CIFRE (Conventions Industrielles de Formation par la Recherche: a scheme under which a company is subsidized to hire a doctoral student with a view to collaboration with a public research laboratory.) Agreement was drawn up between the OPTITEC competitiveness cluster and the research laboratory specialized in labour economy and human resource management. Established in two regions, (Region of Provence-Alpes-Côte d’Azur and Region of Languedoc-Roussillon) this cluster represents the optics and photonics sector of southern France. It consists of a population of 115 industrial companies, 85% of which are SMEs created in the 2000s, occupying market niches in optic and photonic technologies for the environment, health and defence/security/aerospace industries.
3.1 Méthodology

The objective of this agreement was to analyse the HRM process and KM practices in SMEs to support innovation. The collection of research data presented here resulted from an activity as an employee with a dual – complementary and dependent – function in the operational team of a competitiveness cluster which was negotiated and decided with the governance of cluster at the signature of the agreement:

- A function as a strategic workforce planning officer within the cluster;
- An R&D function in a public research body.

In this study, we mobilized a methodology called Participatory Action Research (PAR) (Kindon, Pain and Kesby, 2010) which assimilates this dual posture. This methodology makes it possible to respond both to the expectations of the organization in terms of knowledge management and transfer and to the production of data in accordance with a scientific method. PAR is defined as a collaborative process of research, education and action (Hall, 1981) explicitly oriented around a social transformation. The researcher and the participants identify and examine a situation of change or a research object in order to improve it (Wadsworth, 1998). Research operations are then initiated in order to highlight the possibilities, capacities and evaluations of the action concerned on the basis of research work and materials derived from practice. This methodology coordinates the bodies in charge of the creation and development of knowledge and those who use this knowledge in the framework of action on industrial or social development. It legitimates our positioning within the cluster as an actor in the creation of knowledge, in interaction with the bodies and institutions in charge of what is commonly called competence management. It also enables us to enrich the scientific work by the collection of original materials directly derived from the operational function, such as documents, and observations from the implementation of the strategic workforce planning mechanism for the businesses in the cluster.

3.2 Data collected & data analysis

The PAR methodology thus makes it possible to include on the same footing the traditional methods of research in management science such as semi-structured interviews and focus groups of the collective action, and also visual and performative methods derived from action in a scientific perspective (Kindon, Pain and Kesby, 2010).

We make use in this study of two types of complementary resources that stem from a dual positioning:

We draw on ten interviews carried out in SMEs (To target the SME population concerned here, we used the definition of the GREPME (Groupe de Recherche en Economie et Gestion des Petites et Moyennes Organisations et de leur Environnement) (1994), which approaches SMEs by five characteristic features (smallness, centralized management, low specialization, simple or relatively non-organized internal and external information systems, and an intuitive or relatively non-formalized strategy). numbered 1 to 10 in the labelling of the transcripts, in the framework of the research work of the laboratory. Positioned as a researcher and as an external member of the cluster, we carried out interviews with an average length of two hours thirty minutes, always on the premises of the business itself. The interviewees were always the entrepreneurs of SMEs, all trained as engineers and aged between forty and fifty-five. In this exploratory phase, we opted for semi-structured interviews so as to give the managers the opportunity to express themselves freely and exhaustively, in order to understand how they approached the topic. We did not concentrate exclusively on HRM and competence management processes but approached the topic in a way that was more integrated with company strategy and organization. The interview guide was thus constructed around the following axes:

- The company
- Technology, strategy and organization: developments in technologies and associated knowledge
- HRM and KM: knowledge management processes.

Using the possibilities of PAR we mobilize a second resource resulting from a different posture. We analyse a collective action of competence management carried out within the cluster for five SMEs numbered 11 to 16 in the labelling of the transcripts, which we set up and co-constructed with our partners in the framework of our operational function. We here played a role in the participatory research as a participating actor and observer. This action was initially designed to support five to ten SMEs belonging to the cluster in their competence management and in integrating strategic workforce planning tools. In our case we carried out the action with five companies. We have implemented an intervention that diagnoses the relevance of practices to innovate in each company during 5 days and 3 collective times to favour the experiences feedbacks between entrepreneurs.
By our expertise developed in the cluster, we have reoriented the diagnostic towards topics concerning the following KM processes of the SMEs to support innovation:

- Work organization,
- KM and specificities of SME management

These five companies are also represented by their five entrepreneurs during 3 working sessions of 4 hours to discuss about the feedback of the interventions. The working sessions are co-animated with institutional partners and the subjects are “KM practices to improve innovation process”.

We shall analyse the following material: the discussions around the diagnoses, the exchanges in the focus groups involving the entrepreneurs, the summary document and debriefings carried out by the institutional partners, the content of the training identified by the partners and validated by the companies, and the various research notes made the context of the participant observation.

The data presented are coded with Nvivo in three main dimensions, present in the main question of the interview and the follow-up questions.

These 3 dimensions are the following:

- Recruitment in an innovative environment:
- Training in a context of expertise
- Work organization in an expert community

In the framework of the exploitation of the transcripts and for each dimension of analysis, the data are not exhaustively integrated. The extracts chosen are intended to sensitize the reader to the reasoning of the actors studied and their language, while bringing to light the social categories of their practices.

4. Results

In this part, we study the perception of the formal HRM mechanisms with the specificities of the management of persons and knowledge in SMEs. These results are aimed at understanding what KM processes are mobilized in SMEs and why the expert and technical managers of SMEs have integrated these processes into their everyday activity.

4.1 Recruitment, a decision-making shared and based on KM process

When SME entrepreneur are asked about recourse to recruitment institutions, 12 about of 15 SME entrepreneurs do not see “the interest of such a procedure” (Company 3), which they may find too complex and too time-consuming in relation to performance.

“No, we don’t work with the recruitment partners, it’s too complex” (Company 1)

It can thus be understood why the recruitment assistance services offered by the employment partners do not represent a solution in themselves.

“... first and foremost we do it through our connections [connaissances] because they perform well from the start and meet our needs rapidly” (Company 2).

The question of the knowledge [connaissance] of the novice can be seen as an element in its own right in consolidating a company strategy. Recruiting constitutes a considerable “risk” for the SME entrepreneur inasmuch as he has to acquire knowledge and integrate a “satisfactory” and “reassuring” competence.

“We only do it through the network... it’s reliable and meets our needs” (Company 3).

With the phrase “our needs,” used spontaneously and recurrently, the entrepreneur does not separate himself from the community in the activity of recruitment and acquisition of knowledge by HRM through the collective validation of the need.

The phrasing used in Company 2 and 3 enables us to explore further the role of the knowledge and the social network of the CoP in the recruitment process. The community asserts itself as guarantor of a new scientific contribution (initial value).

“We are all experts in our fields so we know how to identify the people who may interest us in terms of our needs and requirements. And then, when one of us knows someone, he already knows what that person will
bring us [as regards knowledge]. Then he talks to us about it, but except in extreme cases... well, in general, when one of us validates, the others agree. It’s not democratic, it’s just that we and think things the same way.” (Company 12)

In this excerpt, the recruitment processes observed (network recruitment) within the SME then seem to correspond to a practice of consulting the CoP. The use of “we” (“our requirements,” “we are experts,” “our knowledge”) in the remarks quoted shows the involvement of the CoP in identifying the scientific and technical knowledge lacking in the company and its collective validation by the community. This approach reveals the importance of the consultative aspect of the CoP in knowledge acquisition and its involvement in the processes of KM by HRM.

“Well, to start with, when we have a need, generally it’s because we have long-term projects, and then we recruit. The new recruit starts his job, and contributes his added value directly, but then as time goes on he transmits [his knowledge] to his colleagues, informally, but he transmits it all the same, that’s the aim...We all have our specialities but we are still all technical experts, so we understand one another” (Company 11).

The novice contributes directly in a first stage to the conception of the product or service. In a second stage, he supplies the CoP with his knowledge identified and validated by the community, and makes transfer of knowledge to the experts.

So when the entrepreneur consults community to recruit a new expert, he tries to validate scientifically the knowledge of the novice to reduce the risk of his decision-making. By the recruitment, the entrepreneur with CoP create KM flows which assist him in decision making. This approach relativizes the central position of the entrepreneur in the knowledge acquisition process. For while he remains alone in the decision-making, the consultative aspect of the CoP in the analysis of needs seems preponderant. As regards knowledge, the entrepreneur seems to share expertise with the community to ensure the acquisition and transfer of knowledge in technological SME.

4.2 Self-training, an implicit KM process to develop technical knowledge

The absence of formalized process does not imply an absence of strategy. Asked about the modes of training and the development of knowledge, the SME entrepreneurs almost unanimously (13 about of 15) answered: in-house training. The analysis of similar transcripts enables us to understand why the SMEs’ training is done intra-organizationally within the cognitive space of the company in accordance with the specific mode of recruitment previously observed.

“We only train ourselves in-house, there’s no training plan. Management training and so on is of no interest to us. Because we can’t find anything in technical training, we train ourselves here…” (Company 10).

“For everything technical we train ourselves in-house” (Company 5).

As in the case of recruitment, the entrepreneur shows his sense of belonging to the community of experts by regular use of “we”. The community seems here to have validated the technical gaps in training that correspond to its needs. By the discourses analysis, we can even suggest that, from a technical point of view, the entrepreneur involves the community to manage knowledge by identifying the gaps but also the opportunities, through projects, problem solving...

“We provide training in-house by technology watch, through projects, in a word, everything that makes up the environment of our activity…” (Company 2).

“Here, at the technical level, we train ourselves. There’s our technology watch of the sector, the company projects, collaborative projects, national and international trade fairs, everything you can find around the activity” (Company 7).

From the entrepreneur’s representation, the CoP tends to preserve its competitiveness and its expertise. The community seeks to create knowledge by mobilizing, within the activity, all the resources for development of informal knowledge available to it.

The identity of the community experts including their metacognitive activity can then be seen as one of the levers for development of knowledge in the SME community. The idea of co-constructed and shared expertise thus intervenes to expand the notions of work organization centred on the manager.

As one of our interviewees neatly phrased it, in-house training is seen as:

“...a regular system that allows more reactivity and meets our requirements by mobilizing our resources” (Company 8).
In a first stage we can consider the implications of this material. It is relevant here to note that we only interviewed SME entrepreneurs. While the entrepreneur remains the sole decision-maker, “meets our requirements” confirms the responsibility given to the expert members of the CoP in the decision-making process.

“We do a lot of in-house training because it is more effective in terms of the needs of the company, since we directly target what the person concerned has to work on” (Company 10).

“In general we have one expert per domain in the company, who is the reference and trains himself in his area and then passes on the information to the others” (Company 4).

This organization of work through domain experts is intended to enable the performance both of productive work in its own right and work of diffusing information that can be assimilated to a transmission. This configuration allows a coordination of experts and mutual adjustments of knowledge. The specific HRM processes are embedded in the organisation. They consist in organizing knowledge through the metacognitive activity of the experts in the community.

The knowledge of the experts acquired through recruitment and training are put into practice in the activity and the organisation of technological development. CoP involves to support and structure knowledge through transfer. In the same time, reflexive analysis of knowledge in the CoP leads to a structuring of HRM processes (recruitment, technology watch, on-the-job training), bringing to light the needs of knowledge.

The SMEs observed prefer more informal RH processes, functionally, organizationally integrated within knowledge flows into the activity and the organisation such as CoP.

“When one of us is working on a project he gives a technical explanation to the others, and, look around, it’s a small open space, so that we can all see, discuss and ask one another for help” (Company 1).

This extract brings to light the concept of knowledge transfer within the community. The entrepreneurs perform in one and create a “cognitive” distribution of work based on “everyone’s specialities,” putting together. This organizational configuration is deliberately designed for knowledge sharing and on the job training.

“Here we exchange a lot, it’s easy in a space like this... among ourselves” (Company 4).

“...as we only have experts, everyone is training himself on a daily basis and through our contacts with one another...” (Company 10).

These transcripts show clearly the ambiguous place of the manager, who sees himself both in the community (“we”) and at the same time as the prescriber of work organization in the physical space.

“For us, training happens every day, we are constantly on the look-out, we all talk to one another, and since we only have domain specialists, everyone is training himself all the time” (Company 3).

“Our closeness means that we are constantly training one another through our daily contact” (Company 7).

This organizational arrangement then appears as a dynamic process of knowledge transfer from the CoP to the entrepreneur. KM cycle is set in a continuum in which the practices of training between experts and above all a mode de recruitment structuring the acquisition of knowledge reinforce the common knowledge base but also enrich the knowledge flows.

All in all, SMEs show specific recruitment processes because they offer the opportunity to acquire new knowledge quickly to the CoP; CoP structure knowledge transfer and creation through implicit training. To assist the entrepreneur in the decision-making, technical expertise in community then appears as distributed. This approach relativizes the centrality of the entrepreneur in the management of SMEs and legitimates the consultative role of CoP. The distributed expertise in CoP appears like a condition to manage innovation by scientific validation of the knowledge in decision-making for the technological SME.

5. Conclusion and discussion

Knowledge management is at the heart of technological SMEs. We have tried here to understand KM processes in technological SMEs from a practical point of view. We have then observed the articulation of HRM and KM in a dynamics of identification, acquisition, creation and use of knowledge in technological SMEs focusing on recruitment and training.
The aim of this research was twofold: to understand 1/ how the entrepreneur uses HRM process (recruitment and training) to create KM flows in order to innovate 2/ how the implementation of the link between RH and KM takes shape in the practice. Analysis through a participative longitudinal methodology (PAR) then makes it possible to propose an articulation of implicit et informal KM through HRM practices that are non-formalized, integrated into the everyday activity and organisation of the company. HRM thus appears as a means of directly integrating the KM flows stemming from expert knowledge necessary for the internal construction of innovation processes (Grant, 1996). These results go beyond the consultative aspect of Community of Practice (Sparrow, 2001) to involve cognitively the experts stemming from expert knowledge necessary for the internal construction of innovation processes (Grant, 1996). These results go beyond the consultative aspect of Community of Practice (Sparrow, 2001) to involve cognitively the experts stemming from expert knowledge necessary for the internal construction of innovation processes (Grant, 1996).

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Crowdsourcing User-Contributed Solutions to Aerospace Product Development Issues through Micro-Blogging

Richard David Evans¹, James Xiaoyu Gao², Sara Mahdikhah³, Mourad Messaadia³ and David Baudry³
¹Business Information Management and Operations, University of Westminster, London, UK
²Centre for Innovative Product Development and Manufacturing, Faculty of Engineering and Science, University of Greenwich, Chatham, Kent, UK
³CESI/IRISE, Rouen, France

Abstract: Revenue and production output of the United Kingdom’s Aerospace Industry (AI) is growing year on year and the need to develop new products and innovative enhancements to existing ranges is creating a critical need for the increased utilisation and sharing of employee knowledge. The capture of employee knowledge within the UK’s AI is vital if it is to retain its pre-eminent position in the global marketplace. Crowdsourcing, as a collaborative problem solving activity, allows employees to capture explicit knowledge from colleagues and teams and also offers the potential to extract previously unknown tacit knowledge in a less formal virtual environment. By using micro-blogging as a mechanism, a conceptual framework is proposed to illustrate how companies operating in the AI may improve the capture of employee knowledge to address production-related problems through the use of crowdsourcing. Subsequently, the framework has been set against the background of the product development process proposed by Maylor in 1996 and illustrates how micro-blogging may be used to crowdsource ideas and solutions during product development. Initial validation of the proposed framework is reported, using a focus group of 10 key actors from the collaborating organisation, identifying the perceived advantages, disadvantages and concerns of the framework; results indicate that the activity of micro-blogging for crowdsourcing knowledge relating to product development issues would be most beneficial during product conceptualisation due to the requirement for successful innovation.

Keywords: Aerospace Manufacturing; Crowdsourcing Knowledge; Employee Collaboration; Knowledge Management; Micro-Blogging

1. Introduction

The Government of the United Kingdom (UK) considers its aerospace industry a “phenomenal success story” (Hough, 2014), employing a technology-driven workforce of approximately 100,000 direct employees, which represents 1.9% of total UK employment. The UK’s AI is the largest in Europe, with over 2600 companies operating within the sector (ADS, 2014), and is the second largest in the world, after the USA, enjoying a global market share of 17%. The revenue generated by the global AI is increasing at an annualised rate of 5% and in 2015 it is expected that a new record will be set in terms of production output; this is mainly due to the replacement of obsolete aircrafts by next-generation, more fuel-efficient machines together with the ongoing increase in air travel, particularly in the Middle East and Asia Pacific regions (Captain, 2014).

In today’s AI marketplace, manufacturing companies are increasingly becoming alert to the need for on-going product innovation and the development of flexible and responsive work processes to ensure their commercial survival by meeting or exceeding customer expectations. Organisations are now having to develop improved solutions in less time with reduced costs (Carbone et al., 2012); this means that the traditional process of Product Development (PD) is no longer sufficient. Previous practices concentrating upon product cost, quality and time to market are no longer enough to maintain competitive advantage. The focus is progressively turning towards innovation with clearly differentiated product offerings being the anticipated outcome. Against this background, effective employee knowledge sharing is seen as paramount and remains a significant challenge for both small to medium sized enterprises and large Original Equipment Manufacturers (OEMs).

The AI is typified as employing highly skilled and competent workforces, which allow companies to operate effectively worldwide (Richardson et al., 2010). Employee skillsets are now being strained, however, with design and
manufacturing engineers no longer being required to simply have the knowledge to deliver products, such as commercial aircrafts, but additionally they now have to augment their knowledge and skills to be proficient in the use of Computer Aided Design/ Manufacturing/ Engineering (CAD, CAM, CAE), Product Data Management (PDM) and Product Lifecycle Management (PLM) software and other knowledge-based systems (Bertoni and Chirumalla, 2011). Furthermore, research (McAdam et al., 2008) has shown that engineers in PD teams are increasingly expected to work more collaboratively together across geographical boundaries and between multi-functional business units; additionally, they are expected to be conscious of aerospace regulations, such as the International Traffic in Arms Regulations (ITAR), to which companies such as Airbus, BAE Systems and Lockheed Martin must adhere. On top of this, engineering practices and standards in the AI are traditionally based upon high quality components, highly technical data and extended development and production lead times (Johnstone et al., 2009, Niosi and Zhegu, 2005).

Current challenges facing the AI include: 1) The increasing cost of fuel, which as a percentage of operating costs for airlines, has risen to approximately 30% currently compared with only 13.6% in 2001 (International Air Transport Association, 2014); 2) The dramatic rise in air travel by consumers, which has grown by some 8-10% year-on-year (Bouvet et al., 2011) and which is predicted to continue at 4.7% per annum until 2030 (Hough, 2014); and 3) The need for user-contributed social technologies to be introduced to airlines to meet rising customer expectations in terms of communication and entertainment while airborne. These challenges all contribute to global aerospace companies striving to design and manufacture more innovative products which are fuel efficient and provide consumers with cutting edge technology.

In order to meet these identified challenges, the global AI industry has been tasked with creating new or innovative enhancements to existing product lines. The development and production of new, highly-innovative products, however, can often involve extended timescales, high costs and significant risk, relying heavily on employee knowledge to generate new ideas. Consequently, the sector relies heavily on Research and Development (R&D) departments and the use of innovative collaboration technologies, such as micro-blogging, is core to competitiveness. The challenge is further extended as AI employees are often co-located or geographically dispersed around their home countries, typically conducting business and collaborating with colleagues based overseas as they are often part of large multi-national organisations. This has created the requirement of aerospace OEMs to seek novel methods to take advantage of the global knowledge base which their workforces already possess.

This paper aims to explore one such method, micro-blogging, through the development of a conceptual framework introduced in section 4. The proposed framework aims to illustrate how AI manufacturers may use micro-blogging as a social collaboration mechanism to crowdsource user-contributed solutions from dispersed groups for production purposes, thus creating the potential for more open and innovative R&D in PD teams, which have traditionally suffered from a knowledge-silo culture (Evans et al., 2014a).

2. Related Work

2.1 Keyword Analysis

In order to fully appreciate currently-published research relating to the topic of crowdsourcing using micro-blogging as a mechanism for product development activities, a keyword literature analysis was conducted using Elsevier’s academic search engine, Scopus. Numerous keyword strings were searched for using Boolean queries to identify research outputs which were most relevant to the topic of this paper; the first column of table 1 identifies the keyword strings which were identified in published articles together with the year of publication, number of papers published per year and number of publications per type.

Firstly, it is interesting to note that zero research was identified which used all three keywords of “Crowdsourcing” / “Crowd-sourcing” and “Product Development” and “Microblogging” / “Micro-Blogging”; n.b. searches producing a value of ‘0’ have been omitted from Table 1. When the search parameters were expanded, as can be seen in table 1, to interchange “product development” for “manufacturing” or “product design”, research showed a total of 30 papers relating to crowdsourcing in product development and manufacturing. Through analysis of this data, it was identified that three of those 30 papers were duplicates i.e. the authors used two similar keyword terms in one research paper e.g. “manufacturing” and “product development”. Of those identified 27 papers, 14 were published between 2013-2014, 8 papers were written in Universities in the United States, with Germany and the United Kingdom each publishing 5 papers. 15 papers were presented as conference papers and 8 as journal articles.
When analysis concentrated on those papers found using the Boolean search terms: 1) “Crowdsourcing” and “Microblogging”; 2) “Crowdsourcing” and “Micro-Blogging”; 3) “Crowd-sourcing” and “Microblogging”; and 4) “Crowd-sourcing” and “Micro-Blogging”, 11 unique papers were identified. These papers were all written in the time period of 2011-2014. Interestingly, when the review concentrated on the activity of micro-blogging in a product development or manufacturing setting, research was extremely limited, displaying only 1 article, which in fact, was that of the authors of this paper (Evans et al., 2014a).

Table 1: Analysis of Published Literature relating to Crowdsourcing in Product Development or Manufacturing

<table>
<thead>
<tr>
<th>Search Terms</th>
<th>No. of Papers</th>
<th>Year</th>
<th>No. of Papers</th>
<th>No. of Papers per Publication Type</th>
<th>Publication Type</th>
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<tr>
<td>“Crowdsourcing” and “Product Development”</td>
<td>14</td>
<td>2014</td>
<td>4</td>
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<td>Journal Articles</td>
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<td>“Crowdsourcing” and “Product Design”</td>
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<td>“Crowd-sourcing” and “Product Development”</td>
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<td>2011</td>
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<td>Conference Paper</td>
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Conclusions drawn from this analysis exercise include:

- The spelling of crowdsourcing and micro-blogging is not always consistent – micro-blogging is not hyphenated 10 out of 12 times and crowdsourcing is not hyphenated 3 out of 38 times;
- All research papers identified were published from 2008 onwards, even though the term crowdsourcing was first introduced in 2006;
- The majority of research into this topic was conducted between 2013-2014 (57.8%) and were predominantly published as conference papers (63.1%) or journal articles (23.6%);
- Researchers in the USA accounted for 13 (34.2%) published papers, with the United Kingdom (15.7%) and Germany (13.1%) closely behind; and
- The majority of research published was in the Information Systems, Communications or Human Factors subject areas. Those publications with more than 1 paper published were: ACM’s Computer Communication Review and ACM’s Conference on Human Factors in Computing Systems.

2.2 Review of Published Literature

The authors of this paper have published several exploratory studies (Evans et al., 2012a, Evans et al., 2012b, Evans et al., 2014c, Evans et al., 2014b) detailing the use of Web 2.0 technologies, including micro-blogging, within the aerospace industry; their investigations concluded that:

- AI employees are increasingly using online collaboration and information exchange methods;
- AI organisations lack a standardised process for capturing and sharing explicit employee knowledge;
- The use of more interactive Web 2.0 functionality, such as micro-blogging sites, would encourage more formal record keeping, logging of decisions, sharing of knowledge and discussion of ideas; and
- Increased use of social media applications offers the potential for improved knowledge capture and sharing, problem sharing and, ultimately, innovation.

This paper extends this previous work by exploring how micro-blogging, as a mechanism for crowdsourcing, could capture user-contributed solutions to aerospace product development issues.
2.2.1 Using Micro-Blogging to Crowdsource

The concept of crowdsourcing has been a developing research topic in the field of Information Systems and Design Science since the early noughties (Pedersen et al., 2013), but has received little attention in publicised aerospace literature and, indeed, in the manufacturing industry, in general. In the July/August 2014 edition of IEEE’s Software Journal, Wang et al. (2014) concluded that “micro-blogging as a crowdsourcing mechanism hasn’t received much attention in previous studies”, but that there is “clear potential for it”. Ehrlich and Shami (2010) added that micro-blogging has generated a lot of research interest in the public domain, but very little is known yet of how employees may make better use of it.

At present, the most widely-known application of crowdsourcing is within the recruitment industry, where sites such as Amazon’s Mechanical Turk (https://www.mturk.com/) and microWorkers (https://microworkers.com/) have allowed organisations to crowd source ad-hoc members of staff to complete one-off tasks in return for financial reward. As illustrated in Figure 1, the generic business model is one of companies posting an advert detailing a specific job and potential ‘employees’ then bidding for the opportunity to do the job i.e. the organisation selects who to do the job, based on peer-reviews for previous work carried out and a quoted price. For the organisation, it allows them to tap into a global knowledge base and have the work completed for a fee which they judge to be reasonable and competitive. Further applications of crowdsourcing exist in industry and these include, for instance in the field of astronomy, Galaxy Zoo (http://www.galaxyzoo.org/), which aims to crowd source participants to help understand how galaxies are formed and how they may be classified by shape.

![Figure 1: Generic Crowdsourcing Business Model](image)

The most commonly agreed definition of crowdsourcing was provided by Jeff Howe (2006) in an article written for Wired.com in 2006, where he coined the term ‘crowdsourcing’ by stating that it is “the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call”. Other researchers (Brabham, 2009, Surowiecki, 2004) have offered their own definitions of the term and these include Pedersen et al. (2013) stated that “Crowdsourcing is a collaboration model enabled by people-centric web technologies to solve individual, organisational and societal problems using a dynamically formed crowd of people who respond to an open call for participation”. Tarrell et al. (2013) offered a more concise definition, concluding that it is the act of “using the collective intelligence of a large group of people to help solve problems”. Researchers (Tarrell et al., 2013) have also used different inter-changeable terms to describe Crowdsourcing, including ‘Peer Production’, ‘User Generated Content’ and ‘Smart Mobs’.

Increasing corporate usage of Web 2.0 technologies has driven the development of bespoke applications which employ crowdsourcing principles, although the use of such tools to crowd source is still in its infancy. In the academic world, little research has been conducted into the use of crowdsourcing within a manufacturing environment, especially within the AI, as may be concluded from Table 1. Multi-national OEMs have now started to adopt crowdsourcing as a method for problem solving, but current academic research mainly focuses on the activity from the point of view of companies seeking input from external sources i.e. using crowdsourcing as a mechanism to engage with potential customers or suppliers.

Closely aligned to this paper, Yu and Nickerson (2011), in the field of product design, proposed a sketch combination system which was tested by 1047 participants. Each member of the crowd submitted sketched designs of chairs for children whilst other crowd members evaluated the contributions; this allowed the problem owner to develop a complete product through iterative crowd design. Also in the field of product design, Müller, Thoring and Oostinga (2010) developed an online crowdsourcing game, which allowed designers to collect empirical data to understand what meanings users associate with certain shapes; they aimed to develop a crowdsourcing-based method to establish common meaning for shapes/forms.
Academics and industrialists have expressed several concerns in relation to the activity of crowdsourcing. Both Pedersen et al. (2013) and Sonnleitner et al. (2013) commented on intellectual property rights and copyright ownership of the solutions submitted and stated that this could be a crucial barrier impeding the success of crowdsourcing within enterprises. Pedersen et al. (2013) continued by stating that the success of a crowdsourcing campaign may depend on attracting and retaining knowledgeable participants. Organisations must optimise their crowdsourcing retention policies to motivate solution providers to continue contributing ideas to solve identified problems. Trust between problem owners, solution providers and the crowd is a key factor underpinning successful crowdsourcing. The crowdsourcing instigator/problem owner should generally seek to provide constructive feedback to a solution provider to develop motivation; this should help to develop future ties and encourage further contributions from existing crowd sourced participants. Moon and Sproull (2008) concur with this need for positive feedback, stating that users are more likely to return to a problem owner’s issues when feedback has previously been provided.

Researchers (Müller et al., 2010, Kaufmann et al., 2011) tend to agree that the most notable challenge found in crowdsourcing is to keep the solution providers motivated. They separate the reasons for solution providers contributing to crowdsourcing into two distinct categories: extrinsic and intrinsic. Extrinsic motivation refers to tangible payoffs, whereas intrinsic refers to a solution provider achieving some form of personal fulfilment from contributing solutions. Müller et al. (2010) divided the reasons into four motivational categories: money, altruism, usefulness and fun. Other researchers (Arakji and Lang, 2007, Yu and Nickerson, 2011) conclude that by offering extrinsic motivation to solution providers, it may create social barriers in the workplace and discourage cooperation on the part of some. Furthermore, some potential solution providers may wish to sabotage PD projects by submitting solutions which they know will not succeed.

Finally, some academics and industrialists may question the need for crowdsourcing activities when internet search facilities are readily available at each employees desk, but as Savage (2012) stated, humans bring added benefits to crowd sourced problem solving, including their ability to notice unusual things and to ask questions which were not mentioned in the original problem identification. The World Wide Web per se is not able to highlight anomalies or suggest suitable changes, whereas motivated individuals forming part of a large crowdsourcing initiative are likely to suggest and develop novel and more innovative solutions.

2.3 The Identified Potential

Today, huge amounts of explicit knowledge exist in various formats including documents, images, videos and audio files. By employing Web 2.0 technologies, such as micro-blogging, enterprises are able to connect people to people and people to information more effectively; they can facilitate connectivity, sharing and collaboration across boundaries, capture a wide range of views and information that is typically informal or highly dispersed and, indeed, help colleagues locate previously unknown experts (Lee, 2013). More specifically, employees are able to identify and share organisational resources more easily via a less formal communication channel; this in turn encourages greater interactivity and collaboration in the workplace.

Crowdsourcing offers individuals seeking solutions to specific problems the ability to elicit collective knowledge using an informal communication channel, such as micro-blogging. It enables users to reach out to a wider virtual community and extract knowledge which previously remained hidden. The potential on offer in terms of outward facing contact with customers is recognised and being pursued by organisations, such as Lockheed Martin, Northrop Grumman and GE, but the use of Web 2.0-based tools in aerospace manufacturing still appears limited (Aerospace Industries Association, 2010).

Research (Harden, 2012) shows that the use of web 2.0 tools within organisations can impact both positively and negatively on corporate practices. They can increase employees’ knowledge and allow them to find potential solutions far more quickly than typical internet browsing. On the other hand, the use of external web 2.0 tools, may be seen as a distraction to workers and could lead to leakage of confidential information.

In terms of the PD process, Web 2.0 platforms and micro-blogging, in particular, offers the prospect of generating and encouraging innovation. Organisational behaviour research (Paroutis and Al Saleh, 2009, Razmerita et al., 2009) has shown that collaborative Web 2.0 tools are especially effective where a high value is placed on technical knowledge. In global enterprises, it is often difficult to identify and locate individuals who possess highly specific expertise as it can remain hidden – and consequently unexploited – within complex organisational structures. Indeed, in hierarchical
organisations, in particular, where a ‘knowledge silo’ culture is recognised to often exist, there is frequently no incentive for employees to look beyond their familiar workplace setting of nearby colleagues as sources of information. Web 2.0 technologies, however, can help overcome such barriers by encouraging more open communication and knowledge sharing. Expertise and solutions to problems need no longer remain concealed as they may be actively sought out and elicited in a more informal manner. Web 2.0 tools allow for visible communication and the positive input of any employee to collaborative problem solving; consequently, this can be recognised and, indeed, rewarded by management.

3. Methodology

In order to create the proposed framework, an exploratory investigation was conducted within a collaborating aerospace OEM between October-December 2014. The investigation produced an as-is process model which was created to identify the key processes employed by PD teams when searching for ideas and solutions to identified problems relating to design and production. The captured process model was then embedded into the created framework, shown in Figure 2, which identifies 4 key actors for the successful identification of solutions to identified problems by product development teams.

In order to validate the proposed framework, a one-hour focus group meeting was held with 10 employees from the collaborating organisation in June 2015. This allowed for the identification of the perceived advantages and disadvantages of the framework, detailed in section 6.

4. The Proposed Framework

This paper contributes to the general fields of Product Development and Manufacturing Informatics and also extends into the research fields of Information Systems and Design Science. Specifically, we aim to extend published research relating to the use of micro-blogging in product development activities.

In order to improve the crowdsourcing of knowledge to address issues and better inform product development processes, a methodological framework has been developed to illustrate how aerospace organisations may employ micro-blogging to generate user-contributed solutions to PD problems.

As can be seen in Figure 2, the framework is presented against a background of 5 key stages to generate preferred solutions. The stages are broadly based on those found in generic PD processes generally employed within the AI. Essentially, the scope of the activity covers Problem Identification through to Evaluation and Implementation, with a further Post-Implementation stage to address motivational issues to encourage further participation in crowdsourcing activities.

The framework is presented for adoption when problems arise during PD processes or any other situation where organisations need to encourage the contribution of employees and partners to address operational issues. Specifically, it is believed that the framework would prove particularly beneficial during the concept creation and solution development stages of problem solving, where innovation and blue sky thinking is vital and where demanding challenges are most likely to be encountered.

The activities involved when adopting the framework are covered in detail in Table 2, which explains in a step-by-step format, with step numbers marked in Figure 2, the potential actions taken by participants in the framework. The key actors in the process are introduced below and it is suggested that the knowledge captured via the framework will constitute a knowledge base which is accessible to both the problem owner and anyone who is a member of the Crowd. Participants in the process will be able to contribute to the improved sharing of ideas and solutions to manufacturing problems through the more informal mechanism of micro-blogging.

4.1 Key Actors

The **Product Development Team (PDT)** is the key stakeholder group responsible for delivering new products and product enhancements.

The **Problem Owner (PO)** is the employee within an organisation who has been delegated the task of solving a specific problem relating to the design or development of a product or modification. The PO has control over the selection of
Crowd participants who are targeted to receive notification of the problem by assigning targeted @UserAccount or by using specified keyword-rich #Hashtags. He/She also has the final decision on which solutions are selected for presentation to the PDT.

The Crowd (C) is the group of individuals within the organisation, and possibly beyond, who participate in the crowdsourcing activity. Employees within the ‘Crowd’ may not necessarily contribute final solutions, but may identify concerns or suggest comments to inform the evaluation process undertaken by the PO.

The Solution Provider (SP) is an individual or group that proposes a possible solution to the identified problem. The SP may at some stage become involved in implementation activities relating to the proposed solution, when adopted. The SP volunteers their own tacit knowledge or acquired explicit knowledge to the PO, dependent on their motivation and potentially the reward on offer, if the solution is adopted by the organisation.

Within the micro-blogging environment, employees in the ‘Crowd’ may choose to collaborate between each other before and while contributing ideas or solutions to the PO; this communication is visible to others and participation in the discussion by either the PO or other Crowd members may lead to even more informed or innovative solutions being developed.

**Figure 2: Proposed Crowdsourcing Framework Using Micro-Blogging**

**Table 2: Steps to Implement Proposed Framework**

<table>
<thead>
<tr>
<th>Key Stages</th>
<th>Step</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem Identification</strong></td>
<td>1</td>
<td>Product Development Team (PDT) details problems and issues relating to design and production.</td>
</tr>
<tr>
<td><strong>Concept Creation</strong></td>
<td>2</td>
<td>PDT delegates problems to designated Problem Owner (PO) to elicit potential solutions from others (Crowd).</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>PO shares problems with online micro-blogging community using specific keyword-rich #Hashtags and targeted @UserAccount; invites input relating to potential solutions – contributions also encouraged from the wider crowd through re-posting.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Specific problems/issues refined informally through further messaging between Crowd members and PO.</td>
</tr>
<tr>
<td><strong>Solution Development</strong></td>
<td>5</td>
<td>Members of the Crowd suggest ideas and propose potential solutions with one or more emerging to become Solution Providers (SP's).</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>PO communicates specifically with SP’s to evaluate, develop and refine potential solutions, although communication remains visible to members of the Crowd to allow for further input.</td>
</tr>
<tr>
<td><strong>Evaluation and Implementation</strong></td>
<td>7</td>
<td>PO presents potential solutions to PDT for discussion and feedback; further development/refinement of ideas may be requested from the Crowd, on an iterative basis.</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>When preferred solutions agreed, PDT authorises implementation with the possibility of SP’s being involved in the deployment.</td>
</tr>
<tr>
<td><strong>Post-Implementation</strong></td>
<td>9</td>
<td>Constructive feedback given to SP’s by PDT, with potential financial reward.</td>
</tr>
</tbody>
</table>
5. Analysis of Proposed Framework

Howe’s (2006) coining of the term “Crowdsourcing” in 2006 highlighted three key actions to harness the full benefits of using crowdsourcing. Firstly, the specified task must be solvable by a large group of people, whether co-located or dispersed. Secondly, the problem owner must have access to a large group of people that are able to work collaboratively or independently towards a solution, and thirdly, but possibly firstly, the problem owner must be able attract people to join the large group (crowd) via an open call.

The proposed framework meets all three characteristics identified by Howe by 1) allowing the problem owner to send out a company-wide message either via an open call to all or via targeted messages using specified @UserAccount’s or #Hashtags; 2) if the problem is unsolvable within the organisation, the problem owner can make the problem transparent outside of the organisation by posting on an external micro-blogging site, although this is not always encouraged, especially in security-conscious industries, such as the AI; and 3) crowd members are able to work collaboratively by using specified project #Hashtags or are able to work independently and setup a private dialogue directly with the problem owner, if preferred.

When consideration is given to how micro-blogging could be integrated into the traditional product development approach to assist with the crowdsourcing and solving of problems, it can be illustrated against the process proposed by Maylor (1996), shown in Figure 3. During the identification of customer needs, the marketing department of a company may use micro-blogging to communicate with current or potential customers to identify their needs and record any problems previously experienced with current products. During the product design stage, designers could use micro-blogging for project team collaboration and to confirm the marketing brief. During manufacture, micro-blogging could be used by engineers to discuss and solve any issues which arise during production. Finally, once the product is manufactured, marketing can again use micro-blogging to sell the product, via a social media campaign, but can also utilise it for recording initial problems/faults experienced by customers.

![Figure 3: Micro-Blogging Activities involved in Maylor’s (Maylor, 1996) Traditional Approach to PD](image-url)

6. Validation Exercise to determine Advantages and Disadvantages of the Proposed Framework

For initial validation of the proposed framework, a one-hour long focus group with 10 employees from the collaborating AI OEM was conducted in June 2015. The meeting allowed for the identification of perceived advantages and disadvantages of the framework by employees of the organisation who would play a ‘key actor’ role within the crowdsourcing process. Results of this meeting are now provided.

6.1 Perceived Advantages

The focus group revealed that the proposed micro-blogging framework would be welcomed within the product development environment of the collaborating company, with interviewees agreeing that “right now, knowledge is stored in very few places. Knowledge dispersal can only be a positive thing”. However, numerous concerns do exist, as recognised in section 6.2.
With regard to perceived advantages, interviewees believed it would be most beneficial during product conceptualisation; this is due to “most of our ideas and problems arise during initial project meetings”. One respondent stated that the “advantages would be endless. Across the different company sites there are people dealing with the same or similar problems. At present, there is a lack in communication or collaboration between these people and micro-blogging or something similar could help solve this issue”. A further comment was made stating “collaboration is generally driven at senior level and often in response to a programme specific requirement. A developed tool, based on the framework, would allow us to effectively make decisions at production level”.

With respect to security, all interviewees concurred that “if relevant knowledge is shared with people at the correct security level, there should be no issues...the benefits will greatly outweigh any security concerns”.

Interviewees recognised that micro-blogging would allow PD engineers to “contribute information towards a collective project resource”, but that it will depend on “peoples’ willingness to create and share ideas”. One respondent acknowledge that it would allow his team to “find each other and get more personally involved”, allowing employees to “identify experts on any given subject”.

Finally, a major advantage was acknowledged by all – “it would facilitate discovery by removing silo walls”.

6.2 Perceived Disadvantages and Concerns

The meeting raised a number of disadvantages and concerns relating to the proposed use of micro-blogging within an AI organisation product development environment. Firstly, security was seen as a major inhibitor to successful implementation. Interviewees reported that safeguards would need to be put in place, but they were confident that they could be. Documentation which was shared via the micro-blogging tool would need to meet required security levels and must be “assured as free from ITAR and UK security classifications”; interviewees were concerned with how this could be done effectively.

User training was raised as a major concern for the framework and any developed tool based upon it. Interviewees reported time constraints with regard to training could be an issue and that policies would need to be put in place which taught employees what they may and may not share outside of the PD environment; interviewees concurred that “people could inadvertently make something public to the general crowd”. One interviewee added “I think it will be difficult to encourage people to share”, while another added that “access control, particularly across countries, is an area for concern”. A further disadvantage relating to employee knowledge was that interviewees felt that their intellectual capital or product knowledge may be leaked outside of the organisation through sharing or “re-tweeting”.

One respondent identified a potential issue with regards to the user interface of any developed tool, stating that “a key aspect is the user interface. Make it simple to use and people will use it. Make it difficult to use and people won’t use it”.

A final conclusion by all key actors was that the developed micro-blogging tool, based on the proposed framework, must be embedded into current systems which the PD teams are using, such as PTC Windchill, and not developed into “yet another tool” which becomes redundant over a period of time.

7. Conclusions and Future Work

Crowdsourcing within enterprises offers AI organisations and those operating in other industries the ability to capture problem solving knowledge from network-connected contributors via the use of Web 2.0 technologies. This paper proposes a methodological crowdsourcing framework which enables users to elicit solutions to PD problems through the mechanism of micro-blogging. It empowers problem owners to reach out to targeted or unfamiliar colleagues who may be either co-located or dispersed within the business environment.

As with the majority of Web 2.0 technologies which facilitate user-contributed content, crowdsourcing is susceptible to possible interference during usage, including the submission of inaccurate or incomplete knowledge being from colleagues. By including the ‘moderator’ role, it enables trusted users within the organisation are enabled to edit submitted content and delete inappropriate contributions. Motivational factors also come into play when user-contributions are concerned; companies may wish to put in place reward or recognition mechanisms to promote the contribution of solutions to recognised problems.
Large multi-national organisations may face problems with regard to language barriers and may wish to incorporate a multi-lingual translation service into the micro-blogging tool to enable automatic translation of content for colleagues from overseas locations to be able to read problems being faced. A ‘monetary’ award for contributions is also recognised in the literature and could be employed within the framework to improve the sharing of solutions to identified problems.

Of course, it should be acknowledged that certain barriers may exist if organisations wish to use the proposed framework with external micro-blogging tools, such as Twitter.com. These could include unwanted hijacking of discussions by other Internet users who simply ‘guess’ #Hashtags which project groups are using. Indeed, as the aerospace industry is one which is highly security conscious, organisations must also make sure that documents which include sensitive material are not shared on these sites and, for that reason, the authors of this paper recommend that an internal solution based on the framework proposed is developed, rather that incorporating the framework using an external micro-blogging website. In large organisations, future work may include the incorporation of a user-tagging mechanism, which allows users to target specific groups of employees within the organisation, rather than sending out their ‘issues’ to the whole Crowd; this should assist in the minimisation of problem-overload. Finally, from the analysis of the validation study, it can be concluded that employees of the collaborating company believe that the usage of micro-blogging for crowdsourcing ideas and solutions to identified production problems would be beneficial. Further research exploring how the framework may be embedded into bespoke product development activities would be seen as beneficial.

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References


Knowledge Sharing and Business Expertise Factor Relationships

Neil David John Topping
Birkbeck University, Birkbeck, University of London, UK
ndjtopping@hotmail.com

Abstract: Research into knowledge sharing has predominantly utilised qualitative research methods. The quantitative research methods that built models focused upon a narrow grouping of factors. This research sought to develop a holistic model of the predictors of knowledge sharing, with expertise factors added, to qualify the value of the expertise being shared. An extensive literature review and individual / series of interviews were carried out to identify the knowledge sharing factors, of which 18 were recognised. The value of knowledge shared is dependent on the expertise of the individual, and two expertise orientated factors were developed. These two factors were based upon two self-assessment constructs, a Cochran-Weiss-Shanteau measure, and a peer-comparison measure, both of which were used to identify an individual’s the level of expertise. Using these factors a model was developed that, enabled individual self-assessment of knowledge sharing and expertise latent variables. 103 participants completed the survey, and the results were analysed using structured equation modelling (SEM) and confirmatory factor analysis (CFA). The model did not achieve a goodness of fit. There were 6 factors that were significantly related to the intention to share knowledge construct, with both expertise factors found to be significantly related to an expertise construct. The intention to share knowledge construct was significantly related to the expertise construct. This model has been used to identify 4 types of knowledge sharers. These types offer significant practical benefit for human resource activities, specifically in recruitment and organisational design.

Keywords: Cochran-Weiss-Shanteau; Structured Equation Modelling; SEM; Confirmatory Factor Analysis; CFA; Knowledge sharing types; Expertise

1. Introduction

1.1 Purpose Statement

There has been an increase in the research into knowledge sharing. This research has been predominantly qualitative in nature, with many different predictors of knowledge sharing, having been identified. However, there is currently no tool available that effectively enables either;

1) The holistic identification of the factors leading to an individual’s intention to share knowledge.
2) The ability to understand the organisational factors in place that may inhibit or, excite, knowledge sharing.

This research attempts to develop this quantitative tool, which is capable of assessing an individual’s intention to share knowledge, as well as, the organisational factors that will influence this.

1.2 Ontological Assumptions:

The author has listed the following ontological assumptions, to demonstrate the impacts of his social-construction of the world, upon the formation of this research.

- Knowledge basing is not a viable sole method of managing knowledge, and needs to be coupled with effective knowledge sharing mechanisms.
- Knowledge sharing has positive relationships with individual and organisational effectiveness/performance.
- Isolated pockets of knowledge reduce organisational effectiveness.
- Knowledge transferring from one actor, to another, is not possible as a simple linear process (i.e. knowledge sharing must occur between actors).
- Proactively sharing knowledge with others will increase individuals’ own understanding and knowledge.

1.3 Research Background

Drucker (1957, p.122) coined the term “knowledge worker” which, Cooper (2006, p.59) helped to define as people who are “thinking for a living”. This research uses the Cambridge Dictionary definition of a knowledge worker as:

“An employee whose job involves developing and using knowledge rather than producing goods or services.”

Cambridge Dictionaries Online.
Knowledge increasingly becomes viewed as a commodity with the dawn of the knowledge worker. By the turn of the new millennium, Barth (2000), found that only 20% of workers were devoted to industrial work, the rest being devoted to knowledge work.

In any organization, 90% of the knowledge is embedded and synthesized within employees’ heads (Wah, 1999; Bonner, 2000; Lee, 2000).

Fetterhoff & McNamee (2011) identified that knowledge sharing is a top strategic objective for many companies. By encouraging employees to share their useful knowledge, across the organisation, the company can improve and sustain its competitive advantage (Liu and Phillips, 2011). However, Cho et al. (2007) established that individuals do not share as much knowledge as organisations would like.

Therefore, as Salano (2010) contends, the sharing of knowledge leads to increased leads to an increased competitive advantage, and enhanced organisational effectiveness which, it is argued, needs to be sustained, as it is vital for a business to survive.

2. Literature Review

Research into Knowledge Sharing has typically been differentiated by;

- Approach (quantitative or qualitative)
- Median (Web-blogging to face-to-face – Yuan et al. 2013)
- Industry (Engineering (Lin et al. 2012) and construction workers (Zhang and Ng 2012) to IT workers (Borges 2013))
- In-groups/Out-groups (Nesheim & Hunskaar 2015).

However, the practical application of this research is reduced, without defining the criteria that leads to the intention to share knowledge.

Michailove and Minbaeva (2012) identified that, the best way to promote knowledge sharing is, the internalisation of organisational knowledge sharing values. Their research indicated that the organisation can influence internal values to promote knowledge sharing. Kumaraswamy and Chitale (2012), support this idea, with research that showed a collaborative approach to sharing knowledge is achieved through strong communication and discussion, concluding that this is the best way to collectively grow knowledge.

Bautista-Frias et al. (2012) found that utilisation of knowledge mapping, of tacit experts for developing explicit knowledge, such as policies and processes, was effective, but ultimately limited by their focus upon a single academic institution. The qualitative nature of the research meant it was not possible to transfer their findings to other similar institutions, or organisations.

Kennedy et al. (2012) explored individual’s impacts on knowledge sharing processes, but failed to address how to assess individuals’ likelihood to share their knowledge. Wang and Wang (2012) found tacit knowledge sharing among organisation members, tends to be socially driven. If the sharing of knowledge, considered to be owned by an individual, is driven by sociality, the distinction between intrinsic and extrinsic factors, affecting knowledge sharing, needs to be assessed.

Ryan and O’Connor (2013) found that social interaction was important for tacit knowledge sharing to occur. Therefore, it is likely that there is a correlation between the number of social interactions, and the amount of tacit knowledge that is shared.

Gubbins et al. (2012) researched the tacit knowledge conversion process, and whether the conversion of this knowledge, provided increased value to the business. They found that there are many individual factors are involved in the access, capture, and sharing of, expert knowledge. Conclusions indicate that it is the individual who drives the knowledge sharing process (Busch et al. 2003), and for this reason, the individual’s perspective upon knowledge sharing will be considered instead of teams, departments, or whole organisations.

Borges (2013) built a model which, looked at the predictors of knowledge sharing among 143 IT workers. This model was effective at identifying that hardworking, responsible, and introverted employees tend to share their tacit
knowledge, within a supportive environment. The latent variables used, relied on measures, such as the “Big 5”, and not the underlying body of literature that this research has undertaken, to develop its' factors.

3. **Expertise**

The value of expertise to business will initially be discussed and critiqued, as will the approaches that have been employed to measure expertise. These will then be refined, to identify the measures that will be utilised in this research. Since this research is focused solely on “business expertise”, other types of expertise will not be discussed.

3.1 **Value of Expertise**

Experts have better domain specific knowledge than non-experts. The superiority of experts is primarily the result of practice, not innate ability (Ericsson et al. 1993).

“Skill learning refers to the gradual improvement of performance with practice that generalises to a range of stimuli with a domain of processing”

Poldrack et al. (1999, p.208)

Novice problem solvers, through their lack of a rich knowledge base possessed by experts, are more likely to engage in ineffective problem solving strategies e.g. trial and error & unwarranted assumptions etc. (Carr, 2010).

3.2 **Measurements of Expertise**

Expertise has been extensively researched as a concept (Shanteau et al. 2003; Weiss and Shanteau, 2014; Germain and Tereda, 2012), but there has been no single, agreed, definition, of what constitutes of an expert. The different definitions were explored and evaluated.

3.2.1 **Tenure**

The number of hours, days or years, working in a particular area, has been linked to expertise. However, the duration of the focus on a domain does not equate to expertise in the domain. There is extensive research that challenges the assumption that, tenure relates to expertise or effectiveness (Costa and Porter, 2003; Wright and Bonett, 2002). For this reason, tenure has not been included, as an expertise factor.

3.2.2 **Consensus**

Researchers believe that consensus of individuals, is a basis for agreement on the identification of expertise. Therefore, disagreement within the group, of an individual’s status, as an expert, means that they are no longer able to be considered as such. This research is based upon self-assessment responses, and therefore this measure is not feasible.

3.2.3 **Consistency and Reliability**

The level of consistency that an individual exhibits, in answering questions, and the accuracy that they achieve when answering them, has been found to be an effective measure by Cochran-Weiss-Shanteau (CWS – Shanteau et al. 2003). The measure they developed, has been well supported by further research (Weiss and Shanteau, 2014; Witteman et al. 2012; Pauley et al. 2009). Therefore, even though this approach is reliant on a series of domain specific questions, a single question has been devised that will attempt to identify this.

3.2.4 **Comparative Domain Expertise ( Compared to Peers)**

The comparison of an individual, with their peers, is an effective way to identify expertise (McHugh and Lake, 2010). Due to the nature of this research, focusing upon the individual, this measure will be based upon, the self-assessment of business expertise against others in the company.
3.3 Evaluation of Expertise

There have been a multitude of measures proposed to determine expertise, but the lack of agreement of which of these are effective, has made the development of questions relating to this area challenging. The least contested measures have been CWS and Compared to Peers.

The exclusion of other expertise measures, in this research, may restrict the breadth of findings that could be achieved, but this is a deliberate act to reduce the potential negative effect on response rate, as a result of the increased number of questions.

4. Latent variables

There are two latent variables being considered
- Intention to Share Knowledge
- Business Expertise.

4.1 Intention to share knowledge

The intention to share knowledge latent variable is being used by this model to assess the positive correlation, between the intention to share knowledge and knowledge actually being shared, which has been found in various independent sources (Reychav and Weisberg, 2010; Shiuann-Shuoh et al. 2012; Ajzen, 1991).

4.2 Business Expertise

Expertise, or specifically in this case, business expertise, refers to how well versed an individual is in their specific domain. The purpose for the inclusion of expertise, is a qualifying mechanism, with regards to the knowledge that is being shared. The optimal knowledge shared, between one actor and another, can be regarded as Expert Knowledge. Including expertise, as a latent variable, will also assist with the profiling of knowledge sharing. Factors – Intention to share knowledge. The following factors, identified in Table 1, have been identified through reviewing the literature and accompanying research. The selection deliberately sought a holistic list of factors and did not discriminate on researches based upon their sample sizes, amount of citations, or significance criteria identified.

<table>
<thead>
<tr>
<th>Table 1 - Intention to share knowledge factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>Autonomous Motivation</td>
</tr>
<tr>
<td>Ability to share knowledge</td>
</tr>
<tr>
<td>Inability to acquire knowledge</td>
</tr>
<tr>
<td>Self-efficacy</td>
</tr>
<tr>
<td>Enjoyment of knowledge sharing</td>
</tr>
<tr>
<td>Network/Opportunity to share knowledge</td>
</tr>
<tr>
<td>societal</td>
</tr>
<tr>
<td>Motivation to Defend Ego or Distort</td>
</tr>
<tr>
<td>Performance Feedback</td>
</tr>
<tr>
<td>Lack of Trust</td>
</tr>
<tr>
<td>Lack of Reciprocity</td>
</tr>
<tr>
<td>Attitudes towards sharing knowledge</td>
</tr>
<tr>
<td>(Self)</td>
</tr>
<tr>
<td>Attitudes towards sharing knowledge</td>
</tr>
<tr>
<td>(Others)</td>
</tr>
<tr>
<td>Sociability</td>
</tr>
<tr>
<td>Friendship</td>
</tr>
<tr>
<td>Incentives</td>
</tr>
<tr>
<td>Minority Group</td>
</tr>
<tr>
<td>Hierarchical Position</td>
</tr>
<tr>
<td>Perceived level of interest from learner</td>
</tr>
<tr>
<td>Professionalism</td>
</tr>
</tbody>
</table>
**Autonomous Motivation**

Autonomous motivation has been identified to have a positive effect on knowledge sharing (Small and Sage, 2006; Hsiu-Fen, 2007; Hau and Evangelista, 2007).

**Ability to Share Knowledge**

Ozmen (2010) identified that an individual’s ability to share knowledge is essential for knowledge sharing to occur.

**Inability to Acquire Knowledge**

Reinholt et al. (2011) found that the ability to acquire knowledge is an important factor in the sharing of knowledge.

**Self-Efficacy**

Zhang and Ng (2012) found that knowledge sharing was affected by knowledge self-efficacy. This has been supported by Lai and Chen (2014), who found that enjoyment, and self-efficacy, were the most influential factors leading to the intention to share knowledge.

**Enjoyment of Knowledge Sharing**

Papadopoulos et al. (2012), Lai and Chen (2014), and Hau et al. (2013), all found that enjoyment has a positive effect on knowledge sharing.

**Network/Opportunity to Share Knowledge/Societal**

This factor relates to the individual’s position within a network. If an actor within a network is considered to have expertise, then it is important that they can be accessed, both at the right time, and by the right people.

Buckman (2004) found that, people who leveraged their network, for knowledge, were successful at obtaining it through organisational “pull”, rather than centralized “push”.

**Motivation to Defend Ego or Distort Performance Feedback**

If there is a risk to knowledge sharing then, it is more likely that people will hold their knowledge, for private advantage (Chennamaneni et al., 2012; Buckman, 2004).

**Lack of Trust**

Sankowska (2013) found that organisational trust is essential, for the transfer, and creation, of knowledge. Chen et al. (2014) established that knowledge sharing can be realized, when business partners are allowed to build up levels of trust.

**Lack of Reciprocity**

Researchers have identified that reciprocity is an effective motivator in promoting knowledge capacity (Kankanhalli et al., 2005; Wasko and Faraj, 2005; Namjae et al., 2007). This is reinforced by Chennamaneni et al. (2012) who identified, reciprocity as a salient motivator of an employee’s likelihood to share knowledge. This position is supported by Hau et al. (2013), who found that the presence of reciprocity has a positive effect on knowledge sharing.

**Attitudes Towards Knowledge Sharing (Self)**

It is important for an individual to have a positive attitude towards tacit knowledge sharing, or they are unlikely to engage in this practice. Shiuann-Shuoh et al. (2012) found that attitude positively impacts the most upon the intention to share tacit knowledge.

**Attitudes Towards Knowledge Sharing (Others)**

Shiuann-Shuh et al. (2012) did not specify attitude as being towards self or others. Therefore, this has been divided into two factors for this research.

**Sociability**

In an organisation, an individual may be sociable, to a greater or lesser extent. Osterloh and Frey (2000) found that a greater amount of sociability in organisation, led to increased knowledge sharing.

**Friendship**

Osterloh and Frey (2000) found that friendship was an important part of knowledge sharing. In psychological terms, this is likely to create divisions of ‘in-groups’ and ‘out-groups’, depending on how restrictive, and / or how powerful, the knowledge possessed is.
Incentives
Hau et al (2013) found that rewards and incentives reduced knowledge sharing. Incentives of all types have been studied; ranging from financial to non-financial, individual to team, that has support this finding (Hu and Randel, 2014; Wolfe and Loraas, 2008; Fey and Furu, 2008).

Minority Group
This is based upon research by Polzer et al. (2006), who found that minority, or majority, sub-groups, have negative impacts upon knowledge sharing outcomes.

Hierarchical Position
The interviews, this research conducted, yielded an interesting finding, in that peer-to-peer knowledge sharing was more prevalent than hierarchical knowledge sharing.

Perceived Level of Interest from Learner
A common theme uncovered from the interviews in this research indicated that, the individual was motivated when the learner appears interested in the knowledge being shared.

Professionalism
A final finding from these research interviews is that an individuals’ self-perception of their level of professionalism, affected their intention to share knowledge. Individuals, who considered themselves professionals, stated that they would not be prevented from sharing their knowledge with others.

4.3 Factors – Business Expertise
Two factors have been selected that, have been identified, to be related to Business expertise. These are found in Table 2. Whether the factor is intrinsic, or extrinsic, is not relevant, and as a result, is not considered.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Expected Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency and reliability</td>
<td>Positive</td>
</tr>
<tr>
<td>Comparison to peers</td>
<td>Positive</td>
</tr>
</tbody>
</table>

Table 2 - Items relating to business expertise

4.3.1 Consistency and reliability
Consistency and Reliability (the CWS measure), is the ability to answer questions from the business, in the same manner, and with the same degree of accuracy. The CWS specifically, refers to ‘discrimination’, but this was misinterpreted during the interviews, and has been re-presented as ‘reliability’. This is expected to have a positive relationship with business expertise.

4.3.2 Comparison to Peers
Comparison to Peers is the process whereby the individual position themselves, when compared to all of their colleagues, and is specifically relating to their business expertise. This is expected to be positively related to business expertise.

4.4 Latent Variable Comparison - Expertise and Knowledge Sharing
The relationship between business expertise, and knowledge sharing, is expected to be positive. This is based upon the assumption that, as an individual accrues knowledge, they will become more confident in what they know and have a desire to share their knowledge.

Figure 1 shows the relationship between the knowledge sharing factors and the Knowledge Sharing latent variable. The expected correlations can be found in Table 1.
Figure 1: Items related to Knowledge Sharing

Figure 2 details the relationship between the Business Expertise factors and the Business Expertise latent variable. Table 2 shows the expected correlation.

Figure 2: Items related to Business Expertise

Figure 3 shows the relationship between the latent variables and both the Business Expertise and Knowledge Sharing Factors.
5. **Aim**

   **A1:** To attempt to build a model that tests Business Expertise and Knowledge Sharing factors to enable the categorisation of individuals into different knowledge sharing types.

6. **Hypotheses**

   - **H0** – There will be no relationship between the factors and the latent variables.
   - **H1** – Intrinsic factors of knowledge sharing have a positive effect on an individual’s intention to share knowledge.
   - **H2** – Extrinsic factors of knowledge sharing have a positive effect on an individual’s intention to share knowledge.
   - **H3** – Intrinsic factors of knowledge sharing will have a greater impact on an individual’s intention to share knowledge, than will extrinsic factors.
   - **H4** – The expertise factors will have a positive relationship with Business expertise.
   - **H5** – Business expertise and the Intention to share knowledge will be positively related.

   Table 1 identifies whether knowledge sharing factors are intrinsic or extrinsic. H1, H2 and H3 relate to the Intention to share knowledge latent variable. H4 relates to the Business expertise factors relating to the Business expertise latent variable. H5 refers to the relationship between the two latent variables (Business Expertise and the Intention to share knowledge).

7. **Research Method**

   **7.1 Participants**

   Participants were selected on an opportunity basis, reliant upon the social and professional networks of the author. This included social media, specifically Twitter, Facebook, and LinkedIn, along with direct e-mail requests.

   The eligibility criteria were that, potential participants had worked for at least 3 years, and that they viewed themselves as having some degree of subject matter expertise. The sampling was deliberate in not focusing on any specific sector, or profession. This was based upon previous experience, where attempts to apply such a focus was unsuccessful in achieving sufficient participants.

   **7.2 Materials**

   A questionnaire was developed and work flowed into a website, using Lime Service, an open source web research service. The work-flowing specifically broke up the survey, and mandated critical questions to be answered, before the participant was able to progress onto the next section. The questionnaire included an introduction into the research,
and an elective report, detailing the type of knowledge sharer the participant was, based upon the assumptions identified in the literature.

7.3 Design

A questionnaire based design was employed to assess differences between participants. The tool was administered once to all participants, during the four month period between February 2014 and May 2014.

7.4 Procedure

Prospective participants were contacted on an opportunistic basis. They were asked to fill in the survey, and informed that they could receive a report, if requested, detailing their knowledge sharing type. This report was only supplied, after completion, if an e-mail address had been provided.

8. Results & Discussion

8.1 Overview

The model of the research did not achieve a goodness of fit. This means that the model in its entirety needs to be adapted to ensure that it covers both business expertise and knowledge sharing. There are questions that have been used that have been significantly correlated to either Business Expertise or Knowledge Sharing.

This means that these questions can be used in other researches with a degree of confidence.

This section begins with response rates and descriptive statistics. These are followed by the model testing then a summary. The research aim and hypotheses are then considered followed by the researches limitations, implications and recommendations.

8.2 Analytical Method

A Confirmatory Factor Analysis (CFA) was used, based upon Structural Equation Modelling (SEM) output. The two latent variables, intention to share knowledge, and expertise, were created to attempt to confirm the model, based upon the expected relationships with their factors.

8.3 Response Rate

135 participant responses were achieved of which, 103 completed the entire survey. This means that 76% of participants that started the survey and completed all the mandatory questions. Some questions within the descriptive statistics were optional and, as such, did not achieve the 103 completed responses.

For the purposes of the descriptive and statistical analysis, only those surveys where all the mandatory questions had been completed were considered.

8.4 Descriptive Statistics

Gender

Table 3 shows that almost two thirds (2/3) of participants were male.

Table 3 – Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>65</td>
</tr>
<tr>
<td>Female</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
</tr>
</tbody>
</table>
Age

Table 4 shows that there was a wide age distribution of participants, almost covering the entire span of working ages, when taking into account the requirement of 3 years working experience.

**Table 4 - Age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Limit</td>
<td>65</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>24</td>
</tr>
<tr>
<td>Range</td>
<td>41</td>
</tr>
<tr>
<td>Mean</td>
<td>42.5</td>
</tr>
<tr>
<td>Mode</td>
<td>35</td>
</tr>
</tbody>
</table>

Current position

Table 5 shows that very few participants identify themselves as Junior, which might be related to the mean age being 42.5. The majority considered themselves to be professional, with Middle Manager coming in second.

**Table 5 - Current Position**

<table>
<thead>
<tr>
<th>What is your current position?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior</td>
<td>2</td>
</tr>
<tr>
<td>Professional</td>
<td>50</td>
</tr>
<tr>
<td>Middle Manager</td>
<td>30</td>
</tr>
<tr>
<td>Senior Manager</td>
<td>16</td>
</tr>
<tr>
<td>Not Answered</td>
<td>5</td>
</tr>
</tbody>
</table>

Ethnicity

The majority of participants, 85%, identified themselves in the ‘White’ category, with the smallest populations represented being ‘White Irish’, ‘Mixed / Multiple Ethnic Group White and Asian’, and ‘Pakistani’, all of whom registered 1%. A greater ethnic diversity would need to be sought, for further research.

**Table 6 - Ethnicity**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any other Asian background</td>
<td>3</td>
</tr>
<tr>
<td>Any other White background</td>
<td>13</td>
</tr>
<tr>
<td>Asian / Asian British</td>
<td>4</td>
</tr>
<tr>
<td>Chinese</td>
<td>4</td>
</tr>
<tr>
<td>Mixed / multiple ethnic group White and Asian</td>
<td>1</td>
</tr>
<tr>
<td>Mixed / multiple ethnic group White and Black Caribbean</td>
<td>2</td>
</tr>
<tr>
<td>Pakistani</td>
<td>1</td>
</tr>
<tr>
<td>White English / Welsh / Scottish / Northern Irish / British</td>
<td>74</td>
</tr>
<tr>
<td>White Irish</td>
<td>1</td>
</tr>
<tr>
<td>Not Answered</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
</tr>
</tbody>
</table>

Level of Education

Table 7 shows that 72% of participants had completed higher education (Bachelor or Master’s Degree, or PhD). The lowest level of education recorded was Secondary/High School, which made up 5% of participants.
Table 7 - Education

<table>
<thead>
<tr>
<th>What is your highest level of education you have completed?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary/High School</td>
<td>5</td>
</tr>
<tr>
<td>College</td>
<td>12</td>
</tr>
<tr>
<td>Vocational Qualification</td>
<td>12</td>
</tr>
<tr>
<td>Bachelor's Degree</td>
<td>38</td>
</tr>
<tr>
<td>Master's Degree</td>
<td>35</td>
</tr>
<tr>
<td>PhD/ Doctorate</td>
<td>1</td>
</tr>
<tr>
<td>Not Answered</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
</tr>
</tbody>
</table>

Factor Results

Table 8 relates to the factor results from the model. The column on the left details the factors considered within the model. With their loading calculated in the Coef=Loading column. The other columns, from left to right, are the standard error, the Z-score, and the p>|z| significance.

Table 8 - Factor results

| Factor                                      | Coef=Loading | Std. Err | z     | P>|z| |
|---------------------------------------------|--------------|----------|-------|------|
| Autonomous Motivation                       | 0.6511       | 0.12     | 5.42  | 0    |
| Ability to share knowledge                  | 0.2369       | 0.1375   | 1.72  | 0.085|
| Inability to acquire knowledge              | 0.1234       | 0.1336   | 0.92  | 0.356|
| Self-efficacy                               | 0.4271       | 0.1236   | 3.45  | 0.001|
| Enjoyment of knowledge sharing              | 0.1552       | 0.1404   | 1.11  | 0.269|
| Network/ Opportunity to share knowledge     | -0.1924      | 0.1272   | -1.51 | 0.13 |
| Societal                                    |              |          |       |      |
| Motivation to Defend Ego or Distort          | 0.2277       | 0.1277   | 1.78  | 0.075|
| Performance Feedback                        |              |          |       |      |
| Lack of Trust                               | 0.0712       | 0.1419   | 0.5   | 0.616|
| Lack of Reciprocity                         | 0.0441       | 0.1332   | 0.33  | 0.74 |
| Attitudes towards sharing knowledge (Self)  | 0.4423       | 0.1195   | 3.7   | 0    |
| (Others)                                    |              |          |       |      |
| Attitudes towards sharing knowledge         | 0.1556       | 0.1373   | 1.13  | 0.257|
| Sociability                                 | 0.2995       | 0.1355   | 2.21  | 0.027|
| Friendship                                  | 0.1542       | 0.1395   | 1.11  | 0.269|
| Incentives                                  | 0.3297       | 0.1401   | 2.35  | 0.019|
| Perceived level of interest from learner    | -0.003       | 0.1491   | -0.02 | 0.984|
| Professionalism                             | 0.2217       | 0.1264   | 1.75  | 0.08 |
| Hierarchical Position                       | 0.1905       | 0.1386   | 1.37  | 0.169|
| Minority Group                              | 0.3318       | 0.1232   | 2.69  | 0.007|

8.5 Model Testing

8.5.1 Goodness of Fit (GFI)

The chi-square value, produced by Stata, was 208.03, with degrees of freedom of 167. The significance of the chi-square test is p-value of 0.017 (p<0.05).
The root-mean-square error of approximation (RMSEA) is 0.053. The generally accepted level of significance is >= 0.05 (Schumacker and Lomax, 2004, p.81). However, Arbuck (2007) has stated that this figure is based upon a subjective judgement and can be infallible. Therefore, this slightly higher level of significance will be accepted for this research.

Hu and Bentler (1999) offer a rule of thumb for determining cut-off values using:

- RMSEA (<0.6)
- Comparative Fit Index (CFI; >0.95)
- Tucker Lewis Index (TLI; > 0.95).

The CFI value was found to be 0.549, and the TLI value 0.487.

Using Hu and Bentler’s (1999) rule of thumb (RoT);

- RMSEA <0.6; accepted at 0.53.
- CFI >0.95; rejected at 0.549.
- TLI >0.95; rejected at 0.487.

Therefore, this demonstrates that the models’ Goodness of Fit must be rejected. Thus, modification indices need to be considered. These are identified in table 9.

<table>
<thead>
<tr>
<th>Modification indices</th>
<th>MI</th>
<th>df</th>
<th>P&gt;MI</th>
<th>EPC</th>
<th>Standard EPC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enjoyment of knowledge sharing &lt;- Business Expertise</td>
<td>4.894</td>
<td>1</td>
<td>0.03</td>
<td>-2.20106</td>
<td>-0.53708</td>
</tr>
<tr>
<td><strong>Covariance (Co)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Autonomous Motivation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitudes towards sharing knowledge (Self)</td>
<td>3.032</td>
<td>1</td>
<td>0.05</td>
<td>0.910484</td>
<td>0.281958</td>
</tr>
<tr>
<td>Consistency and reliability</td>
<td>7.371</td>
<td>1</td>
<td>0.01</td>
<td>0.593275</td>
<td>0.372752</td>
</tr>
<tr>
<td><strong>Ability to share knowledge</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>4.016</td>
<td>1</td>
<td>0.05</td>
<td>0.464363</td>
<td>0.231576</td>
</tr>
<tr>
<td><strong>Self-efficacy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incentives</td>
<td>5.027</td>
<td>1</td>
<td>0.02</td>
<td>-0.53983</td>
<td>-2683524</td>
</tr>
<tr>
<td><strong>Autonomous Motivation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived level of interest from learner</td>
<td>7.928</td>
<td>1</td>
<td>0</td>
<td>1.183926</td>
<td>0.304742</td>
</tr>
<tr>
<td>Comparison to peers</td>
<td>4.329</td>
<td>1</td>
<td>0.04</td>
<td>-0.52385</td>
<td>-0.28743</td>
</tr>
<tr>
<td><strong>Lack of Trust</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitudes towards sharing knowledge (Others)</td>
<td>6.887</td>
<td>1</td>
<td>0.01</td>
<td>0.772673</td>
<td>0.283812</td>
</tr>
</tbody>
</table>
Modification indices

<table>
<thead>
<tr>
<th></th>
<th>MI</th>
<th>df</th>
<th>P&gt;MI</th>
<th>EPC</th>
<th>Standard EPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Reciprocity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitudes towards sharing knowledge (Others)</td>
<td>5.258</td>
<td>1</td>
<td>0.02</td>
<td>0.817311</td>
<td>0.247636</td>
</tr>
<tr>
<td>Attitudes towards sharing knowledge (Others)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sociability</td>
<td>4.214</td>
<td>1</td>
<td>0.04</td>
<td>-0.83207</td>
<td>-0.22871</td>
</tr>
<tr>
<td>Friendship</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived level of interest from learner</td>
<td>5.331</td>
<td>1</td>
<td>0.02</td>
<td>0.995493</td>
<td>0.249868</td>
</tr>
<tr>
<td>Incentives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived level of interest from learner</td>
<td>12.34</td>
<td>1</td>
<td>0</td>
<td>1.306489</td>
<td>0.393379</td>
</tr>
</tbody>
</table>

Table 9 - Modification Indices

Even were all of the modifications adapted into the model it would still not achieve a Goodness of Fit. The covariances provide a view of how some of the factors could be clustered. Such as:

Lack of Reciprocity, Attitudes towards sharing knowledge (Others) and Sociability
Perceived level of interest from learner, Friendship, and Incentives.

Variable Testing

8.5.2 Intention to Share Knowledge Latent Variable

Only 6 factors were identified as being significantly related. These can be seen below, ranked based upon the strength of their factor loading.

1) **Autonomous Motivation** (P>0.05). The factor loading was 0.65, with a standardised error of 0.12, and a Z-score is 5.42.
2) **Attitude towards sharing knowledge (Self)** (P>0.05). The factor loading was 0.44, with a standardised error of 0.12, and a Z-score of 3.7.
3) **Self-efficacy** (P>0.05). The factor loading was 0.42, with a standard error of 0.12, and a Z-score of 3.45.
4) **Minority Group** (P>0.05). The factor loading was 0.33, with a standardised error of 0.14, and a Z-score of 2.35
5) **Incentivisation** (P>0.05). The factor loading was 0.33, with a standardised error of 0.14, and a Z-score of 2.35.
6) **Sociability** (P>0.05). The factor loading was 0.16, with a standardised error of 0.14, and a Z-score of 2.21.

This means that, of the factors listed above, 1, 2, 3, and 6 are intrinsic in nature, whilst 4 and 5 are extrinsic.

The greater the number of intrinsic factors, with a collectively higher factor loading, means we can confidently infer that, an individual’s intention to share knowledge, is driven, to a greater extent, by intrinsic factors, rather than extrinsic factors.

The non-significantly related items can be observed in Table 9.

Critique of the Intention to Share Knowledge Latent Variable

The identification of 6 factors that are significantly related to the latent variable is promising, but diminished by the lack of GFI. The rejection of 12 factors, which were not found to have a significant relationship, can assist in the focusing of further research into knowledge sharing.
We can consider this to be partially successful in explaining a quarter of core organisational knowledge processes identified by Sambamurthy and Subramani (2005).

**8.5.3 Expertise Latent Variable**

**Consistency and Reliability**

Consistency and Reliability (the CWS measure) was found to be significantly related to Business Expertise (p>0.01). The factor loading was 0.47, with a standardised error of 0.15, and a z-score of 3.23.

However, this technique has been used in a domain specific assessment of expertise, rather than being distilled into a generic question-based format. This format has been successful, as can be seen from the significant result, and has wider implications for the research literature, proposing the CWS technique as a new gold standard for measuring expertise. However, this would need to be further supported by research with a larger sample.

**Comparison to Peers**

Comparison to Peers was also found to be significantly related to Business Expertise (p>0.01). The factor loading was 0.62, with a standardised error of 0.18, and a z-score of 3.51. Interestingly, this is less significant than the Consistency and Reliability latent variable, but has a higher factor loading.

**8.5.4 Latent Variable Correlation**

The latent variables of Intention to share knowledge and Business Expertise were found to be significantly related to each other (p>0.01), with a factor loading of 0.71, a standard error of 0.19, and a z-score of 3.66. We can see from the high positive factor loading that, this relationship is positive, whereby, the higher the business expertise, the greater the intention to share knowledge.

**8.6 Summary**

The research has been successful in confirming the overall relationship of the factors for the intention to share knowledge latent variable. The 2 factors, comprising the business expertise latent variable, were also found to be significantly related to the latent variable. Both of the latent variables were found to be significantly related to each other. However, a GFI was not achieved, for the model, which means there are further factors that need to be considered.

**8.7 Aim Testing**

The aim of this research was to attempt to build a model that enabled the categorisation of individuals into different knowledge sharing types. 4 Knowledge Sharing Types are identified, however, the limitations of the model are detailed in the critique.

**8.7.1 Types of knowledge sharer**

Knowledge Sharing Types were defined based upon the 2 business expertise factors and the 6 significant knowledge sharing factors.

The "low" business expertise was comprised of a score of "6" on Consistency and "Average" or lower on Comparison to peers. 13 participants were "low" and 90 were "high".

The "low" knowledge sharing was based upon re-coding the 6 factors in "+3" for Strongly Agree, "+2" for Agree, "+1" for Slightly Agree, "0" for Neutral, "-1" for Slightly Disagree, "-2" for Disagree, and "-3" for Strongly Disagree. When a question was reversed these ratings matched. These were totalled for each participant. A positive total meant "high" knowledge sharing and a negative total meant "low" knowledge sharing. 102 participants were "high" and 1 participant was "low".

Instead of using complex categories as follows:

I. High Knowledge sharing; Low Business Expertise (HKSLE)
II. High Knowledge sharing; High Business Expertise (HKSHBE)
III. Low Knowledge sharing; High business expertise (LKSHBE)
IV. Low Knowledge sharing; Low business expertise (LKSLBE)

This research has opted for naming different types of knowledge worker:

I. HKSLBE: Catalyst
II. HKSHBE: Maestro
III. LKSHBE: Encyclopaedia
IV. LKSLBE: Novice

Building upon the 6 intentions to share knowledge factors, and the 2 business expertise factors, we can create a Venn diagram (Figure 3).

![Figure 3: Venn Diagram of Knowledge Sharing Types](image)

The naming of the different type of knowledge sharer is a product of this research. The specific naming is intended to reflect the identity of the category. These will be detailed and each categorisation critiqued.

The inclusion of the Venn diagram, when the results of this research categorise over 87% of participants into a single type, is to provide a framework for further researches.

**Maestro**

This is an individual who has both, a high degree of knowledge sharing intention, and business expertise, and is regarded as the optimal type of knowledge sharer.

In terms of their expertise, they are consistent, reliable, and identified as one of the best, in the company, for their domain of business specific knowledge. As long as the business expertise they possess is relevant to the organisation, they will be considered valuable.

Their intention to share knowledge is high, based upon the 6 significant factors identified. As 4 out of 6 factors here are intrinsic, they must have at least a moderate degree of intrinsic factors leading to their intention, but these need to be balanced with high extrinsic factors.

**Catalyst**

This individual has a high degree of knowledge sharing, but can potentially be considered a liability, due to the fact that they do not possess a high level of business expertise. They can be converted into an organisational asset, if they are positioned in an area of relevance, or growth, where they could develop their expertise, with the view of becoming a maestro.
In terms of expertise, they are inconsistent, unreliable, and not identified as one of the best in their domain. However, like the maestro, they must possess, at least, a moderate degree of intrinsic factors that lead to the intention to share knowledge.

**Encyclopaedia**
This was a description that one of the interviewees made regarding their manager, who apparently knew everything about their domain, but was not well placed, or sufficiently motivated, to share their knowledge.

An encyclopaedic individual is consistent, reliable, and identified as one of the best, for their business expertise, but does not intend to share their knowledge. For Encyclopaedias, it is worth considering whether, through leveraging extrinsic factors, they could move to a moderate degree of knowledge sharing.

Failing this, once they have fulfilled their purpose, they should be removed from the organisation, to mitigate any potential damage, of the departure of their tacit knowledge.

**Novice**
This individual has neither high business expertise, nor the intention to share their knowledge. This means that they do not have the same degree of liability of a Catalyst, who would share knowledge even though they only know a little. However, because they know a small amount of knowledge, but would not be inclined to share it, their membership of an organisation is questionable.

They could, through training and investment, move to a position of encyclopaedia, but this effort would have an element of risk associated with it, since they still would not share their knowledge. Ultimately, they would need to be removed from the organisation.

8.7.2 Critique of Types of Knowledge Sharing Types

Based upon these categorisations, the results of this survey can be found in table 12

**Table 12 - Count of Knowledge Sharing Types**

<table>
<thead>
<tr>
<th>Knowledge sharing type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maestro</td>
<td>90</td>
</tr>
<tr>
<td>Catalyst</td>
<td>12</td>
</tr>
<tr>
<td>Encyclopaedia</td>
<td>0</td>
</tr>
<tr>
<td>Novice</td>
<td>1</td>
</tr>
</tbody>
</table>

We can see, from the categorisation of individuals, that they are not evenly distributed. For expertise, this is an expected outcome, based upon the participant selection criteria, where individuals needed to have had at least 3 years business experience. There is also expected to be a degree of self-assessment bias in these results, relating to expertise through the self-assessment process. A greater number of participants is also needed along with a model that provides a Goodness of Fit.

8.8 Hypothesis Testing

**H0** – There will be no relationship between the factors and the latent variables.

Whilst not all of the items had significant relationships to their latent variables six out of eighteen factors (or 33.3%) were significantly related to the intention to share knowledge. Both of the expertise factors were significantly related to the Business Expertise latent variable (or 100%).

Therefore we can reject the null hypothesis.

**H1** – Intrinsic factors of knowledge sharing have a positive effect on an individual’s intention to share knowledge.
When we exclude the non-significant factors, we can see that the 4 intrinsic factors knowledge sharing factors have a positive effect on an individual’s intention to share knowledge.

The 4 significant intrinsic factors have an average factor loading of 0.45, showing a positive effect.

This is a moderate positive effect, but still a positive effect, therefore this hypothesis cannot be rejected.

**H2 – Extrinsic factors of knowledge sharing have a positive effect on an individual’s intention to share knowledge.**

There were only 2 knowledge sharing factors that were found to be significant in this research that were identified as extrinsic. These were found to have a positive correlation to the individual’s intention to share knowledge.

These two factors had an average factor loading of 0.33, demonstrating a positive effect, and therefore, this hypothesis cannot be rejected.

**H3 – Intrinsic factors of knowledge sharing will have a greater impact on an individual’s intention to share knowledge than extrinsic factors.**

The greater quantity, and quality, of intrinsic factors, over extrinsic factors, means that we cannot reject this hypothesis. This is reinforced by intrinsic factors (0.45) having a greater factor loading than extrinsic factors (0.33). However, it is worth noting that, a smaller selection of extrinsic factors were identified in the literature, and have therefore not been included in this research.

**H4 – The expertise factors will have a positive relationship with business expertise.**

The two factors are both significantly related to business expertise, with positive factor loadings. Therefore this hypothesis must be accepted.

**H5 – Business expertise and the Intention to share knowledge will be positively related.**

This has been found to be true, for this research, and means that this hypothesis must be accepted.

**8.9 Limitations**

There were two main limitations of this research.

**The goodness of fit of the model**

The model was rejected in terms it’s GFI. Further research would benefit from identifying additional modification paths, and factors, for consideration. Further factors would need to be considered to achieve a GFI, since the paths alone are insufficient to achieve this.

**Number of participants**

The number of participants was at the lower end of the scale, but accordingly to Ding et al.’s (1995) review of studies, 100 to 150 participants is the minimum for SEM. This means that more participants would be beneficial for future research.

**8.10 Implications of this research**

The implications are separated into academic benefits and practitioner implications.

**8.10.1 Academic implications**

This research has been partially successful at collecting and testing factors found in the literature that, are expected to have some degree of correlation to the intention to share knowledge. However, the lack of GFI means that further exploration is required beyond what has been found in this research. Additionally, the low sample size means that a greater number of participants for future research would be needed.

Intrinsic factors were found to relate more strongly, than extrinsic factors, to the intention to share knowledge. Therefore, future research into knowledge sharing would benefit from focusing particular effort on intrinsic factors.
The CWS measure has successfully been employed in a generic questionnaire based manner. This indicates that the following question could be tested in wider research into expertise.

“Relating to your business expertise above - out of the last 10 questions at work, how many did you quickly and correctly answer?”

8.10.2 Practitioner implications

The four types of knowledge sharer and expertise measures, with their underlying data, specifically benefit organisations in 4 ways.

1) **Recruitment** – To identify if a prospective employee exhibits knowledge sharing attitudes. This would effectively enable the removal of prospective candidates, if they do not demonstrate the required amount of intention to share knowledge.

2) **Assessing organisational state** – The questionnaire could be used to identify factors affecting business units, or the organisation’s levels of knowledge sharing, for both base-lining either, a change in programme, or a longitudinal review of knowledge sharing, within the organisational area, to evaluate success.

3) **Restructuring** – This tool could be used, in conjunction with other methods, to determine how best to restructure teams. Specifically with regards to creating innovative teams, or less innovative teams, depending on the business requirements.

4) **Team Building** – Identifying inhibitors of knowledge sharing, across teams, and then taking relevant action to address this.

8.11 Recommendations for further research

The recommendations for further research are grouped into five categories.

**Factor enhancement**

We have successfully identified 6 factors that are significantly related to the intention to share knowledge. If the significant factors were broken down into their component parts and analysed within a larger sample population, this would add accuracy and power to the model.

**Consideration of additional knowledge processes**

This research focused upon knowledge sharing. However, the three processes that were omitted were knowledge creation, knowledge storage, and knowledge application.

Were these to be added to this model, a holistic overview could be achieved of all the organisational knowledge processes. A holistic model would add value to both academics and practitioners that would enable the identification of the factors that act as predictors to all four processes.

**Enhancement of the focus upon expertise**

Expertise comprised of two questions that were significantly related to business expertise. The reason that further factors were not included was to focus upon the intention to share knowledge latent variable. Future research could expand upon these aspects.

**Observer assessment**

This research has focused exclusively upon individual’s self-assessment against various questions. The reason for this was twofold; to reduce the number of questions to attempt to maximise response rates, and by removing the need for participants to know each other. This last point would certainly be needed for the inclusion with an observer assessment. Zhou et al. (2012) found assessment of others removed the self-assessment bias.

**Agency Based Social Simulation**

A growing focus of literature is using social situation software to generate models for behaviour (Lanham and Carley, 2014; Nemiche et al. 2013; Villatoro, 2013). The four core knowledge organisational processes, when analysed, could be coded into such a model. This should then be able to identify the patterns of behaviour among employees for all these processes.
9. Conclusion

This research has been partially successful in achieving both its aim and testing the hypotheses. A model has been developed that achieves part of it's purpose in identifying who is likely to share their knowledge within an organisation and the underlying reasons for this. This model also can also be used to categorise individuals into 4 distinct types of knowledge sharer. The model itself would benefit from further testing and refinement.

The lack of goodness of fit of the model meant that, the items require further consideration, along the lines of the modification indices that were offered. The modification indices alone are insufficient to achieve a Goodness of Fit, and therefore further knowledge sharing factors need to be identified.

Further research would benefit from building on foundations of this research to encompass the additional organisational knowledge processes. This would enable a holistic view of the knowledge life-cycle within organisations. This research should include observer assessment, which would act as a countenance to the self-enhancement bias that has potentially occurred in this research.

A much greater number of participants and an exploration into the relationship between participants would enable observer assessments to be conducted. This would require participants to know each other, this would perhaps, be facilitated in a single medium to large company.

If this research was to be repeated, a greater amount of interviews, and focus groups, should take place, to identify further items that may have led to the intention to share knowledge.

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