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The Strategic Role of Knowledge Auditing and Mapping: An Organisational Case Study

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ABSTRACT

This paper presents the results of research which aimed to evaluate the current position of the knowledge management (KM) capabilities of a multi-national energy services company. This was achieved through the development and application of three methodological 'tools' designed to facilitate the collation of relevant data upon which the KM strategy would be based. These were: a Knowledge Process Audit to develop an understanding of how employees viewed current knowledge-based practices within the organisation; a Knowledge Inventory and Map to identify and list tacit and explicit knowledge assets within the organisation; and a Knowledge Needs Analysis to determine the types and forms of knowledge assets required or desired by members of staff to perform their roles more effectively.

While a number of strategic approaches to knowledge management have been posited, there has been a general lack of material describing the development and use of methodologies which may be used as a basis for KM strategies. This research emphasises the need for and use of a rigorous approach to the collation and application of relevant data on which to develop a suitable strategy.

Practical implications are provided in the form of key findings for the research, including the importance of internal tacit knowledge; consultation of external sources only after internal searches have failed; difficulty of new integration of employees; lack of knowledge sharing at a wider level. Methodological implications for the development and application of knowledge audit and mapping tools are also presented.

BACKGROUND

As understanding of the benefits and limitations of knowledge management (KM) within organisational contexts continues to develop, so too does the development and application of tools and techniques used to support various aspects of KM. A critical antecedent to implementation is to develop an understanding of the current KM context through the use of approaches such as knowledge audits and maps (BSI, 2001).

Over the last twenty years, the knowledge audit and map have been acknowledged as important processes in determining and illustrating the knowledge held within an organization. Indeed, the knowledge audit is widely recognised as the first 'critical' stage of

introducing KM into the workplace (Liebowitz *et al.*, 2000; Hylton, 2002; Perez-Soltero *et al.*, 2006a): ‘...through an audit, organisations can identify and evaluate all information resources and workflows and determine user requirements, which will vary widely from wide access (e.g. policies and procedures) to extremely limited access (e.g. payroll information)’ (BSI, 2001). Knowledge maps are visualisations of knowledge embedded within the people, systems and documentation of an organisation. Vail (1999) defines knowledge mapping as ‘the process of associating items of information or knowledge, preferably visually, in such a way that the mapping itself creates additional knowledge. The mapping process often creates intellectual capital value through the creation of new knowledge from discovering previously unknown relationships or gaps in expected ones’ (Vail, 1999, p. 5). The map shows what tacit and explicit knowledge exists, where this can be found and how this knowledge moves around the organisation from where it is to where it is needed.

A knowledge audit provides an understanding of the types of knowledge and knowledge processes which exist in a specific context (such as an organisation). This may include the location of the knowledge, how it flows through an organisation as well as identifying any gaps between required and existing knowledge (Levantakis *et al.*, 2008; Bright, 2007). Implementing this type of organizational ‘health-check’ allows for the evaluation and identification of the most appropriate initiatives and approaches required to improve the management of knowledge (Liebowitz *et al.*, 2000).

RATIONALE

Prior to the 21st Century very little attention within the field of KM was given to knowledge auditing and mapping. Despite recognition of their importance (Liebowitz *et al.*, 2000; Koulopoulos and Frappaolo, 2000) the lack of literature relating to the practicalities of undertaking a knowledge audit may have acted to discouraged implementation attempts and may even had an impact on their success (Burnett *et al.*, 2004). To build on the lack of empirical evidence, a number of methodologies based on KM practice and research emerged in the early 2000s (e.g. Skyrme, 2002; Liebowitz *et al.*, 2000; Lauer and Tanniru, 2001; Hylton, 2002; Burnett *et al.*, 2004; Choy *et al.*, 2004). While differences between the models exist, these approaches broadly focus on a number of key elements: the identification of knowledge needs (through questionnaires and interviews); the discovery of the types of knowledge present and their locations; how knowledge is maintained and stored; its use and relevance; how it moves within a specific context; the construction of a knowledge map and the development of a final report (Perez-Soltero *et al.*, 2006a). Aspects of these original models have subsequently been used by other researchers and practitioners to develop further knowledge audit frameworks to suit different contexts and environments (Schwikkard and du Toit, 2004). Consequently these frameworks (including those developed by Liebowitz *et al.*, 2000 and Burnett *et al.*, 2004) are still being used today to inform the execution of knowledge audits (Huck *et al.*, 2011).

Based on several of these original models, Levantakis *et al.* (2008) developed new concepts incorporating knowledge strategy development and social network analysis to produce a high level method. Five ‘donators’ were selected, including the model devised by Burnett *et al.* (2004) and these were compared with the super method process, defined by Hong *et al.* (1993) as the smallest common denominator of activities addressing existing knowledge audit methods. This analysis disclosed limitations of each of the five donators. For example,

Levantakis *et al.* (2008) suggest that the approach by Burnett *et al.* (2004) focuses less on the in-depth investigation and more on evaluating the data but consequently could be used to further develop existing models. Xiao *et al.* (2010) also consider existing models to produce an integrated framework with emphasis on the core knowledge audit processes.

The focus of knowledge auditing has also moved towards improving the representation of findings through social network analysis, taxonomies and ontologies (Sharma *et al.*, 2010, Perez-Soltero *et al.*, 2006b, Eppler, 2009), using a balanced scorecard method (Iazzalino and Pietrantino, 2005) highlighting the importance of culture and other organisational factors (Levy *et al.*, 2009), consideration of core processes (Perez-Soltero *et al.*, 2006a), and the importance of knowledge inventory analysis (Levy *et al.*, 2009, Perez-Soltero *et al.*, 2007, Levantakis *et al.*, 2008, Bright, 2007, Cheung *et al.*, 2007).

Levy *et al.* (2009) criticised the models developed in the first part of the 21st Century for not including a KM infrastructure audit whereby the culture, knowledge processes and IT within the organisation are assessed. By integrating methods from the fields of both knowledge auditing and system modelling, Levy *et al.* (2009) believe their framework is able to identify issues, opportunities and impacts of knowledge assets, their format and location in relation to business processes. The authors indicate that this, as opposed to the focus on either social or technical aspects as employed by previous models, aims to build the KM infrastructure of culture, knowledge processes and IT. However, it must be noted this methodology was also developed by analysing five frameworks informed by the original methodologies (Bright, 2007; Iazzolino and Pietrantino, 2005; Handzic *et al.*, 2008, Levantakis *et al.*, 2008, and Perez-Soltero *et al.*, 2006a).

Investigations into knowledge audit methodology focusing on core organisational processes have been carried out by Perez-Soltero *et al.* (2006a, 2007). Perez-Soltero *et al.* (2007) suggest that the majority of these original models failed to consider the core processes of a particular organisation rather, auditing everything whether important or not. Their model therefore focuses on the knowledge that is contained within the core processes ensuring the existence of key knowledge critical to the success of the organisation. Moreover, despite their critique of the model developed and applied by Burnett *et al.* (2004), Perez-Soltero *et al.* (2007) do, however, acknowledge that it would be possible to employ this model when planning to measure knowledge processes within certain core processes.

As such, this research aims to revisit the work conducted by Burnett *et al.* (2004) in order to examine how it may be usefully developed further through the incorporation of ensuing developments in the field (such as those noted above) with a view to continuing the development of knowledge auditing and mapping approaches. This paper examines the application of these approaches within the context of an organisational case study in order to address two research questions:

- Where is the organisation currently, in terms of (formally and informally) managing organisational knowledge?
- What is the appropriate direction for the organisation in relation to KM?

The subsequent sections of this paper describe in detail: the process undertaken; the reasons why this process was employed; and what the results indicated, for each approach and stage illustrated above.

METHODOLOGICAL APPROACH

The case study organisation is a multi-national energy solutions company operating in both the oil and gas and the alternative energy sectors. The organisation employs over five hundred people across locations in Europe, the Middle East, Australasia, and the United States. In order to address the questions presented above, a two stage programme of research was developed. The first stage identified and evaluated the current KM position of the case study organisation by developing and applying:

- A Knowledge Process Audit (KPA) - to develop an understanding of how employees view current knowledge-based practices within the organisation
- A Knowledge Inventory and Map – to identify and list tacit and explicit knowledge assets within the organisation in the form of a knowledge assets register
- A Knowledge Needs Analysis – to determine the types and forms of knowledge assets which members of staff require or desire to perform their roles more effectively

In turn, these aimed to determine:

- the effectiveness of knowledge-based processes
- how enabling factors impact on these processes
- what knowledge assets exist in the organisation
- the perceived value of knowledge assets by employees
- where the resources are within the organisation
- issue affecting the use of knowledge asset by employees
- what knowledge resources are required by employees

Details of how each of the methodological steps was conducted and the results obtained from those steps are described in the following sections.

THE KNOWLEDGE PROCESS AUDIT

Methodology

The Knowledge Process Audit (KPA) intended to develop an understanding of how employees view current knowledge-based practices within the organisation. This particular audit aimed to examine the current state of knowledge capability of the organisation and what the organisation was currently doing in terms of managing knowledge through focussing on two aspects (Figure 1):

- The organisational enablers of managing knowledge (i.e. what the organisation does to support KM):
 - Strategic Vision
 - Infrastructure
 - Structure and Environment
 - Culture and Behaviour
- The KM processes which employees carry out (i.e. how individuals within the organisation engage with KM activities):

- Knowledge Capture and Access
- Knowledge Creation and Development
- Knowledge Sharing and Transfer
- Knowledge Retention and Storage



Figure 1: Knowledge Management Enablers and Processes

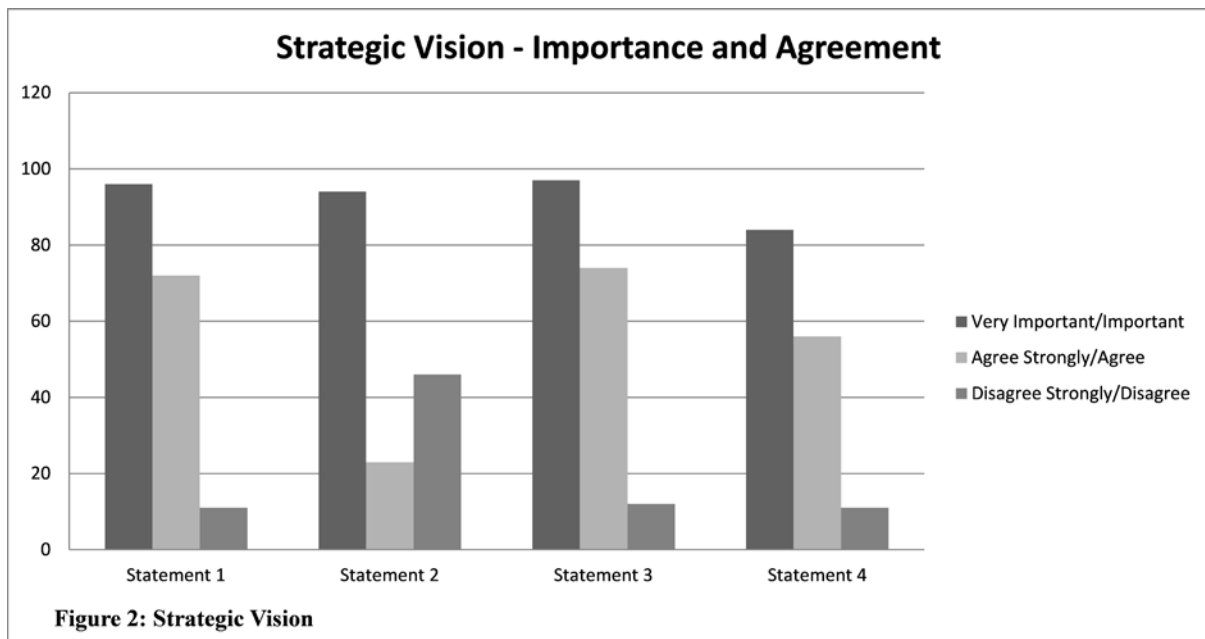
Previously developed KM processes and enablers were reviewed and adapted to the needs of this particular programme (e.g. Perez-Soltero *et al.*, 2007). These were used as the framework for the knowledge audit questionnaire. Based on this review and additional discussions, statements were developed for each process and enabler. A total of 49 statements were included in the questionnaire which related to each of the processes or enablers (Appendix A). The number of statements relating to each of the processes and enablers varied between 4 and 9. Once finalised, the statements were transferred to an online questionnaire using Google Document Forms. Some technical issues were encountered due to the language settings and browser limitations and as such, paper-based questionnaires were produced and disseminated to ensure all staff had an opportunity to participate in the research. Employees were emailed a link to the questionnaire. In total, 107 responses were received.

Respondents were asked to rate the extent to which they agreed with each of the statements, and the level of importance of the statement. As a result of the literature review, it was decided that statements using Likert scales for both 'Agreement' and 'Importance' would be utilised to identify the current state of KM in the organisation and indicate what participants believe are critical requirements. Data for both the agreement and importance statements were separated into the enablers and processes where key themes and patterns were identified. These data were then used to produce charts for each of the enablers and processes as well as highlight significant issues and also the perceived value and potential.

Findings

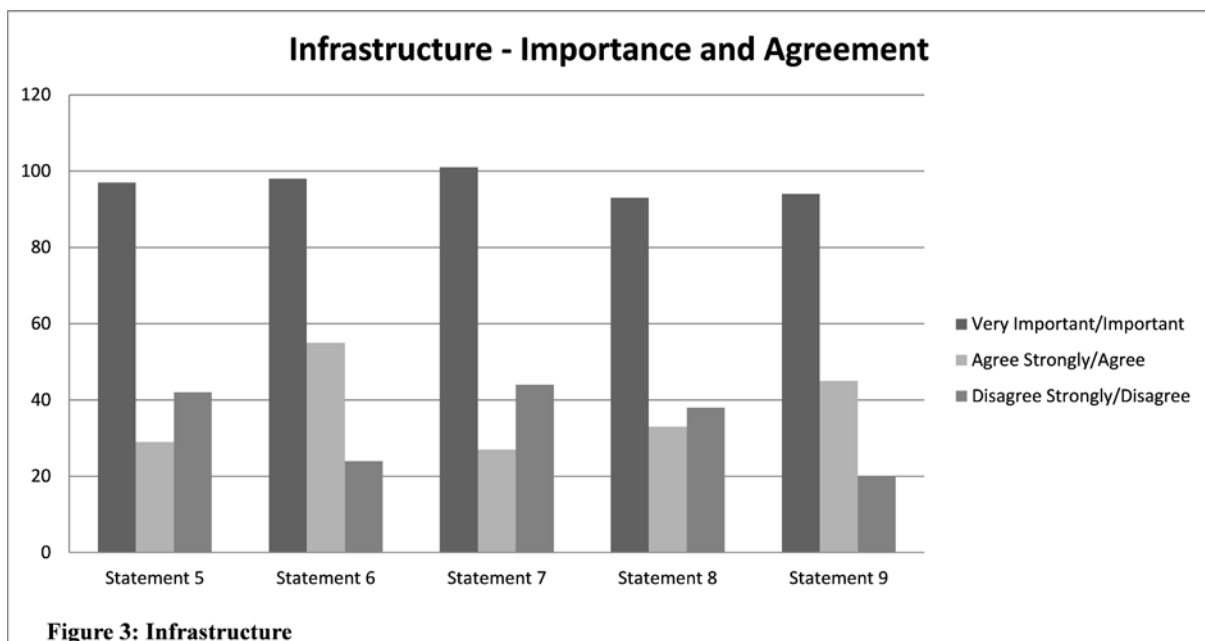
Enablers

Strategic Vision



In general, the data indicated that at a strategic level, the organisation recognises the need for KM to operate successfully in a very competitive market. While there may be a need to raise awareness of how KM can add value to the organisation, it is currently seen as a key part of the organisation's strategy. The overall perception is that KM can play an important role in identifying external best practice and obtaining insight into competitors. As such, it is clear that the organisation's vision supports the role of KM across the organisation (Figure 2).

Infrastructure



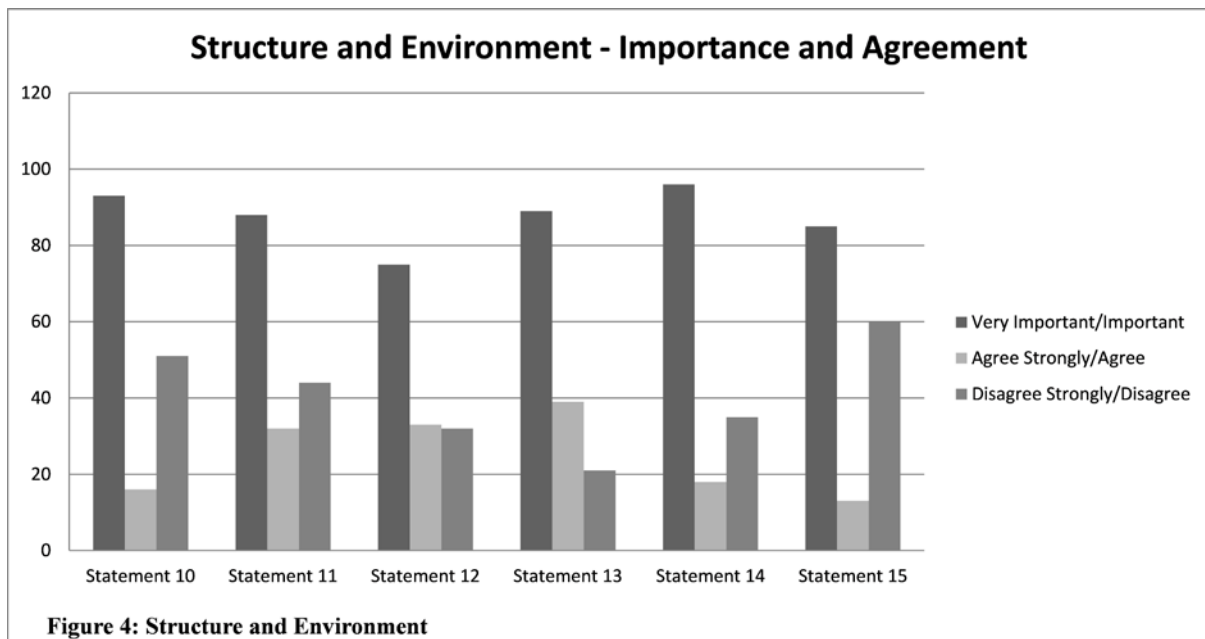
“The organisation and retrieval of knowledge stored on the projects database on the intranet needs reworked to better capture key categories and accurately export search results and to cut down the time spent having to sort information manually.”

“Where and how we save project files on shared drive is not consistent across departments. Finding and then access to completed projects could be made easier, is there a database of projects with good description of the work completed. Cross-department communication is poor at present.”

“Better use and/or development of IT and communication for both external and internal meetings and for a more seamless management and employment of an integrated 'global virtual team'”

The respondents clearly see the importance of having the appropriate tools and technologies in place to support the delivery of a successful KM programme. Indeed, there is a perception that the appropriate systems are currently in place to ensure effective communication throughout and across the organisation. However, it can be suggested that there is a need to raise awareness of how these current technologies can be utilised to also undertake effective processes to ensure the identification, retention and capture of new and existing knowledge. In addition, there is a clear indication that the technology currently available can help to ensure a more globally integrated organisation (Figure 3).

Structure and Environment



“In my area, senior employees often lack the time to manage their knowledge within the team in the way they would like: project delivery must always receive priority but support may be required to provide better ways of sharing knowledge.”

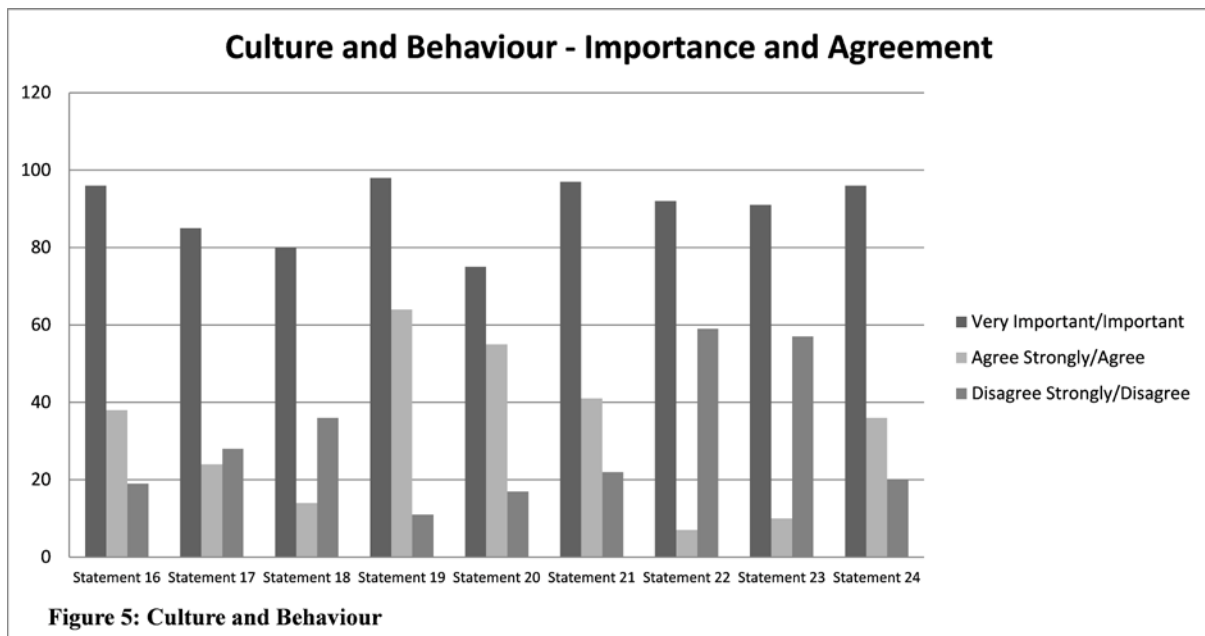
“The part of business stream I come from, I have limited knowledge on the activities carried out across the company.”

“The degree to which any policy is successful is down to individuals and management at the local and global level. Some managers are good at this, others either don't care or aren't given time. One reason that is expressed often is we don't have a critical mass in some disciplines within offices.”

“I feel that my knowledge/expertise [is] not utilized organisation-wide. The more focus is on revenue and less focus on retaining, updating knowledge and skills.”

Despite clear indications that the organisation currently has an environment that supports both formal and informal knowledge sharing there are some concerns regarding how conducive the current organisational structure may be for the general management of knowledge. Several participants also mention the lack of time available to carry out KM processes. A lack of awareness about what is happening throughout the organisation both in terms of KM and other developments may also have an impact on the success of a knowledge programme. Indeed, with a number of global locations, the organisational structure needs to facilitate integrated working practices (Figure 4).

Culture and Behaviour



“Within the alternative energy side of the business there does not seem to be a large culture of sharing knowledge promoted from management.”

“I think that there is a good culture in the organisation for sharing knowledge and info and for helping colleagues.”

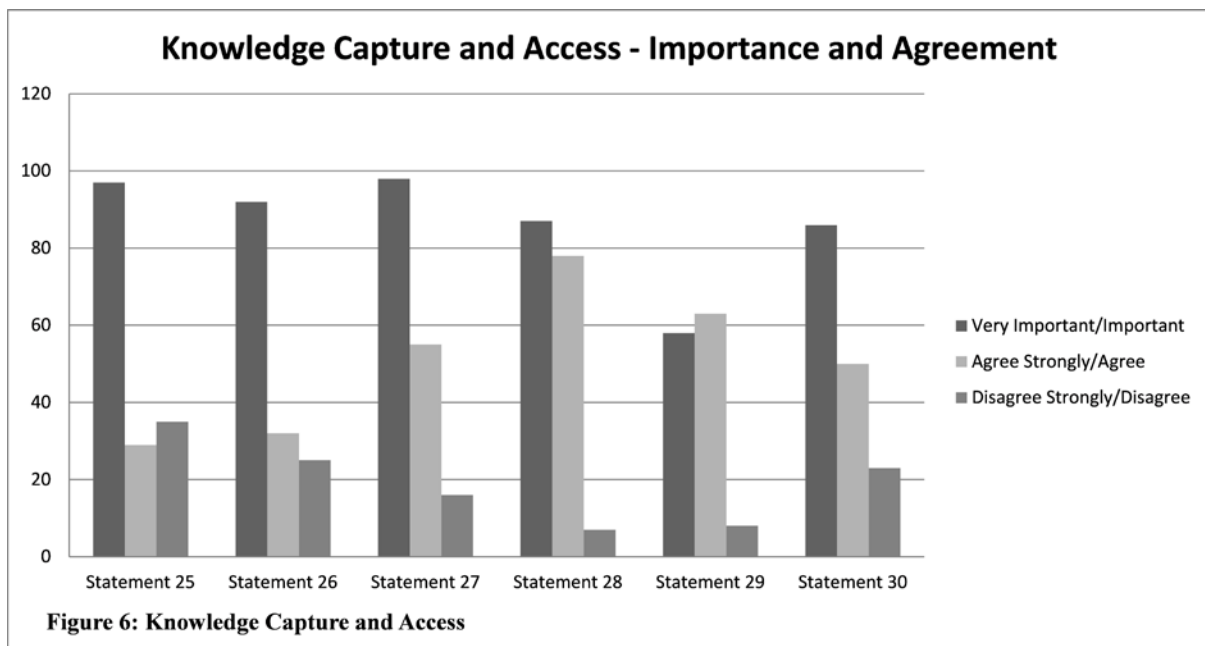
The culture of the organisation is perceived to be a key enabler in the effective delivery of KM. There is a perception amongst employees that the current culture encourages openness, teamwork and trust, stimulates creativity and innovation and provides an environment where people learn from each other. There is therefore the potential to build on this very receptive culture to ensure knowledge sharing is carried out as employees leave the organisation as well as on completion of projects (Figure 5).

Enablers - Perceived Value and Potential

Overall the respondents believe that the organisation has the potential to effectively enable KM through the key enablers of culture and behaviour, infrastructure, structure and environment and strategic vision. Key aspects of each need to be reconsidered and developed to ensure a successful and effective KM programme. The current IT provision could be expanded and redeveloped to support certain aspects of KM including knowledge storage and sharing. It does appear that the organisation has the capabilities to encourage KM within the organisation.

KM Process

Capture and Access

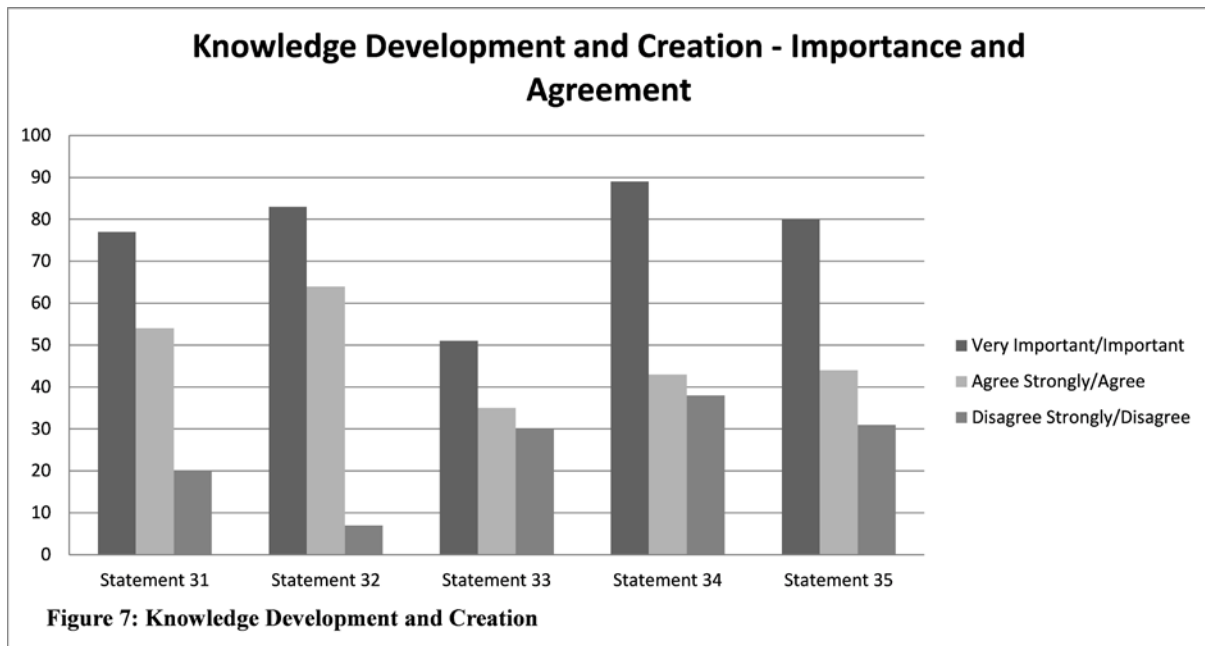


“Alternative energy is run as a separate business from the rest of [the company]. We do not routinely share information between UK, US and Australia and have no access to each other’s files.”

“To obtain knowledge from leaving colleagues requires us being told that they are leaving.”

It is clearly evident from the data gathered that a high proportion of essential knowledge is regularly sought from and held in the heads of colleagues particularly in the respondents' own team and department. Indeed, there is a certain level of satisfaction in terms of their team's explicit knowledge. However, there may be a need for further improvements to the capture and access of knowledge within the whole of the organisation and external to the organisation (Figure 6).

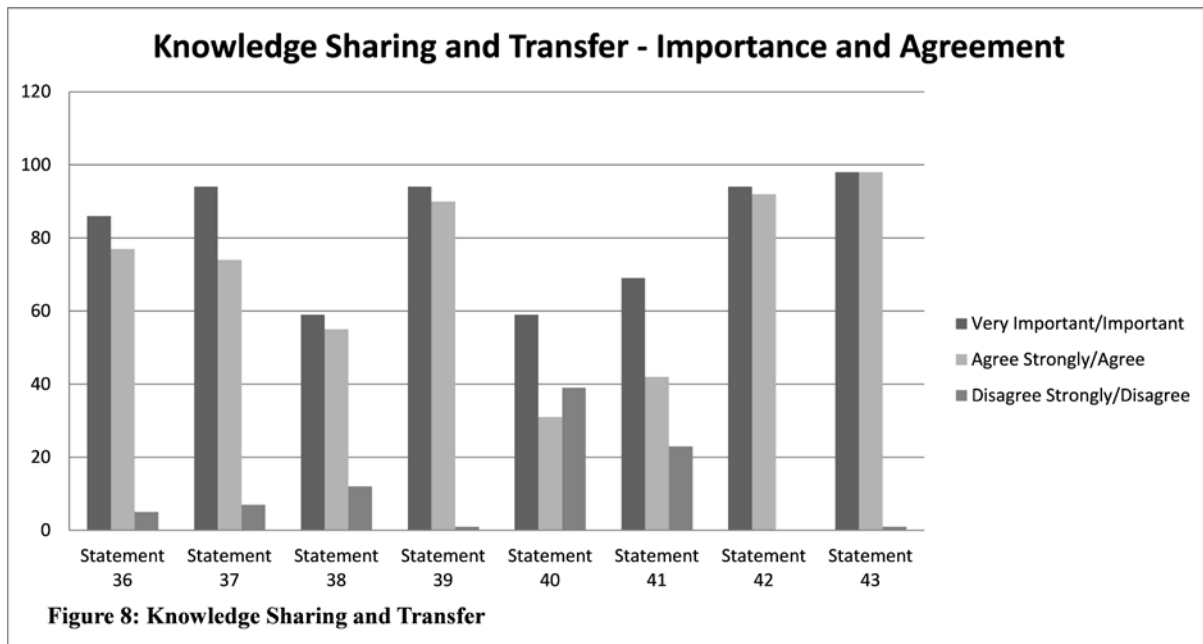
Knowledge Development and Creation



“We need to know how to practically apply new knowledge, without it in my opinion knowledge mgt is more likely to fail and be viewed as an overhead not a value adding.”

Attempts are made by employees to ensure their tacit knowledge is made explicit and incorporated into new products, processes etc. However, there is still potential for additional training, coaching and raising awareness of using specific techniques to generate and create new knowledge. In addition, the benefits of discussion forums and similar platforms may require a higher profile to ensure these are taken advantage of when required (Figure 7).

Knowledge Sharing and Transfer



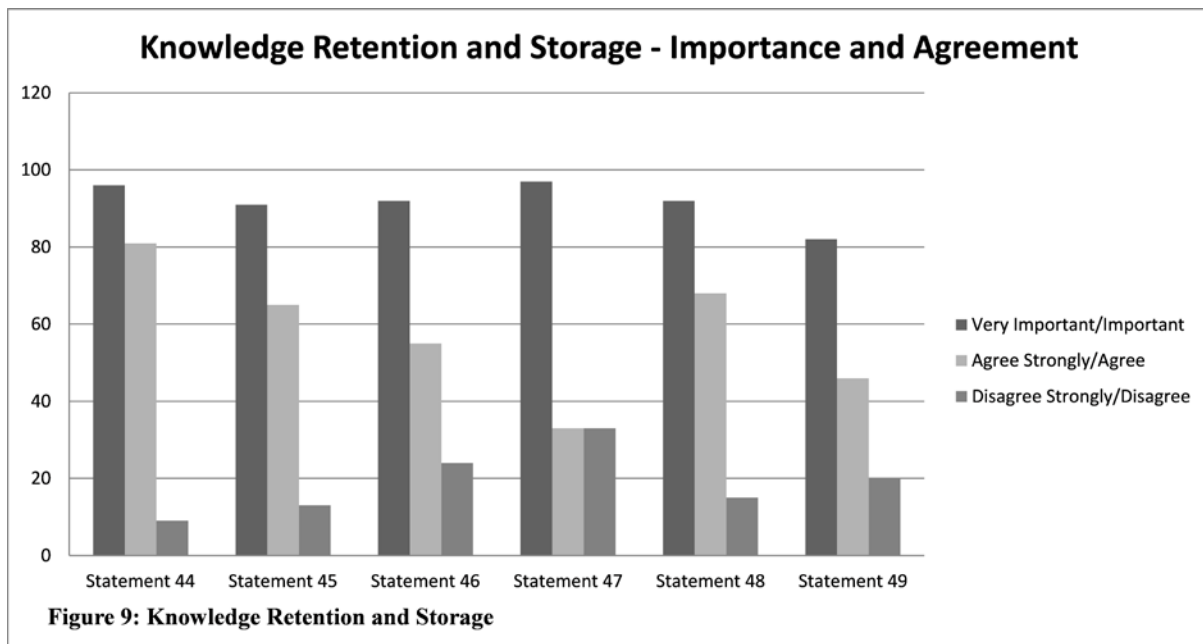
“The organisation requires a more “technological” way of sharing project data, instead of sharing files in a drive (P). A system such as “Sharepoint” will enable not only to share information but also to keep a better tracking of document versions.”

“Currently, technical best practices are implemented and shared between project members but there is no online board where people can share these practices and new knowledge gained with the rest of the world. It may be useful to consider the creation of different technical interest groups (TIGs) where our staff can share knowledge and solicit help and guidance rather than through the email system.”

“Knowledge transfer requires openness from all parties which is not always the case. Some colleagues are unwilling to share perhaps believing that they need to be ‘indispensable’ and the only way to retain that is to ‘hoard’ their knowledge.”

“The principal problem is a lack of intrinsic knowledge transfer in the employees themselves (from my experience) and it is not proactively encouraged by management - I don't think this is deliberate I just don't see it being done.”

The majority of respondents agree that sharing knowledge is routine and attempts are regularly made to volunteer and transfer knowledge to others. However, levels of participation in both formal and informal networks within and external to the organisation seem to be fairly low. This perhaps indicates that knowledge transfer is carried out by alternative means. Indeed, the findings suggest that employees independently seek out others with similar interests to share experiences and knowledge. In addition, there is a definite willingness to collaborate with others across departments (Figure 8).



“It is important that there be standard practices for knowledge storage (e.g. on shared drives, not on local hard drives), and that there be systems to retrieve that data easily -- systems which work even when the requestor does not know the data exists.”

“Much knowledge is stored in the form of specific application files...There are real problems about availability of licences simply to be able to look at available data.”

Despite the practice of continually documenting and storing knowledge, limited knowledge from completed projects is retained through the implementation of after action reviews and the identification of lessons learned and best practices. This is also in contrast with the fact that more than half of the respondents indicated that they tend to review completed projects for knowledge and best practice. In addition, the majority of respondents use databases and shared drives (particularly their own personal folders) to store their own specific knowledge. The results also indicate that attempts are made by individual employees to retain knowledge from departing colleagues (Figure 9).

KM Processes - Perceived Value and Potential

Overall the findings indicate that KM is viewed as important/very important to the organisation and its employees. However, there is a recognised need for a number of repositories and/or databases that can be used to collate specific types of knowledge. The results also suggest a requirement for collating and sharing knowledge relating to previous projects to be made available to all throughout the organisation. In addition, the data collated indicates that the organisation currently has a high level of subject specific expertise embedded in individuals. Because of the perceived willingness to embrace sharing there is the potential to raise awareness of this expertise to encourage general awareness and

knowledge transfer beyond the locale of specific subject or project experts. There is also an opportunity for the development and documentation of specific processes and procedures.

KNOWLEDGE INVENTORY AND MAP

Methodology

Having identified the KM processes and enablers in the previous stage, the next step was to determine what knowledge assets existed in the organisation and where they were located by developing and applying a Knowledge Inventory and Map. Cheung *et al.* suggest that 'the purpose of the knowledge inventory is to create a snapshot of knowledge assets so that the explicit and tacit knowledge and the current status of the existing corporate knowledge can be quantified, measured and valued. It is a stock-take of the intellectual capital of the organization so that the organization can make good use of it for strategic planning' (2007 p. 144). For the purposes of the inventory, the following definition of knowledge assets was used: 'Those parts of an organization's Intangible Assets that relate specifically to knowledge, such as Know-How; Best Practice; Intellectual Property; and the like. Knowledge assets are often divided into human (people, teams, networks and communities), structural (the codified knowledge that can be found in processes and procedures) and technological (the technologies that support knowledge sharing such as databases and intranets)' (Knowledge Research Institute, 2009).

Participants were asked to identify their five mostly common used knowledge assets. For each of these assets, the participants were then expected to indicate: the subject sought; the format of the knowledge asset; the location of the knowledge asset; what the knowledge required is used for; how the knowledge is accessed; how frequently is used; and how important it is. Again, once finalised, this template was then transferred to an online questionnaire available on Google Docs forms. As with the knowledge audit questionnaire, this particular questionnaire was made available to all staff for a 3-week period. In total 48 responses were received for this stage of the project.

Once collated, the data was transferred to a spreadsheet where they were separated into the organisation's geographical sites where the assets were believed to be located as indicated by participants of the online questionnaire. This included a 'Not Known' worksheet as participants described the location of online assets as 'not known' or in some cases were not aware where the individual staff member was based. These assets were quantified in terms of the number of users i.e. those participants who had indicated consulting the particular knowledge asset for each location. If an asset was mentioned more than once the mean of the frequency and importance of use has been included in the table.

In line with the knowledge types matrix (Tables 1 and 2) the knowledge assets were then split into internal and external assets and also explicit and tacit assets. This resulted in four main types of knowledge assets: internal explicit; internal tacit; external explicit and external tacit.

TACIT

| | |
|---|---|
| <p>Intangible asset for the organisation Requires training/development Salary cost implications</p> | <p>Need to maintain relationships May end on retirement etc No quality control Requires no internal maintenance Potential cost implications for</p> |
|---|---|

| | | |
|-----------------|---|---|
| | | access |
| EXPLICIT | Tangible asset for the organisation Requires internal maintenance Control over quality and quantity | Not an intangible asset Requires no internal maintenance No control over quality Subject to termination Potential costs implications for access |
| | INTERNAL | EXTERNAL |

Table 1: Knowledge Types Definition

| | | |
|-----------------|-----------------|-----------------|
| TACIT | 67 | 5 |
| EXPLICIT | 51 | 23 |
| | INTERNAL | EXTERNAL |

Table 2: Knowledge Assets Matrix

A knowledge asset register template was then designed to list the most commonly used knowledge assets within the organisation and also identify the number of users for each as well as other knowledge attributes including frequency of use, importance of use, access method and format. Although it was originally planned to produce only one knowledge asset register, the large volume of assets for certain locations within the organisation dictated the need to develop a knowledge asset register for each location within the organisation.

In order to identify where knowledge is held it was decided that, as with the knowledge asset registers, the knowledge maps should be associated with a particular location within the organisation. It was important to produce a clear but concise map that would indicate the commonly used knowledge for each location. As a result, each map was divided into the four knowledge types as described above and the named asset and subject sought is indicated by frequency of use.

Findings

The following outlines the main findings from the knowledge inventory. The section covers the internal tacit knowledge, internal explicit knowledge and the external knowledge used as well as the knowledge sought and the impact the office location has in knowledge access. The table below indicates the division of knowledge by tacit, explicit, internal and external.

Internal Tacit Knowledge Assets

Perhaps not surprisingly, the majority of knowledge consulted by participants of this particular questionnaire is held within the organisation. Indeed, there is an emphasis of seeking knowledge from employees and of the 145 assets identified just under half (67) mentioned are individual members of staff and/or teams. Four individual employees are consulted by a number of the study participants due to the knowledge and experience they hold on certain aspects and subject matters. One participant indicated that:

“Textbooks do not have experience!”

However, it is clear from the study that in addition to these individuals and those classed as ‘non-specific colleagues’ there are still 45 individual employees consulted for specific types of knowledge. This perhaps suggests that many employees have their own specific knowledge assets and may not be aware of those other individuals who may also hold vital knowledge. This suggestion is corroborated by a participant:

“I think that there is a good culture...for sharing knowledge and info and for helping colleagues. It works on a personal note if you ask the right person. But if that person is not available or you don't know who they are, the system breaks down....”

Interestingly, it seems that access to the relevant tacit knowledge is particularly important for new starts and those who join projects mid-way through. Several participants indicated specific individuals that are essential to ensuring a knowledge base is built quickly when new to the organisation and/or an established project.

“Having come into a project in the middle I need to know what has been done, where to find the data and info. Main contact is XXXX who has worked in the area with the client for years.”

“As I am new to the organisation I consult XXXX about where and how to find information.”

Internal Explicit Knowledge Assets

Of the remaining 78 assets, 51 are located within the company and available in databases and/or files. This includes the Intranet, past projects located on the Intranet and personal and network drives, and applications including Salesforce (an integrated set of cloud-based customer relationship management applications) and a resource planning application. Other internal explicit assets include books, coursework and a time management application: Timetracker. However, it seems that several participants are not satisfied with particular

current internal explicit knowledge assets as they believe they do not meet requirements and require further development.

In relation to Salesforce, one individual indicates:

“As an input provider it serves limited value for my function and is sold as all singing all dancing. Not yet it isn't.”

In relation to the resource planning application, another participant suggests that:

“[It] does not work effectively. Not readily available.”

That being said the ‘Past Projects database’ located on the Intranet is consulted regularly and participants use it to identify similar projects and to assist in the development of new proposals.

Finally, from the data collated it is clear that participants from a number of locations within the organisation only accessed internal knowledge assets, explicit and tacit.

External Tacit and Explicit Knowledge Assets

In many cases the external knowledge assets mentioned by participants are not primary assets and are only consulted once it is perceived that the knowledge is not available within the organisation, it is not known where to locate the specific knowledge or there is limited time available.

“I refer to this knowledge asset [SPE Digital Library] as secondary to my colleagues as it is typically more time consuming.”

In addition, external explicit knowledge assets such as the Internet and the search engine Google are referred to because they are available as and when required.

“OnePetro is consulted because it is freely available, comprehensive and often can give insights into field data and technological approaches.”

“Google is consulted because it is freely and instantly available.”

A number of participants also indicated that need to consult digital libraries such as SPE (Society of Petroleum Engineers) and SEG (Society of Exploration Geophysicists) to obtain knowledge on technical papers and case studies as well as become up-to-date on new technologies etc.

Only 5 external tacit knowledge assets were mentioned by participants and these included knowledge from conference proceedings and external companies and experts.

Knowledge Sought

Internal Knowledge

When asked to state reasons for consulting specific internal knowledge, a number of assets were mentioned several times. Because of the type of response required these vary from very specific subject matter to a very broad purpose. See Table 3 for further details.

It is clear that the top three knowledge sought is embedded in the heads of staff. The remaining internal knowledge is found within either tacit or explicit sources. In addition to the knowledge identified, there is also a huge range of other internal knowledge that is required by only a small number of participants.

The table reiterates what has been revealed previously, internal tacit knowledge is seen as the most vital knowledge within the organisation and the company relies heavily on the knowledge of its staff.

| MOST SOUGHT KNOWLEDGE/PURPOSE | |
|--------------------------------------|---------------------|
| Knowledge/Purpose | No. of Users |
| Experts/People | 15 |
| Experience/Historical Info | 14 |
| Advice | 12 |
| Past/Previous Projects | 10 |
| Geology/Geophysics | 10 |
| Petrophysics | 7 |
| Project Management | 5 |
| IP | 5 |
| Best Practice | 5 |
| Offset Wells | 4 |
| Engineering | 4 |
| Sand Control | 3 |
| Resource Availability | 3 |
| Production Technology | 3 |

Table 3: Internal Knowledge Assets Most Sought

External Knowledge

Table 4 describes the knowledge participants seek from external resources. These mainly focus on best practice, case studies and technical papers as well as keeping up-to-date with new developments in terms of technology and practices. Other knowledge stated by only one participant included offset well data, core analysis and outcrop analogues.

| MOST SOUGHT KNOWLEDGE/PURPOSE | |
|--------------------------------------|---------------------|
| Knowledge/Purpose | No. of Users |
| Best Practice | 8 |
| Case Studies | 7 |
| Technical Papers | 7 |
| New Tech/Practice/Info | 7 |
| Research | 6 |
| Petrophysics | 3 |

| | |
|----------------------------|---|
| Geology/Geophysics | 3 |
| Fields | 3 |
| Technical Knowledge | 2 |
| Standards | 2 |
| Processes | 2 |

Table 4: External Knowledge Assets Most Sought

Impact of Users' Location

The data suggests that the larger the site/office the more likely employees consult colleagues in the same office for their particular tacit knowledge. This is as a result of several factors including convenience, difficulty in identifying the right individual and the perception that other individuals from other locations will not have useful knowledge specifically relating to projects being undertaken on the other side of the world. Indeed, one participant indicated the need to consult external experts:

“To obtain information that is not (readily) available in the organisation and often relates to location specific experience.”

In addition, as the company has offices in countries in other time zones the relevant knowledge may not be readily available when required. It is therefore a necessity to ensure the relevant knowledge is made available to all and is not dependant on where the individual is located.

“...Need to use the Intranet because helpful, knowledgeable, available people are hard to identify or locate in the right timezone...”

KNOWLEDGE NEEDS ANALYSIS

Methodology

While knowledge maps, audits and inventories are critical tools in determining knowledge which is present in organisations, they are less useful in identifying the knowledge requirements of employees within that organisation. The Knowledge Needs Analysis (KNA) intended to determine the types and forms of knowledge assets which members of staff require to perform their roles effectively. It determined:

- what knowledge is required by employees
- the forms of required knowledge
- the types of required knowledge
- why employees believe this knowledge would be beneficial
- the perceived impact of the use of this knowledge on their activities

The knowledge needs questionnaire followed the format and layout of the knowledge inventory questionnaire i.e. the top five needs and their associated knowledge attributes. As a result, a similar analytical process was carried out and the needs table also followed the same format of the knowledge asset register. This would indicate what knowledge assets are

currently required and their perceived importance by location. It would also enable the possibility to compare the current knowledge sought with what is required.

Once collated, the data was transferred to a spreadsheet where they were separated into the organisation’s geographical sites where the needs were required as indicated by participants of the online questionnaire. These assets were quantified in terms of the number of users i.e. those participants who had indicated the need for a particular knowledge asset. If an asset and/or need were mentioned more than once the mean of the frequency and importance of use has been included in the table. In line with the knowledge types matrix the knowledge needs were then split into internal and external assets and also explicit and tacit assets. This resulted in four main types of knowledge assets: internal explicit; internal tacit; external explicit and external tacit.

In the same way as the knowledge asset registers, a needs table was to be produced for each location where it is perceived to lack certain types of knowledge. However, only a small number of needs were identified per location. As the research team envisaged that all needs suggested by participants would be beneficial to all staff, one table listing all needs was used for analytical purposes.

It was decided to also present the knowledge needs data in the form of a map. It was anticipated that this would be developed by location, however due to the fact that the majority of needs were identified as being The organisation wide only four maps were produced, one for each knowledge type. These maps were analysed by importance of use and indicate the level of importance allocated to each knowledge need. As with the knowledge audit and inventory questionnaires, this particular questionnaire was made available to all staff for a 3-week period. Twenty-seven responses were received for this stage of the project.

By producing a knowledge needs table that reflected the main knowledge attributes of the knowledge asset register it was possible to compare the inventory and needs data to identify gaps in the organisation’s knowledge as well as areas of unnecessary duplication. In addition, this particular knowledge needs process was undertaken to guide the development of the strategy tailored for the organisation and therefore allowing the researchers to focus on the knowledge that is important to the organisation.

Findings

The following describes the needs in terms of internal and external knowledge required. Table 5 highlights the number of knowledge assets required by internal, external, tacit and explicit knowledge. It must be noted that several of these needs were suggested by more than one participant.

| | | |
|-----------------|-----------------|-----------------|
| TACIT | 21 | 3 |
| EXPLICIT | 13 | 6 |
| | INTERNAL | EXTERNAL |

Table 5: Knowledge Needs Matrix

Internal Knowledge Needs

| TOP INTERNAL KNOWLEDGE NEEDS | |
|-----------------------------------|--------------|
| Knowledge/Purpose | No. of Users |
| Subject/product/project expertise | 16 |
| Previous Projects | 9 |
| Resource Allocation/Utilisation | 7 |
| Seismic Images/Datasets | 2 |
| C++ and Visual Studio | 2 |
| Current Projects | 2 |
| Informal Knowledge Sharing | 2 |

Table 6: Internal Knowledge Needs

Again as with the inventory data, the majority of knowledge required is internal and held by individuals. However, the participants feel there is a need to capture this particular knowledge to the advantage of all staff within the organisation. Indeed, as outlined in Table 6, the majority of participants indicated the need for subject specific, product specific and project specific knowledge to be made available in order to assist in the development of proposals and potential projects. Several participants indicated reasons for this:

“Clients routinely ask for the organisation’s previous relevant experience. At present, putting that information together can be very time consuming and valuable experience can be omitted. Some information is available through [the organisation]’s Intranet but accessible data is often sparse.”

“Readily available good quality information on prior projects could improve [the organisation]’s competitiveness on winning work and could improve [the organisation]’s ability to perform current projects efficiently.”

“It can be difficult to find who in [the organisation] and its associated pool has knowledge specific areas and topics.”

In addition, participants also perceive there to be a need to capture and disseminate resource availability and utilisation particularly in relation to time and money. Benefits of capturing this type of knowledge and making it readily available can include improving accuracy of bids submitted and highlighting areas where the organisation’s performance could be improved.

“Apparently, no-one in [the organisation] knows what it actually has taken in terms of time and money to complete prior projects. Consequently, when we prepare bids for new projects we are flying blind.”

It is also acknowledged that the majority of vital knowledge is available internally, however many participants believe very few employees are aware of the existence of this knowledge. Therefore, there is a perceived need in capturing this knowledge to ensure all staff has access. Indeed, one participant states:

“If you know what is available you are likely to use it.”

While another believes:

“There MUST be large amounts of Technical/well specific/previously used Mud Systems/lesson learned/equipment used all over [the organisation]. Some is "filed" away in a project file. This is OK if you know it is in there or the person to ask who MAY know it even exists. Like most Engineers, it will probably reside on their hard disc - I'm included here - so the knowledge resides with the person, or group within a specific project.”

One other participant feels that the reliance on tacit knowledge that is not held centrally means it is not always readily available:

Note: we have people with this expertise, but they are generally too busy with other work to properly transfer knowledge.”

It is evident that the knowledge needs gathered focuses on the capture of existing knowledge, raising awareness of its existence and ensuring it as available to all staff as and when required.

External Knowledge Needs

Only a small number of the needs specified are available in external sources/assets, most of which relates to software and its associated training. In addition, there is also a perceived need for academic papers for research purposes (Table 7).

| MOST SOUGHT KNOWLEDGE/PURPOSE | |
|--------------------------------------|---------------------|
| Knowledge/Purpose | No. of Users |
| Training for Specific Software | 3 |
| Subject Specific Software | 2 |
| Academic Papers | 2 |

Table 7: External Knowledge Needs

DISCUSSION AND CONCLUSIONS

Although some minor advancements have been made over the last few years, the knowledge audit methodologies and frameworks developed around the turn of the century are still relevant and being used today to undertake knowledge audits in a variety of organisations and contexts (Skyrme, 2002; Liebowitz *et al.*, 2000; Lauer and Tanniru, 2001; Hylton, 2002; Burnett *et al.*, 2004; Choy *et al.*, 2004). As the importance of these frameworks is still recognised, it is important to consider improvements and advancements based on the findings

of the current literature. This paper introduces a redeveloped framework based on an original methodology (Burnett *et al.*, 2004) and presents the results of the approach as applied in a multi-national energy solutions company.

The research tools have taken into consideration recent advancements in the field of knowledge auditing and mapping and consequently include a knowledge inventory analysis and knowledge asset register (Cheung *et al.*, 2007). In addition, the evaluation of KM enablers (conducted as part of the knowledge process audit) examines culture and behaviour, infrastructure, structure and environment and strategic vision.

A consistent theme within the results is the likelihood that relevant subject knowledge does exist within the organisation. The findings indicate that internal tacit knowledge is seen as vital knowledge and in a majority of cases external sources of knowledge are only consulted once searches for relevant internal knowledge have failed. Despite this and the emphasis placed by participants on readily available knowledge, only a small proportion of knowledge is accessible to all staff throughout the company. This is due to a reliance of knowledge embedded within the head's of employees and in some instances in personal files and drives.

A consequence of this lack of awareness and availability is having a workforce that is unsure where or how to locate relevant knowledge. This can be exacerbated if the knowledge holder is unavailable either due to illness or annual leave, or as a result of different time zones. Indeed, this is possibly also an issue for new starts as mentioned by a number of participants. The lack of relevant knowledge affects the new starts ability to adapt quickly to the environment and the task in hand.

Regardless of this, knowledge sharing is fairly common in certain areas of the organisation. Moreover, there is a prevalence of sharing knowledge within the knowledge holder's team and/or office i.e. at a local or personal level and there is evidence to suggest that knowledge sharing is rarely carried out throughout the organisation or at global level. Indeed, knowledge sharing is carried out on an ad hoc basis and individuals independently seek others with similar interests and relevant knowledge.

In terms of key enablers, it is acknowledged that certain systems are currently in place but there is definite need for improvement. In fact, it is clear that the organisation has the culture, infrastructure and environment to facilitate a successful KM programme. However, there is a need to raise awareness of how KM can add value and how current technologies, processes and practices can be utilised and adapted to ensure efficient management of knowledge. While these key enablers exist there are a number of other barriers in place. This mainly centres on a lack of time and resources that can impede the level of KM undertaken particularly by staff at certain levels.

It can therefore be suggested that currently knowledge is managed informally with very few formal procedures and processes in place. While a number of changes, improvements and initiatives are required to achieve benefits from the vast amount of knowledge currently available within the organisation, it is believed that the organisation has the basic capabilities to realise an effective culture of knowledge sharing and to implement and establish a successful KM programme, and the results from this research will be used as a basis for the organisation's KM strategy.

The overall results of the knowledge needs aspect of the research indicate that to some extent there is satisfaction of current knowledge within the organisation. However, there is a definite need to ensure knowledge relating to best practice, expertise, and resource utilisation is captured and accessible to all staff. Also, the data suggests that knowledge sought from external sources is required to ensure the organisation keeps up-to-date with new practices and technologies and certain external knowledge is deemed to complement the knowledge available internally. It is important that in future employees learn from existing experience while still consulting external sources simultaneously to ensure this knowledge is developed and new knowledge is created. Lastly, it is important to recognise the potential of KM within the organisation as acknowledged by one employee:

“All I would say at this point is we as an organisation should be capable of great things. Knowledge management is fundamental in realising that. I hope this opportunity is grasped, realised and appreciated for what it can do for all of us...”

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Appendix A – Questionnaire Statements

| No. | Statement |
|-----|---|
| 1 | Managing knowledge is a key part of the organisation's strategy |
| 2 | The value of knowledge management is clearly understood throughout the organisation |
| 3 | The organisation recognises the need for knowledge of industry best practice and emerging trends to be successful |
| 4 | The organisation recognises the need to obtain knowledge of its competitors to be successful |
| 5 | People generally know how to use IT to find the knowledge they need within the organisation |
| 6 | The organisation has IT which allows people to communicate effectively across boundaries and time zones |
| 7 | The organisation has IT in place which allows it to store and retain knowledge effectively |
| 8 | Electronic tools are available for capturing and accessing new as well as existing knowledge |
| 9 | There are appropriate IT security procedures in place (backup, etc) |
| 10 | The organisation's structure enables ease of knowledge sharing |
| 11 | Sufficient space is available in locations within The organisation to facilitate informal interaction and knowledge sharing |
| 12 | There are specific locations for storing hard-copy documents, manuals, etc |
| 13 | The organisation uses Communities of Practice (informal or formal groups of people with similar roles, responsibilities, competencies and/or interests) to facilitate knowledge sharing |
| 14 | The overall environment of The organisation facilitates knowledge management |
| 15 | Employees with valuable and scarce knowledge rotate among different business units and participate in a variety of improvement teams |
| 16 | The organisation has a culture that supports and encourages knowledge sharing |
| 17 | Hoarding knowledge is actively discouraged |
| 18 | Good knowledge management behaviours are recognised and acknowledged in the appraisal system |
| 19 | There is a culture of openness, teamwork and learning within The organisation |
| 20 | People trust each other; learn from each other and share successes and failures |
| 21 | The overall The organisation culture stimulates creativity and innovation |
| 22 | The knowledge of departing employees is captured and passed on to successors |

| No. | Statement |
|-----|--|
| 23 | The process of sharing best practices and lessons learned has been formalised across The organisation |
| 24 | Management knows which employees are the carriers of valuable and scarce knowledge |
| 25 | I can easily find and access the people who hold the relevant expertise and knowledge within The organisation |
| 26 | I find it easy to locate and utilise appropriate knowledge located outside The organisation |
| 27 | The necessary knowledge for carrying out my role is readily available to me and I know where to find it |
| 28 | I regularly require access to colleagues' expertise to successful carry out certain tasks |
| 29 | The specific knowledge that I need resides with experts rather than being stored in databases, etc |
| 30 | I am satisfied with the explicit knowledge that is available in my department/team to use |
| 31 | My personal tacit knowledge is (as far as possible) made explicit by creating documents I can share with others |
| 32 | I attempt to ensure that my knowledge is constantly being implemented and incorporated into new products, services and processes |
| 33 | I use specific techniques to generate new ideas and knowledge |
| 34 | My knowledge is kept up-to-date by means of training, coaching and talent development programs |
| 35 | I actively participate in a programme of business conferences and other discussion forums inside and outside The organisation |
| 36 | I try to improve ways of working through the development of new knowledge and processes |
| 37 | Sharing knowledge is routine and second nature to me |
| 38 | I locate like-minded people or people with similar interests to share experiences and work together |
| 39 | I volunteer knowledge that I think will be of use to my colleagues |
| 40 | I participate in formal networks in order to disseminate my knowledge to others |
| 41 | I take part in informal networks across the organisation |
| 42 | I try to transfer knowledge effectively as and when required |
| 43 | I am willing to collaborate across departments within The organisation |
| 44 | I use database(s) and shared drives to store and organise important knowledge |
| 45 | I continually document and store knowledge I have obtained and developed |

| No. | Statement |
|------------|--|
| 46 | Prior to commencing a new project I review completed projects for relevant knowledge and best practice |
| 47 | On completion of projects I carry out after action reviews to capture lessons learned and best practice |
| 48 | I ensure that my knowledge is retained and made available to colleagues in the event that I am on sick leave or unable to attend work for personal reasons |
| 49 | I attempt to acquire relevant knowledge from departing employees |