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# Facilitating Knowledge Transfer for Innovation: Towards a Decision Support System to Identify Knowledge Stock in the ICT Profession

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## Abstract

The external knowledge acquisition and the internal knowledge transfer are both critical to the development of organisational knowledge stock. The two processes must be managed closely together if the effect of knowledge stock development for innovation is to be maximised. However, it is often a challenge to many organisations to realise their knowledge stock. Using a design science research methodology, this paper considers the problem of enabling knowledge transfer through the assessment of knowledge stock. Our contribution from this research is to present a conceptual framework for knowledge transfer enabling innovation. We develop a Decision Support System (DSS) prototype to identify knowledge stock measured in terms of ICT skills using the Skills Framework for the Information Age (SFIA). We simulate the DSS prototype to measure knowledge stock at individual and organisational level. A comprehensive evaluation of the DSS in the knowledge management context is planned for future research.

**Keywords** knowledge management, knowledge transfer, Skills Framework for the Information Age (SFIA), design science research, decision support system

## 1 Introduction

One of the key objectives of knowledge management in any organisation is to generate maximum value to foster innovation from their available knowledge. Based on the “knowledge as a resource” world-view, generating value for innovation involves identifying the knowledge stock of employees, partners and customers. This facilitates knowledge flow of ideas within the employees and departments (i.e. closed innovation) and also with that of other organisations (i.e. open innovation) in order to formulate best practices out of the knowledge stock and flow (Tzabbar et al. 2008).

When dealing with knowledge management, the concepts of stock and flow are often used (Kyriakopoulos and de Ruyter 2004). *Knowledge stock* reflects the amount of knowledge elements that an organisation has accumulated over time and is ready to be used to its best when necessary (Wu and Shanley 2009). However, it is static in nature and requires *knowledge flow* to generate any value – to ensure that the available stock is transferred from a point to the other in an appropriate manner (Lai et al. 2015). The flow of knowledge in knowledge management indicates the amount of knowledge which is transferred between organisational members so as to create a healthy knowledge management culture (Lam 2005).

Organisational productivity and innovation depends upon the employees and the management. The stock of knowledge that resides in an organisation and its staff members is the source of knowledge creation for the organisation. Throughout our lives, we have collected much information and built up a number of explicit skills that may be represented in processes and documents, as well as tacit knowledge which is embedded in our brains. The knowledge stocks are of little use for an organisation unless they stay current (Ballantyne 2000). Members of the organisation need to acquire new knowledge from outside and transfer the new knowledge for internal use for a sound knowledge management. Thus, external knowledge acquisition provides a powerful source of knowledge creation for an organisation (López-Sáez et al. 2010). Internal knowledge transfer among members within the organisation helps to combine new knowledge with existing organisational knowledge for continuous innovation (Nonaka et al. 2006). These two processes are not mutually exclusive and must be managed closely together if the effect of knowledge stock development for innovation is to be maximised (Kong 2015).

The old management adage that ‘you can’t manage what you don’t measure’ is likely accurate for the development of organisational knowledge stock. It remains a challenge to many organisations how to make decisions on matching their existing and expected internal knowledge stock and when to acquire external knowledge, if needed, for sustainable innovation. This paper argues that the problem of enabling knowledge acquisition and transfer may be resolved through the assessment and realisation of knowledge stock in terms of people skills. In this light, the research question is: how can the knowledge stock be assessed to facilitate knowledge transfer in an organisation?

The paper is organised as follows. First, a brief overview of the importance of knowledge in contemporary organisations with a discussion of external knowledge acquisition and its relationship with knowledge transfer is offered. A conceptual framework illustrating the relationships between external knowledge acquisition, internal knowledge transfer and innovation is then presented. We then explain our Design Science Research (DSR) project in terms of design and demonstration of a Decision Support System (DSS) prototype to identify knowledge stock measured in terms of skills for the ICT profession using the Skills Framework for the Information Age (SFIA). Future research direction of the paper is explained before we conclude this paper with implications for knowledge management and practice.

## 2 Knowledge Acquisition and Transfer in Contemporary Organisations

Knowledge can be in tacit and explicit forms (Herschel et al. 2001). Explicit knowledge is more obviously transferable while tacit knowledge is better transmitted through actionable and social experiences (Geisler 2009). Therefore, tacit knowledge is best transferred through rich communication media such as observation rather than more explicit media (Nadler et al. 2003). Knowledge, in particular tacit knowledge, has been identified as the only resource that leads to strategic advantage in organisations (Kong 2015). Such knowledge can be a source of differentiation between firms if it is rare, valuable, costly to imitate, and non-substitutable, leading to innovation (Barney 1991; Wernerfelt 1995). A definition of innovation that is recognised by Organisation for Economic Co-operation and Development (OECD) countries around the world is adopted for the purpose of this paper:

*Innovation is the implementation of a new or significantly improved product (good or service), process, new marketing method or a new organisational method in business practices, workplace organisation or external relations (OECD, 2005, p.46).*

Innovation is believed to be strongly correlated with knowledge creation (Miller et al. 2008) and knowledge transfer (Cavusgil et al. 2003). It may involve the use of new knowledge or new approach of using existing knowledge (or a combination of both). Innovation is usually the outcome of new knowledge arising out of research and development activities and is driven by people. Innovation is essential for firms to survive in today's hyper-competitive global environment. It may take many forms and may rely heavily on technological development or not at all (Australian Government 2009). It is believed that innovation is critical for firms' survival in today's competitive environment.

In a world that is filled with uncertainty and increasingly complex, organisations will thrive only if they possess absorptive capacity (Kong 2015). Absorptive capacity has been mainly used to capture a firm's ability to identify, assimilate, transform, and apply valuable external knowledge (Cohen and Levinthal 1990). External knowledge may be defined as knowledge from academic institutions, industry associations and consulting firms, as well as clients and customers, suppliers, alliance or contractual partners and government agencies (Segarra-Blasco and Arauzo-Carod 2008). An organisation's absorptive capacity will need to be constantly renewed or the value of the organisational knowledge stock will quickly become depreciated (Ballantyne 2000). So, Devinney & Midgley (2007) also argue that organisations gain competitive advantage over their competitors if they constantly acquire external knowledge. The flow of external knowledge into an organisation's existing knowledge stock may have a dynamic impact on the organisation's ability to innovate.

It is important to note that external knowledge needs to be transferred and internalised as internal knowledge stock before it can be utilised effectively in an organisation (Kong 2015). Thus, external knowledge acquisition provides a powerful source of knowledge creation for an organisation (López-Sáez et al. 2010). However, knowledge transfer helps to facilitate internalisation and combination of external knowledge with existing knowledge stock for continuous innovation (Nonaka et al. 2006).

Despite the diversity of research on knowledge transfer, theoretical explanations of this phenomenon can be organised into three organisational contexts: the properties of units, the properties of relationships between units, and the properties of knowledge itself (Argote et al. 2003). The network structure in which the units are embedded affects the effectiveness of knowledge transfer (Reagans and McEvily 2003). The literature has highlighted some critical factors for enhancing knowledge transfer such as direct relations with short path-length between the transmitter and the recipient (Hansen 2002). Knowledge transfer is a prerequisite to learning but requires effective networks and appears difficult across different units of an organisation if pre-existing relationships are absent (Szulanski 1996). Tsai (2001) argues that the transferability of knowledge within organisational units is contingent on the network position of the transmitter and the absorptive capacity of both transmitter and recipient. Networks of inter-unit links favour access to and exchange of knowledge between different units in an organisation. Further, according to Tsai (2001), the centrality of position is critical.

The transfer of routines (organisational practices) is determined by the transferability of meaning and value, in addition to the transferability of knowledge (Kostova 1999). Another dimension of the properties is the ambiguity of knowledge which is an important pediment to transfer (Simonin 1999). Knowledge transfer can also be facilitated or inhibited by the degrees of tacitness of knowledge (Baumard 2002). Contrary to information, knowledge is 'sticky', i.e. it tends to be hidden and not shared (Asheim and Isaksen 2002). The notions of information and knowledge are hierarchical where information is data to which an individual attributes significance and knowledge requires that the individual first articulates all available information and then appropriates and incorporates it (Michaels et al. 2006).

Past research have confirmed improvements in group performance when members of a group were assessed to identify fellow member's expertise (Cummings and Teng 2003). Beyond people skills, organisations have conducted assessments from different perspectives to facilitate knowledge transfer, such as number of patents (Roper and Hewitt-Dundas 2015), technology infrastructure and business strategies (Miranda et al. 2011) or process assessments in IT service management (Shrestha et al. 2014). It, however, remains a challenge to many organisations to conduct assessment of their internal knowledge stock and when to acquire targeted external knowledge, if needed, for sustainable innovation.

### 3 A Knowledge Acquisition and Transfer Conceptual Framework

A knowledge acquisition and transfer conceptual framework is presented in Figure 1 based on our literature review in the discipline of knowledge management. This framework illustrates the relationships between external knowledge acquisition, internal knowledge transfer and innovation. The framework positions our expected research contributions. An explanation of the framework follows.

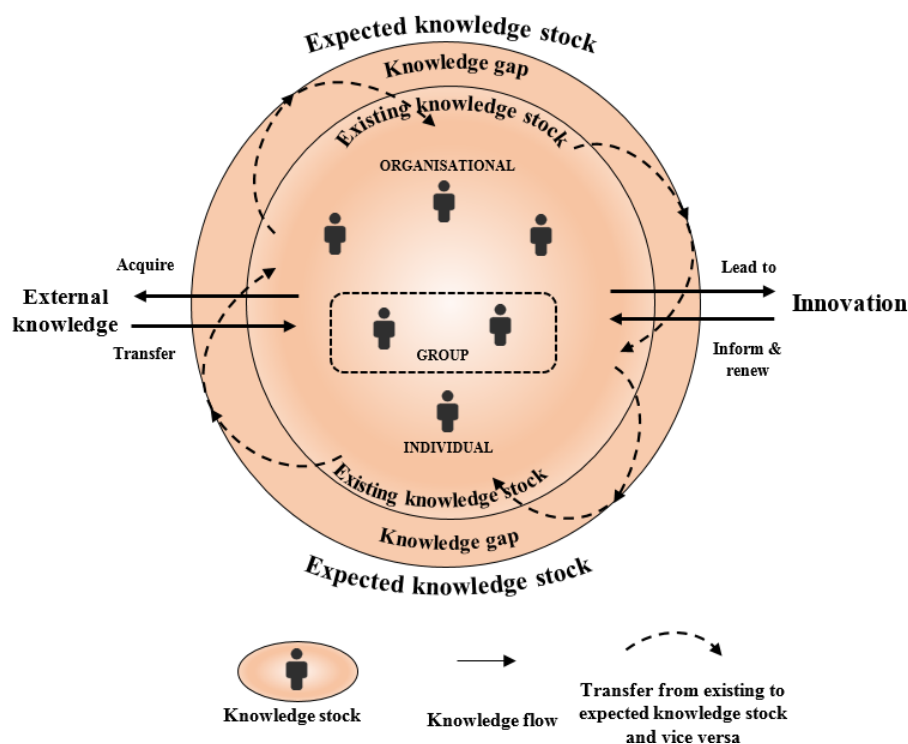


Figure 1: Knowledge Acquisition and Transfer Conceptual Framework

The organisational knowledge stock comprises a number of group and individual knowledge stocks that reside within an organisation. The knowledge gap is represented by the difference between the expected knowledge stock and the existing knowledge stock. As part of its knowledge management initiatives, an organisation aims to intensify knowledge flow between itself and external knowledge source to acquire and transfer knowledge stock. The intensified knowledge flow leads to innovation and innovative outcomes may renew knowledge stock.

The literature review presented in Section 2 discussed the associations between the external knowledge acquisition, internal knowledge transfer and innovation. The framework puts the concepts together so that further evaluation can be conducted. Table 1 presents the relationships between elements of the framework and key literature supporting them.

| Framework Element                       | Key Supporting Literature                                |
|---|--|
| Knowledge Acquisition → Knowledge Stock | Kyriakopoulos and de Ruyter 2004; López-Sáez et al. 2010 |
| Knowledge Stock                         | Tzabbar et al. 2008                                      |
| Knowledge Stock → Knowledge Flow        | Miranda et al. 2011; Roper and Hewitt-Dundas 2015        |
| Knowledge Flow                          | Ballantyne 2000  |
| Knowledge Flow → Knowledge Transfer     | Miranda et al. 2011                                      |
| Knowledge Transfer                      | Lai et al. 2015; Cummings and Teng 2003                  |
| Knowledge Transfer → Innovation         | Nonaka et al. 2006; Wu and Shanley 2009                  |

Table 1: Mapping Conceptual Framework Elements with Supporting Literature

One of the concepts in the framework is the realisation of knowledge stock. Unfortunately the internal knowledge transfer between the existing and expected knowledge stock is often hindered due to the lack of the understanding of knowledge stock at the organisational, group or individual level. We adopt a Design Science Research (DSR) methodology (Hevner 2007) to address this problem and build an artefact to identify knowledge stock using a skills assessment framework within the ICT profession.

## 4 Design Science Research Methodology

The primary goal of a DSR project (Peppers et al. 2008) is to develop and evaluate an artefact that demonstrates contribution to a body of knowledge and practical relevance to a problem. A key DSR requirements agreed by the major schools of thought in Information Systems (Österle et al. 2011) is to clarify knowledge contribution and practical demonstration of the IS research.

Our research draws on the DSR methodology for information systems research with a three cycle view: relevance, rigour and design cycles (Hevner 2007). The *relevance cycle* inputs requirements (*challenges of knowledge transfer*) from the knowledge management discipline into the research and proposes a research artefact for identification of knowledge stock. Section 1 provided an input to this cycle. However, being a cyclical process, more iterations are required to represent the research opportunities in an actual application environment.

Likewise, the *rigour cycle* investigates past comprehension in the area of knowledge transfer and presents a conceptual framework for knowledge acquisition and transfer for the research (sections 2 and 3 of this paper). Again, as a cycle, the conceptual framework is expected to evolve as subsequent feedback is sought to refine the design further. Finally the *design cycle* supports the loop of research activities that provides the development, evaluation and improvement of the research artefact associated with the assessment of knowledge stock. This following sections report the current status of the ongoing work on the design cycles of the DSR project.

### 4.1 Artefact Design

Knowledge transfer between the members of an organisation is a complex process. Knowledge stock can be measured and interpreted from several perspectives at different levels – individual, group or organisational. For an individual, the knowledge stock may simply be their level of understanding at their current job. A group may refer to the collective team knowledge where individual knowledge stocks are infused with team dynamics. As discussed in Section 1 representing the relevance cycle, this research looks into the issue of knowledge transfer in the organisational setting. The initial rigour cycle concluded that a major challenge for an organisation is to optimise knowledge flow across its teams and staff so that its strategic objectives including innovation goals are fulfilled.

We apply our conceptual framework (Figure 1) during artefact design with an argument that the existing knowledge stock is determined by, inter alia, the current skill levels. The dynamic nature of an organisation means that the jobs and roles change frequently. There are also shifts in skill levels of the staff members in an organisation both in the positive direction (career progression, trainings) or the negative direction (staff turnover, skill attrition). Identifying the existing and expected knowledge stock is therefore critical for knowledge transfer.

As part of the internal design cycle which is the heart of any DSR project (Hevner 2007), we develop a decision support system (DSS) prototype that helps decision makers to determine existing knowledge stock measured by an assessment of available and required skill set in an organisation. Once we can objectively identify the skills possessed by individuals and match them with skills required in an organisation, this will enable us to determine skill gaps, thereby highlighting the knowledge gap. We selected digital skills within the ICT profession for our demonstration, as digital skills are considered to be a critical resource for the current and future workforce (Colbert et al. 2016). A detailed and explicit specification of digital skills can be found in the Skills Framework for the Information Age (SFIA) framework (SFIA 2017). The SFIA framework is useful to match the skills of the employees of an organisation as per the needs and requirements of the business. A brief introduction of SFIA follows next.

#### 4.1.1 Skills Framework for the Information Age (SFIA)

A formal definition of SFIA, as presented on their official website [sfia-online.org](http://sfia-online.org), is: a practical resource that provides a two-dimensional reference model consisting of skills and responsibility levels to describe professional competence levels (SFIA 2017). Since SFIA is one of the widely accepted common language for the skills and competencies required in the digital world, we refer to SFIA as an ontology - a

specification of conceptualisation that enables knowledge sharing (Gruber 1995). SFIA is a practice-oriented ontology and its development was initially led by the British Computer Society in the year 2000. Currently in version 6, with an open consultation for version 7 underway, SFIA adopts a collaborative development methodology with open practice-driven consultation. SFIA is currently managed by the SFIA foundation and is a registered trade mark in over 30 countries including Australia (SFIA 2017). In the current version, SFIA describes 97 skills where each skill comprises an overall definition and descriptions of up to seven responsibility levels at which the skill might be assessed. The SFIA ontology provide a common language reference of how the skill and responsibility level in combination can produce a more granular competency level for an ICT professional. Although SFIA is heavily practice-based, research-oriented input has been sought from open consultation and the successful use of the framework for ICT curriculum design has been reported (von Kinsky et al. 2016). SFIA is currently proposed to offer assistance in the Human Resources and talent/ skills management areas such as HR planning, recruitment, performance appraisals and remuneration. We demonstrate our artefact in the next section with a view to extend the use of SFIA in the discipline of knowledge management.

## 4.2 Artefact Demonstration

Based on the conceptual framework as an artefact and its operational DSS prototype (using SFIA framework), we can demonstrate the effectiveness of the artefact. In an organisation, candidates (existing staff, new staff or outsourcing partner) differ in their skill abilities while the current and potential job requirements of the organisation have different skill requirements. SFIA underpins a skills model to determine the equilibrium relationship between candidate and job characteristics in an organisation. While SFIA does not represent the complete knowledge stock in the heads of all employees, we argue that it can provide a sufficient level of detail of competence in particular batches of knowledge in clearly-defined areas within the ICT profession. Using this argument, we demonstrate the use of SFIA for skills management in a new application domain of knowledge management. An application domain does not only refer to the new systems, but it is about the interactions of a new system with people to work towards a new goal (Hevner 2007), i.e. the goal of understanding knowledge stock to enable knowledge transfer in our research.

The pre-defined lists of skills and responsibility levels from SFIA v6 were imported into our DSS tool. A list of standard ICT job profiles (for e.g. CIO, service desk analysts, network engineers, project managers) were also imported with the expected level of relevant skills based on SFIA v6. To demonstrate the artefact, we adopted an online survey assessment approach that allows candidates to self-report their skills to pertinent jobs – considering their current position (existing knowledge stock) and their future position where they would like to move as part of their career progression (expected knowledge stock). As part of a simulation exercise, test data were imported for 32 fictitious candidates and their skill and responsibility levels were entered as sample data.

To simulate the representation of knowledge stock, we used data visualisation tools provided by Microsoft® PowerBI technologies (Microsoft 2017) in order to investigate the potential candidates for any job, or the relevant jobs for any candidate based on their skills. Figure 2 presents some outputs generated from the simulation exercise. In this exercise, “Sophia Lawrence” is a fictitious candidate and her current job is Project Manager with 55.26% skills match towards the skills required for a project manager according to SFIA v6. The first graph - (a) skill-centric mapping - shows all the candidates for the job of project manager represented by the central node. The width of the connection between the central node and the candidates demonstrate the intensity of skills match. As one can see, Sophia is fittingly best skill-matched for the job of project manager although another candidate “Sergey Vol” (highlighted) appears to have highly relevant skill set. Likewise, the second graph - (b) person-centric mapping - is a different view showing all the jobs that a candidate (Sophia) can do based on her skills. As expected, Sophia has the best skills fit for the job of Project Manager (highlighted) but she also possesses skills required by a business analyst or a senior programmer in this scenario.

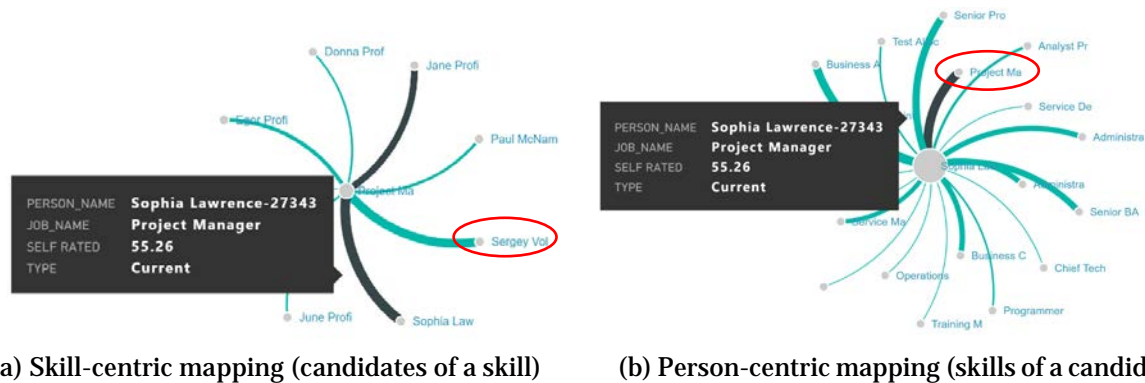


Figure 2: Visualising Skills Gap to Identify Knowledge Stock

According to Figure 2, it is straightforward to identify some direct benefits of visualising skills gap at an individual level, such as identifying the current skills and the need for additional skills for a candidate. Consequently, actions may be undertaken by a candidate to minimize skill gaps, such as new qualifications, trainings, and experience with new projects. At an organisational level, this data visualisation presents an up-to-date skill information and enables an optimal allocation of right resources to meet the requirements of current and potential jobs.

From a knowledge management perspective, this demonstration can provide benefits for both organisation (to determine corporate knowledge stock) and their staff (individual knowledge stock). Organisations will be able to find candidates who possess the skills they need at the level required for the jobs. Likewise, candidates can step into relevant jobs confident that they are qualified and that their skill levels are valued. This is an example of identification of knowledge stock measured by staff skills within the ICT profession. When the knowledge stock is assessed, it provides a platform for knowledge transfer through appropriate organisational intervention, such as job rotation, trainings, knowledge management systems and communities of practice.

Further, we argue that this demonstration highlighted how to “conserve” knowledge: since organisations are able to select candidates that “just fit” instead of those with the highest fits, jobs can be staffed such that knowledge are not wasted where they are not needed. This leaves a more valuable pool of candidates from which to select from the knowledge stock, thereby promoting knowledge flow.

### 4.3 Future Artefact Design Cycles

At the time of this writing, we have undertaken a major iteration of rigour and relevance cycle; and an initial design cycle in terms of artefact design and demonstration have been completed. We have presented a conceptual framework for knowledge acquisition and transfer that illustrates the overall research direction. Moreover, a visual demonstration of knowledge stock based on ICT skills is illustrated. Further work is needed within the design cycles to return the artefact into the environment for study and evaluation in the application domain (Hevner 2007). A research team is being formed to expand our field of study so that the artefact can be further developed and evaluated in a real world setting by means of appropriate technology transfer methods.

## 5 Conclusions

The research question for this paper was about finding a way to assess existing and expected knowledge stock in order to facilitate knowledge transfer in an organisation. We conducted a comprehensive literature review within the knowledge management discipline and came up with a conceptual framework for knowledge acquisition and transfer based on the flow of knowledge stock. Another contribution of this paper is to demonstrate a practical solution using a DSS prototype that facilitates ICT skills management in order to simulate the knowledge stock. We reported future design cycles planned for artefact development and real-life case study evaluation.

We build our research on the premise that the success for knowledge transfer is dependent on an organisation’s understanding of the level of knowledge of their staff. However we agree that this is only one perspective and wider views are possible, for example other research have looked into number of patents, technology or processes to determine knowledge transfer success. Nevertheless, human capital forms a major investment in any enterprise and effective management of human resources has a strong



impact on the overall knowledge management of such enterprises. Another limitation is that our DSS prototype is confined to the digital skills based on the SFIA framework and therefore not a complete representation of organisational knowledge stock. However, we believe the prototype can be applied in a variety of contexts and is only viewed as one instance of demonstration for knowledge stock. In this light, we continue to extend our artefact in order to assess knowledge stock so that significant gaps between the “as-is” existing stock and an expected “to-be” stock can be identified, thereby determining areas for knowledge transfer that fosters innovation in an organisation.

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