Knowledge management and measurement: a critical review

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Abstract

Purpose – Knowledge is the currency of the current economy, a vital organisational asset and a key to creating a sustainable competitive advantage. The consequent interest in knowledge management (KM) has spurred an exponential increase in publications covering a broad spectrum of diverse and overlapping research areas. The purpose of this paper is to provide a literature review and categorised analysis of the rapidly growing number of KM publications, and offer a comprehensive reference for new-comers embarking on research in the field with a particular focus on the area of knowledge measurement.

Design/methodology/approach – A total of 350 articles published in peer-reviewed journals over the last decade are carefully reviewed, analysed and categorised according to their specific subject matter in the KM context.

Findings – KM research tends to fall in one of five categories: Ontology of Knowledge and KM, Knowledge Management Systems, Role of Information Technology, Managerial and Social issues, and Knowledge Measurement. Despite the accumulation of extensive publication efforts in some areas, a series of disagreements and a theory-practice gap are revealed as challenging issues that need to be addressed.

Research limitations/implications – The scope of this study does not cover KM research in its entirety due to the vast nature of the research field.

Originality/value – This paper presents a new birds-eye view of the KM landscape through a novel taxonomy of KM research providing researchers with new insights for future applied research, and offers a comprehensive critical review of major knowledge measurement frameworks.

Keywords Knowledge sharing, Knowledge management, Knowledge transfer, Knowledge workers, Knowledge creation, Knowledge Management Systems

Paper type Literature review

1. Introduction

Knowledge has been recognised as a valuable organisational resource from a strategic perspective (James, 2004) and a foundation for competitive advantage in today's business environment (Erden *et al.*, 2008). Its value is magnified by it being closely related to another important organisational resource in today's dynamic global markets – time. Today's organisations are viewed as ''wellsprings of knowledge'' (Leonard, 1995) and thus cannot afford to lose time ''reinventing the wheel'' (Dani *et al.*, 2006) or looking for old knowledge they are unable to retrieve by trying to ''know what they know'' (Sieloff, 1999).

Such knowledge losses, which can have detrimental consequences for any organisation, can occur as a result of many internal and external factors such as lay-offs, resignations, retirements, restructuring and outsourcing (Delen and Al-Hawamdeh, 2009). When employees leave, they are likely to take away with them years of experience and valuable knowledge that could be priceless to their organisations (Du Plessis, 2005; Hofer-Alfeis, 2008). Attempting a valuation, a US Fortune-500 company estimated the loss of only one experienced marketing manager to exceed $1 million due to the loss of knowledge (Parise

et al., 2006). The potential loss of knowledge is expected to increase as workforce mobility, employee turnover and layoffs caused by downsizing increase, especially during the current global financial crisis (Serban and Luan, 2002, Martins and Meyer, 2012).

The subsequent growing interest in Knowledge Management (KM) has resulted in an exponential growth in KM publications over the last decade at a rate of almost 50 per cent per year (Bontis and Serenko, 2009; Serenko and Bontis, 2004; Zack, 1999). A study of research published in 11 key KM journals identified 3,109 unique authors affiliated to 1,450 institutions between 1994 and 2008 (Serenko *et al.*, 2010). The real numbers of KM publications may be multiples of those reported, since a significant portion of KM research is published in non-KM journals (Ma and Yu, 2010). This is because – unlike other fields – the KM field has no clear boundaries (Lloria, 2008), but rather a heterogeneous nature that creates overlaps with other domains (see Figure 1). This paper therefore attempts to characterise KM as a crucial business area by presenting a comprehensive literature review and a categorised analysis of KM research publications.

2. Methodology

The literature review process was conducted in light of the frameworks proposed by Jesson *et al.* (2011) and Tranfield *et al.* (2003). First, a research plan was devised to outline the scope and methodology of the review and the publication selection criteria. The criteria for inclusion were English peer-reviewed journal and conference articles retrieved from the *Emerald Insight* and *Science Direct* databases and published during the period of 1995 to present. This time period represents the prosperous period of KM research (Ma and Yu, 2010) with particular emphasis on publications in the last five years (see Figure 2). Non-academic research, publications in other languages or in other databases were criteria of exclusion. Database search used the general keywords knowledge management and knowledge measurement. In total, this study has extensively reviewed more than 350 references, of which 213 are cited in this article, with the majority (89 per cent) of references being peer-reviewed journal articles. Almost 50 per cent of the articles were published in the *Journal of Knowledge Management*, the oldest (Lambe, 2011) and highest ranked journal in

Figure 1 Overlapping areas between KM and other fields
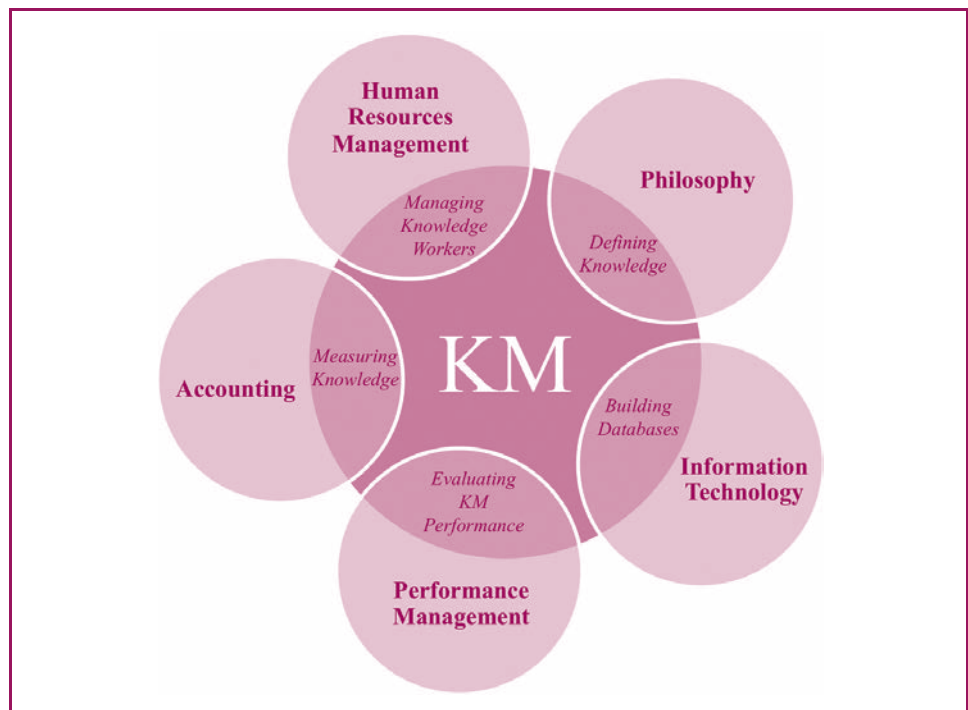
Figure 2 Chronological distribution of references

- 2007-2012 — 43%
- 2002-2007 — 24%
- Before 2002 — 33%
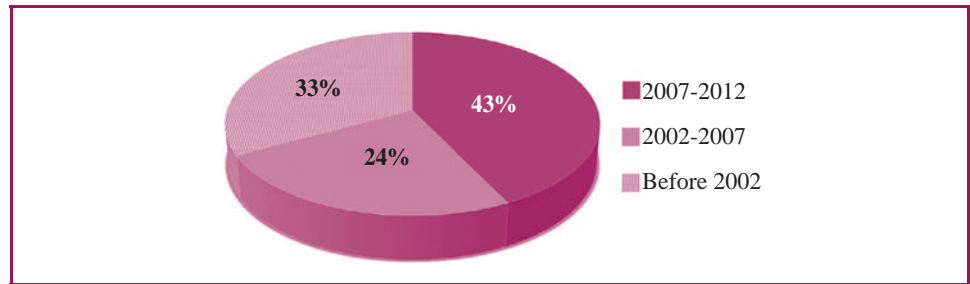
the field (Bontis and Serenko, 2009). Other publications from the *Journal of Intellectual Capital* and *Knowledge Management Research and Practice* and key publications of books or reports in KM (i.e. top cited) were also included.

A review and thematic analysis were carried on publications with an objective of developing a comprehensive framework. The inductive approach was used to classify articles and was not based on a predefined classification (Rynes *et al.*, 2001; Crilly *et al.*, 2010). As the review progressed, the authors developed the boundaries of a taxonomic framework of KM subdomains in which each paper was categorised under a certain theme according to its content and the taxonomy was iteratively refined. Since an exhaustive review of the KM literature is practically impossible due to the immense scope of the field (Kalling, 2003), this study adopted Glaser and Strauss's (1967) ''theoretical saturation'' notion. They define saturation as being achieved when ''no additional data are being found whereby the researcher can develop properties of the category'' and he/she ''becomes empirically confident that a category is saturated'' and hence concludes the review when the contribution of further studies is perceived to add little value (Mitchell and Boyle, 2010). Analysis of each category in the framework has enabled the authors to critically conclude the key findings and highlight the potential future areas of interest in the domain with a particular interest in knowledge measurement.

3. Classification of KM literature

The resultant proposed taxonomy presented a degree of similarity to that of Maier (2002) in the overall framework, however, there were still significant differences with regards to literature categories and subcategories. Overall, KM studies were classified into one of five categories: Ontology of Knowledge and KM, Knowledge Management Systems, Role of Information Technology, Managerial and Social issues and Knowledge Measurement (see Figure 3).

Figure 3 Classification of KM literature

Figure 3 Classification of KM literature

- Ontology of Knowledge & KM
- Knowledge Management Systems
- Role of Information Technology
- Managerial and Social Issues
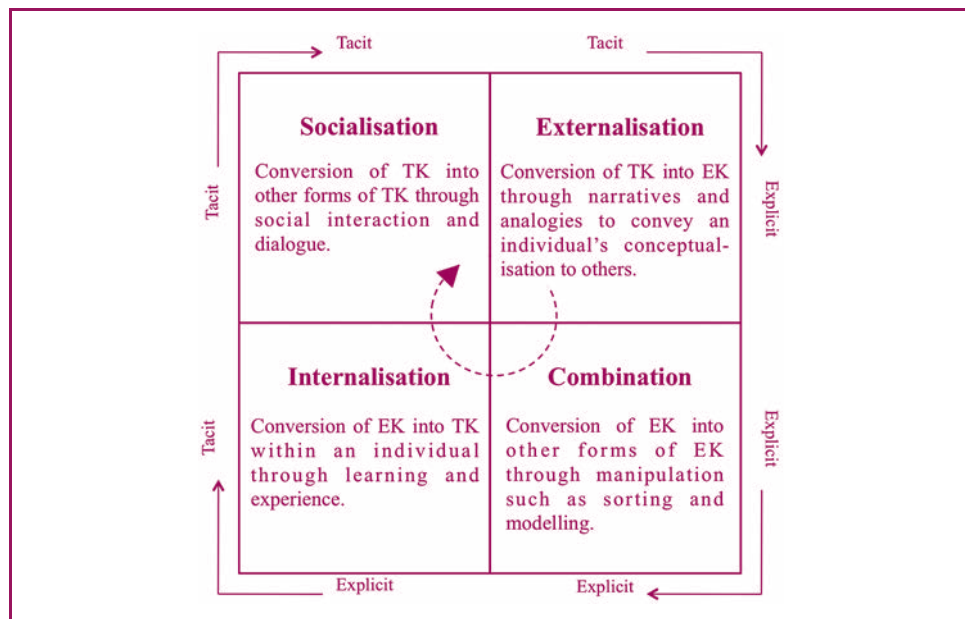- Knowledge Measurement
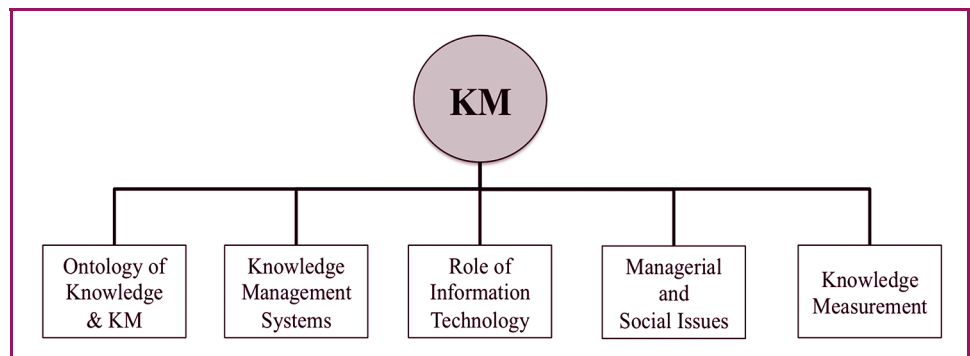
3.1 Ontology of Knowledge and KM

This category of the literature includes definitions, types and characteristics of knowledge and KM and grows from a controversy about the nature of knowledge that has remained unresolved since the age of the philosophers of Ancient Greece. A complex debate about the definition of knowledge is the subject of a dedicated branch of philosophy called epistemology (Zelic, 2005; Jakubik, 2007). The most common definition of knowledge is the top tier in a three-level hierarchy that begins with ''data'' (i.e. raw facts), which, when processed, yields ''information'' (Moteleb and Woodman, 2007), which, when combined with experience and judgement and used in decision-making becomes ''knowledge'' (Kidwell *et al.*, 2000). Although this classical hierarchy is widely accepted in the literature, some authors still question the relationship between information and knowledge, pointing out that the distinction between them is vague in many contexts (Hicks *et al.*, 2006; Faucher *et al.*, 2008). Aside from seeing knowledge through this relational hierarchy, other authors define it as a state of mind (Schubert *et al.*, 1998), a process (Zack, 1999), an object (Zack, 1999), a condition of access (McQueen, 1998), or a capability (Carlsson *et al.*, 1996), among other definitions (Chang Lee *et al.*, 2005).

There is similar debate about the classification of types of knowledge, but the most widely used is the tacit/explicit dichotomy (Polanyi, 1967). Explicit knowledge (EK) is that which can be codified and stored in various formats – such as printed manuals or electronic databases – and so can be transferred without losses (Stevens *et al.*, 2010). Tacit knowledge (TK), on the other hand, lies in an individual's judgement and experiences and cannot be articulated or stored (Grant, 2007). It is what Polanyi describes as ''we know more than we can tell.'' Despite being personal, embedded, contextually-bounded, TK can still be managed using appropriate methods (Johnson, 2007). Again, as in the case of the knowledge hierarchy, some authors still question the consistency of the tacit/explicit dichotomy and their inter-relationship (Oguz and Sengün, 2011). The prominent SECI conversion model (see Figure 4), formulated by Nonaka and Takeuchi (1995) based on this dichotomy, proposes that valuable TK resides within individuals and can add value only if converted to EK through one of four conversion modes (Diakoulakis *et al.*, 2004; Mouritsen and Larsen, 2005). Despite having its challengers (Wilson, 2002), this model is widely used in the literature as a foundation for discussing KM.

Figure 4 The SECI Model (Nonaka and Takeuchi, 1995)

" Overall, KM studies were classified into one of five categories: Ontology of Knowledge and KM, Knowledge Management Systems, Role of Information Technology, Managerial & Social Issues, and Knowledge Measurement. "

Numerous taxonomies of knowledge – other than the tacit/explicit dichotomy – have been identified in the literature of this area. For example, Heisig (2009) identified 28 other knowledge dichotomies, including: individual/organisational, internal/external, used/unused, undocumented/documented, structured/unstructured, relevant/irrelevant and objective/subjective knowledge. Other taxonomies include embrained/embodied/ encultured/embedded/encoded knowledge (Blackler, 1995), catalogue/explanatory/ process/social/experiential knowledge (Millar *et al.*, 1997), and the simple yet comprehensive 'know-what/know-why/know-how/know-who' taxonomy (Lundvall, 1996). Debates about the nature and types of knowledge have remained unresolved for decades, and are likely to continue, due to the philosophical nature of this area and its dependence on subjective views. As with other resources, the need to manage the knowledge resource gave rise to the field of Knowledge Management (KM). The literature is rich with various definitions of KM, but one of the most simple and comprehensive definitions is ''[a] conscious strategy of getting the right knowledge to the right people at the right time and helping people share and put information into action in ways that strive to improve organisational performance'' (O'Dell *et al.*, 1998). Organisations have always attempted to manage knowledge through documentation or archiving activities, but these initiatives were mostly fragmented and tended not to be managed under an organisation-wide KM rubric (Carlsson, 2003). KM differs from such activities in being a conscious and systematic approach to the capture, retention and transfer of knowledge (Bergeron, 2003). Notions of the ''right knowledge'', the ''right people'' and the ''right time'' demonstrate the need to identify the required knowledge among the large amount of information an organisation creates every day (Duffy, 2000), who holds it, and when and how it should be transferred.

The definition shown previously also makes an essential association between KM and corporate strategy, a link which ensures KM is oriented towards improving corporate performance and making a company's management and employees aware and aligned with its KM objectives (Du Plessis, 2007; Kamara *et al.*, 2002). KM also contributes to the formulation of such strategy due to its key role in decision making, a managerial process that is significantly knowledge-intensive (Holsapple, 2001). Nicolas (2004) identifies three phases of decision making in complex situations – intelligence, conception and selection- all of which rely on KM processes, namely knowledge acquisition, knowledge sharing and knowledge utilisation.

KM is vital not only for the success of organisations, but also for the development of societies. The societal role of KM grows from the fact that knowledge is the foundation of economic progress and growth of communities in the current era (Romer, 1986). To meet the demands of a globalised economy, today's nations have to leverage the knowledge of their citizens and provide knowledge-related infrastructures such as education, apprenticeships, research programs, and ICT, all of which would be managed by KM (Wiig, 2007).

3.2 Knowledge Management Systems

A Knowledge Management System (KMS) is a managerial, technical and organisational system structured to support the implementation of KM within an organisation (Massa and Testa, 2009). The literature has identified three approaches to designing a KMS: codification, personalisation, people-finder, in addition to a hybrid approach.

The codification ('hard') approach focuses on the capturing and storage of knowledge in electronic repositories, making it available for retrieval and, due to its nature, tends to pursue EK (Shin, 2004). This approach adopts a 'people-to-documents' strategy, seeking to reuse knowledge by investing in building robust databases and rewarding employees who contribute to the IT-based KMS (Hansen *et al.*, 1999). In contrast, the personalisation ('soft') approach focuses on the transfer of knowledge through face-to-face social interaction activities such as communities of practice and story-telling (Shin, 2004). This approach adopts a 'person-to-person' strategy aimed at sharing knowledge and nurturing innovation, and so is seen as more suitable for the dissemination of TK (Massa and Testa, 2009). In this approach, moderate investment is made in IT as its function is only to connect people, and more investment is made in recruiting highly qualified human resources and rewarding them for sharing their knowledge (Hansen *et al.*, 1999).

Conceding that not all knowledge can be articulated, and not wanting to neglect valuable tacit knowledge, the People-Finder KMS approach does not attempt to capture knowledge itself but instead aims to map the location of this knowledge within the organisation (Becerra-Fernandez, 2000). This approach tries to create 'Knowledge Yellow Pages' to direct those seeking certain expertise towards those within the organisation who hold it, and to ensure they are accessible for consultation or knowledge sharing (Lloria, 2008). To trace where knowledge is located within the organisation more accurately, some studies have analysed the flow of knowledge and the roles of different members in knowledge acquisition and sharing. They divided employees into external communication stars who acquire external knowledge and bring it into the organisation, internal communication stars who disseminate knowledge within the organisation, and gatekeepers who have the unusual capability to do both tasks (Whelan *et al.*, 2010). The literature presents sundry views as to the processes any KMS should incorporate. While different authors have identified between four and ten processes, all of them can be grouped under four core KM processes: knowledge creation and acquisition, knowledge storage and retrieval, knowledge transfer and sharing, and knowledge application (Alavi and Leidner, 2001).

Given the preceding approaches and processes, the literature presents a myriad of different KMS frameworks that attempt to provide a systematic solution for managing knowledge. It is generally observed that the majority of proposed KMS frameworks tend to be ''prescriptive'' by providing outlines of the KM procedures firms need, but without always detailing specifically how they would be implemented (Holsapple and Joshi, 1999). Although some argue that a company must choose between a codification and a personalisation strategy in developing its KMS (Hansen *et al.*, 1999), others (Snowden, 2002) believe both can be pursued simultaneously (Aidemark, 2009). Hence, a more recent trend is to design a 'holistic' KMS that would address all KM processes and would use a hybridisation of both codification and personalisation (Diakoulakis *et al.*, 2004).

Besides proposing different approaches to KMS, numerous other discrepancies can be observed when reviewing studies in current KMS literature. Authors disagree as to the processes that should be included in a KMS and their sequence, as well as in the terminology used. Consequently, a universally accepted KMS framework has yet to exist (Metaxiotis *et al.*, 2005). In a step towards consensus on basic KMS principles, recent efforts have attempted to develop KM standards, such as the *European Guide to Good Practice in Knowledge Management* published by the European Committee for Standardisation (Heisig, 2002).

3.3 Role of Information Technology

This is a grey area between management and IT literature that is populated with extensive research on the design and implementation of IT-based solutions and their role in KM. Computer science research in this area has investigated the development of new algorithms to improve the performance and ease of use of current KM solutions using such programming tools as data mining, artificial intelligence, expert systems, database technologies, search techniques, and modelling (Liao, 2003). Utilising these tools, a wide spectrum of software has been produced, each labelled as a ''KM solution''. Table I

Table I Software tools for KM

Software type	Main features	KMS approach
Document and content management	Storing/uploading of documents Retrieval based on indexing techniques and advanced searching mechanisms Access from any internet connected workstation	Codification
Organisational taxonomy	Organisation of unstructured knowledge into structured categorised maps based on taxonomies	Codification
Collaborative services	Instant Messaging White-board collaboration Co-authoring of documents	Personalisation
Knowledge discovery	Generation of knowledge from existing raw data using data mining and visualisation	Codification
Expert networks	Providing a forum for problem solving through peer-to-peer support Expertise brokerage Expert identification	People-Finder
Knowledge portals	Integration of several information sources to make them accessible from one interface Personalisation of the presentation of content and data sources	(Depends on the services integrated in the portal)
Customer relationship management	Customer support tools (self-help) Customer support personnel tools (help-desk) Automatic direction of customer requests to representatives based on customer profiles and representative expertise Recording of customer behaviour	Codification
Competence management	Creation of profiles for organisational members based on their knowledge and competencies Expert Search	People-Finder
Intellectual property management	Management of patents, copyrights and trademarks Tracking of approval processes	Codification
E-learning management systems	Reusable learning object libraries Adaptive web-based course delivery Component based authoring Scheduling and reporting tools Student evaluation and progress tracking	Personalisation

summarises the features of each type of software and its KMS approach based on detailed research by Lindvall *et al.* (2003), who concluded that no comprehensive KM package yet exists because of the variety of KM attributes a truly comprehensive IT suite would need to cover.

The massive growth of the Internet has taken IT aspirations to another level in the KM domain, and new areas of research have emerged, particularly since the introduction of WEB 2.0 technologies based on user-generated content. With more than one billion Internet users, several authors have strongly encouraged businesses to adopt WEB 2.0 solutions, such as wikis and social networks, to manage knowledge emphasising its advantages that include ease of use, structured content, collaboration, tracking and revision capabilities (Grace, 2009; Levy, 2009).

Initially such ambitions led to unrealistic expectations of what IT could offer to the management of knowledge, and exaggerated predictions led some organisations to adopt entirely IT-based approaches to KM. Unfortunately, many of these initiatives failed considerably due to two main reasons. First, KM relies on cognitive processes exercised by the human brain and involves socio-cultural interactions that IT remains unable to capture (for an in-depth account of human cognitive processes please refer to Kahneman, 2011). When technologies involved did not come as close to being comparable with the human brain as its proponents had hoped, it became evident that there is a limit to what technology

could do for KM (Davenport and Prusak, 2000). In the same time, IT systems that focused only on knowledge that could be codified (i.e. EK), ignored people's valuable TK resources (Storey and Barnett, 2000). The second reason is that in taking an IT-based approach, some organisations overlooked the complexities of human behaviour by assuming people would be willing to share their knowledge, which in many contexts was not the case (Garcia-Perez and Ayres, 2010).

The consequential reporting of numerous cases of failure of IT-based KM approaches led to the general understanding that KM is not an IT issue. It became evident that depending solely on technological solutions would never lead KM initiatives to succeed because of the cultural barriers and organisational change issues that technology alone cannot solve (Beesley and Cooper, 2008; Cleveland, 1999; Lang, 2001; Syed, 1998; Zeleny, 2002; Fahey and Prusak, 1998; Call, 2005). This gave rise to a new, more moderate, attitude towards IT use in KM, where IT is viewed only as an important ''catalyst'' (Tsui, 2005) to support KM initiatives. As Mohamed *et al.* (2010) conclude: ''IT as a utopian panacea will fail. Equally, the KM initiative that undervalues IT will follow suit.''

3.4 Managerial and Social Issues in KM

An Ernst & Young survey of 431 US and European companies found that the gravest reported difficulties in organisations were ''changing people's behaviour'', and the existence of ''inappropriate organisational cultures'' (Ruggles, 1999). Therefore, studies in the fourth identified category in the KM literature examine the relationship between KM and other managerial and cultural aspects of an organisation that are vital for KM success. This stream looks at the social aspects of KM, particularly of knowledge sharing and transfer, and has received well-deserved interest and research intensity over the past few years.

A common major problem – and a starting point for research in this area – is the tendency of employees to hinder KM initiatives, which stems from their resistance to sharing their knowledge with others. The main reason for such knowledge ''hoarding'' is people's fear of losing their ''unique value'' that would reduce their chances of promotion and increase those of others with who they have shared their knowledge (Renzl, 2008; Hislop, 2009). Their fear may extend much further, as was shown by a case study in which employees expressed their perceptions that contributing to the company's KMS could (indirectly) cause them to lose their jobs (Damodaran and Olphert, 2000). This resistance is amplified by the fact that knowledge hoarding is not proscribed while knowledge sharing is mostly not recognised nor rewarded in today's organisations (Lam and Lambermont-Ford, 2010). In fact, in some cases knowledge exchange may be perceived negatively as wasting time in ''chatting'' (Davenport and Prusak, 2000). Those who are willing to share their knowledge may be inhibited by the lack of time needed to put it into a form suitable for sharing, unawareness of what knowledge needs to be shared (Levy *et al.*, 2010), fear of publishing something confidential (Paroutis and Saleh, 2009), and the lack of an organisational culture and/or structure that fosters knowledge sharing (Ling, 2011).

To overcome these barriers and change human behaviour, in-depth research has been conducted in the area of overlap between KM and Human Resources Management (HRM). Based on the fact that ''people'' are the main drivers of KM (Yahya and Goh, 2002), research in this area studies HRM functions from a KM perspective. In the case of motivation, for example, studies focus on how to encourage employees to share their knowledge (Vilma and Jussi, 2012) and engage with KM initiatives (Sié and Yakhlef, 2009; Swift *et al.*, 2010). The dominant view is that employees do not share their knowledge for nothing, and that knowledge is transferred through transactions that take place in a ''knowledge market'' in which there are buyers and sellers (Barachini, 2009). The ''price'' of sharing knowledge

''**There is a lack of consensus on elementary issues in KM.**''

could be ''reciprocity'', where the seller expects to receive something in return; ''repute'', where the provider wants to be known as a knowledgeable person, or ''altruism'', where the knowledge sharer simply derives personal satisfaction from helping others (Davenport and Prusak, 2000). Other studies have investigated the effect of other HRM functions – such as recruitment, retention and training – on the ''knowledge worker'' and knowledge sharing (O'Donohue et al., 2007; Yigitcanlar et al., 2007).

Organisational culture has been identified as a fundamental determinant of the success or failure of KM, and extensive research has been conducted to identify cultures that promote knowledge sharing (Al-Adaileh and Al-Atawi, 2011). The general observation is that knowledge sharing flourishes in less formalised, more decentralised (Chen and Huang, 2007) ad hoc cultures (Tseng, 2010) that foster trust (Holste and Fields, 2010) and entrepreneurial attitude (Suppiah and Sandhu, 2011). At the national level, few researchers conducted comparative KM studies across different countries (Magnier-Watanabe et al., 2011). Others used the cultural dimensions developed by Hofstede et al. (1991) and found that knowledge transfer is more prevalent in collectivist than in individualistic cultures (Moss et al., 2007), and is impeded by cultural differences in other dimensions, such as uncertainty avoidance and power distance (Chen et al., 2010, Wang et al., 2011).

Organisational structure has also been studied as being as important as culture in relation to KM success. Flat organisational structures with few hierarchal levels are generally found to promote more knowledge sharing since they enhance interaction and communication between employees (Claver-Cortes et al., 2007). Studies have also explored the most suitable structure for governing KM functions (Schroeder et al., 2012). One approach has been to establish a formal KM governance structure as part of the organisational structure headed by the Chief Knowledge Officer (CKO) to lead the company's KM efforts and report directly to the top management (Kannabiran and Pandyan, 2010). Others propose creating a hybrid organisational structure by retaining the company's traditional structure while organising a superimposed ''virtual'' structure to manage KM activities (Mahesh and Suresh, 2009).

In another cluster of research in this category, some authors have tried to summarise the managerial factors required for KM to succeed. Ample numbers of case studies in this area offer a number of undisputed social and managerial factors that are seen as crucial for the success of KM initiatives. They are reported in the form of lists of ''success factors'' (Al-Alawi et al., 2007), ''barriers and facilitators'' (Damodaran and Olphert, 2000), ''required organisational capabilities'' (Gold et al., 2001) or ''organisational enablers'' (Kamhawi, 2012) that have been extracted from various examples of success and failure. Some researchers have gone further to specify separate success factors for each stage of KM implementation (Lin, 2011), while others have limited their studies to certain industry classes, such as small businesses (Evangelista et al., 2010, Susanne and Ingi Runar, 2012; Susanne and Stefan, 2012), project-based companies (Ajmal et al., 2010), telecom (Al-Adaileh and Al-Atawi, 2011), accounting and banking (Chong et al., 2011; Oluikpe, 2012), higher education (Cranfield and Taylor, 2008; Kidwell et al., 2000), hospitality (Hallin and Marnburg, 2008), construction (Dave and Koskela, 2009), law (Forstenlechner et al., 2009) and police force (Seba and Rowley, 2010) contexts. Based on the conclusions of several authors (Anantatmula and Kanungo, 2010; Bishop et al., 2008; Mullich, 2001; Quaddus and Xu, 2005; Mason and Pauleen, 2003; Xue et al., 2011), the main KM success factors reported are:

- understanding, defining KM and communicating its benefits;
- linking KM to the business strategy;
- defining criteria for organisational knowledge;
- managing both EK and TK;
- integrating KM with other initiatives;
- top management participation and support;
- recognising and rewarding knowledge sharing;

- creating a culture of communication and team work;

- installing an appropriate IT Infrastructure to support KM;

- adopting a holistic approach to KM that is not entirely dependent on IT;

- appointing dedicated staff to champion the KM initiative and provide training; and

- providing standardised and documented KM policies and procedures to ensure clarity of roles and processes.

3.5 Knowledge Measurement

Knowledge measurement is one of – if not the – most difficult of KM activities (Chen *et al.*, 2009). The fluid and intangible nature of knowledge makes its measurement an enormously complex and daunting task (Kankanhalli and Tan, 2005). Discussions of knowledge measurement are often coupled with the related concept of Intellectual Capital (Galbraith, 1969) which is generally defined as ''knowledge, information, intellectual property, and experience that can be put to use to create wealth'' (Stewart and Ruckdeschel, 1998). In the traditional conceptualisation where organisational knowledge is envisaged as a series of ''stocks and flows'', Intellectual Capital (IC) can be viewed as an organisation's stock of knowledge at any particular time (Bontis, 2004). It comprises knowledge that has been acquired and formalised to be used to create value and so gain competitive advantage (Chatzkel, 1998). Organisations, therefore, implement KM processes to capture and disseminate knowledge flows with the object of accumulating IC (Ahmed and Omar, 2011).

The drivers behind IC measurement are viewed from two organisational perspectives: internal and external. From an internal perspective, managers may not know the value of their own IC, nor where it exists within their organisations, despite it being their main source of competitive advantage (Bontis, 1999). Accordingly, IC measurement attempts to discover ''hidden'' knowledge assets so they can be utilised more effectively to improve organisational performance (Edvinsson, 1997). When IC has been discovered, a measurement tool can continue to be crucial to evaluate KM's impact on increasing IC (Robinson and Kleiner, 1996) and to convince top management of the value of KM (Liebowitz and Suen, 2000). The enormous growth in KM expenditure – estimated in billions (Poston and Speier, 2005) – has been coupled with strong demands for solutions that provide robust justifications for the massive costs of KM (Khalifa *et al.*, 2008).

From an external perspective, there is a widespread view that a company's value could only be assessed if intangible assets are taken into consideration. This view has emerged because of the wide gaps between companies' book and market values, where the ratio of the latter to the former has multiplied in the past decade. A recent example is Facebook's billion-dollar acquisition of *Instagram*, a small photo-sharing smartphone application start-up that has only 13 employees. Generally Accepted Accounting Principles (GAAP) are criticised for not reflecting a firm's real value by only reporting physical assets on the balance sheet and disregarding intangibles ones. They are also critiqued for reporting investments in IC (such as KM programs) as costs to be deducted from profit despite IC being an ''asset'' that can be exploited to generate value. The ''gap in the GAAP'' (Skyrme, 2003) conundrum has led a number of researchers to propose alternative accounting methods that would reveal a company's ''true'' value (Boda and Szlavik, 2007). The literature offers a plethora of knowledge measurement methods, where three main approaches are identified: Financial Methods, IC Methods, and Performance Methods.

3.5.1 Financial methods. This first type of research uses financial models to calculate an overall value for a company's IC using information from its financial statements. The following are the most prevalent methods:

Tobin's Q. Developed by the Nobel laureate economist James Tobin (1969), Tobin's Q is a tool to evaluate investment decisions that measures a company's market-to-book ratio, but values tangible assets using their replacement cost rather than their book values (Luthy, 1998). Tobin theorises that a Q that is higher than one and is higher than that of competitors indicates the company possesses an ''intangible advantage'' with which it can create more value than can its rivals. This advantage is its IC. Since Tobin's Q relates IC to stock prices which may fluctuate due to countless factors, it has been criticised for being a measure that ''rises and falls with market exuberance'' rather than being an appropriate method for measuring IC (Lev and Feng, 2001).

Economic Value Added (EVA). EVA (Stewart, 1994) is a financial measure originally introduced as an indicator of shareholder value created (Stern *et al.*, 1995). It involves applying 164 adjustments to traditional balance sheets to account for intangibles, for example by adding back research and development costs to assets (Skyrme, 2003). EVA is then calculated by deducting the cost of capital from operating profit (Weaver, 2001). EVA cannot be used to measure IC directly; rather it can only suggest that an increase in EVA is an indicator of efficient management of IC (Chen *et al.*, 2004). Since this link remains questionable, some authors conclude EVA is unsuitable as an IC indicator (Hong Pew *et al.*, 2008).

Human Resource Accounting (HRA). Originating in the 1960 s, the objective of HRA (Hermanson, 1964) is to use financial data to quantify the economic value of people as ''human assets'' (Flamholtz *et al.*, 2002). Researchers have suggested three types of HRA models: cost models, market models and income models. In cost models, human capital is valued as the cost of acquiring human assets (i.e. their recruitment and training cost) or, alternatively the discounted value of employees' gross compensation (Bontis, 1999). Market models equate human value with cost of buying an individual's services from the market, for example via consultancy. Finally income models use the present value of the revenues a person is expected to generate while working for a company. HRA has been criticised as being dependent on a multitude of assumptions including employee service life and forecasted revenues, and for equating value with cost which lowers its reliability and may lead to results that are skewed by subjectivity (Mayo, 2001).

Value Creation Intellectual Coefficient (VAIC). VAIC is a value added and IC evaluation method proposed by Ante Pulic (2000) that aims to measure how efficiently financial and intellectual capital are utilised to generate value for the company through the calculation of a series of formulae listed in Table II (Ståhle *et al.*, 2011).

It should be noted that VAIC is limited to providing an overview of IC and identifying broad areas where value creation deficiencies exist. Pulic himself suggests deeper IC monitoring requires complementing VAIC with another IC measurement tool (Skyrme, 2003).

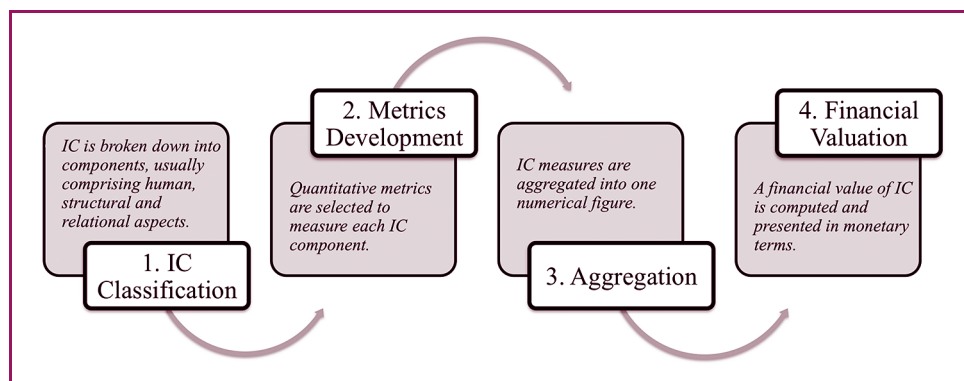| **Table II**	VAIC calculation steps
1.	Calculate Value-Added (VA) VA = Outputs (revenues) − Inputs
2.	Calculate Capital Employed Efficiency (CEE) CEE = VA/CE where CE is financial capital employed
3.	Calculate Human Capital Efficiency (HCE) HCE = HC/CE where HC is the total labour cost
4.	Calculate Structural Capital Efficiency (SCE) SCE = SC/CE where SC = VA − HC
5.	Calculate Value Creation Intellectual Coefficient (VAIC) VAIC = CEE + HCE + SCE

3.5.2 IC methods. Within the second approach, IC models split a company's value into financial and intellectual capital, and then break down the latter into different elements which are evaluated individually (Luthy, 1998). The majority of such models tend to apply at least the first two of the following four processes: IC Classification; Metric Development; Aggregation; Financial Valuation (see Figure 5).

When classifying IC, most authors agree with the tripartite classification proposed by Stewart (1998), in which IC is broken down into Human Capital (HC), Structural Capital (SC) and Relational Capital (RC) (Kwee Keong, 2008). HC includes the combined knowledge, skills and abilities that employees possess (Luthy, 1998), and is an important source of an organisation's innovation (Bontis, 1998). Since HC cannot be ''owned'' by the organisation, it is lost when employees leave (Carson *et al.*, 2004). SC (also referred to as Organisational Capital) is the supportive infrastructure – physical resources, information systems and organisational processes – the company makes available for its employees (Kannan and Aulbur, 2004). In contrast, SC is owned by the organisation, and so has been referred to as ''knowledge that doesn't go home at night'' (Stewart and Ruckdeschel, 1998). RC (also referred to as Customer Capital) refers to the combined value of an organisation's external relationships with stakeholders, such as suppliers and customers, who are valuable sources of both revenue and market knowledge for the organisation.

Following classification, sets of quantitative metrics are developed to measure each IC component. Metrics could be direct counts, monetary values or ratios/percentages (Lerro *et al.*, 2012). In cases where metrics measure a qualitative attribute (such as motivation) scale-based surveys are used to convert qualitative values into quantitative figures. The next step in many frameworks is to aggregate all these IC measures into a single quantum, using different methods (averages, weighted averages, etc.). Some models then attempt a final IC valuation in monetary terms or propose a correlation between the computed value of IC and that of the company. An extensive literature review found the widely cited frameworks summarised in Table III to be the ''key'' models in this area (Marr *et al.*, 2004).

Cited more than 3,000 times, the *Skandia Navigator* is the most prominent attempt to measure IC. Led by the world's first corporate IC director, the Swedish Insurance company Skandia AFS was the first to publish an IC supplement to its shareholders with its annual report in 1997 (Hawkins, 2001) using a framework that applies all four processes in considerable detail. Roos *et al.* (1998) followed this initiative with their *IC Index,* which attempted to offer a more generic and flexible framework that would overcome some of the Navigator's drawbacks. The *IC Rating* (Jacobsen *et al.*, 2005), *Knowledge Assets Map* (Marr *et al.*, 2004), *Intangible Assets Monitor* (Sveiby, 1997), and its subsequent *Modified Intangible Assets Monitor* (Petty and Guthrie, 2000) frameworks limit their scope to internal reporting to allow top management to assess the status of a company's IC and assist in decision making. They do not target external presentation of the company's IC and thus only implement the first two processes (Classification and metric development). Finally, the *Technology Broker* IC Audit (Brooking, 1996) adopts an extensive auditing approach to IC

Figure 5 IC methods' main processes

Table III IC measurement frameworks

Framework	IC classification	Metric development	Aggregation	Financial valuation	Criticism
Skandia Navigator (Edvinsson, 1997)	Human Capital Structural Capital Customer Capital Organisational Capital Process Capital Innovation Capital	Developed 112 metrics that cover five foci; each focus relates to a component of IC, in addition to a financial focus Sample metrics include: revenues/employee, staff turnover, customers lost, number of PCs per employee, and patents developed	Combines all financial indicators into a single monetary value C Converts all the remaining metrics into ratios then aggregates them into an efficiency indicator I	The overall financial value of IC is equal to I multiplied by C	Tailored to fit the insurance industry and thus could not be generalised (Hong Pew et al., 2008) Offers a "snap shot" valuation that does not represent dynamic knowledge ?ows (Roos and Roos, 1997) Some metrics have inherent false assumptions, such as assuming the number of PCs per employee is an indicator of knowledge acquisition and transfer (Bontis, 2001)
IC Index (Roos et al., 1998)	Human Capital (thinking part) Competence Attitude Intellectual Agility Structural Capital (non-thinking part) Relationships Organisation Renewal and Development	Does not propose specific metrics Provides a framework by which every organisation would set its own indicators in light of its strategy, characteristics and the surrounding environment	Indicators must be expressed as a dimensionless numbers Indicators are assigned weights to reflect their relative importance, and are aggregated into a single index using a weighted average	Does not provide a financial valuation of IC Indicates the behaviour of a correctly designed IC Index should be correlated to financial value	Does not allow inter-organisational comparisons since each company would have its unique indices, i.e. lacks generalisability Selection of indicators and weights is based on subjective judgements (Marr et al., 2004)
Intangible Assets Monitor (Sveiby, 1997)	Internal Structure External Structure Human Competence	Proposes indices to measure each IC component from three perspectives: Growth and renewal Efficiency Stability	Aimed at visually presenting IC components' strengths and weaknesses in a aggregated tabular form and hence provides no numerical aggregation	No financial valuation	Lack of numerical aggregation Lack of financial valuation

(Continued)

Table III

Framework	IC classification	Metric development	Aggregation	Financial valuation	Criticism
IC Rating (Jacobsen et al., 2005)	Human Capital Management Employees Organisational Capital Process Intellectual Properties Relational Capital Network Brand Customers Business Recipe	Evaluates 200 parameters through in-depth interviews with the internal and external stakeholders Assesses IC components from the perspectives of: Effectiveness Risk Renewal	Results are presented using a letter grading system ranging from "AAA" to "D" in one diagram, but no numerical aggregation is conducted	No financial valuation.	Not adaptable to specific organisations' conditions when alterations to the questions are required Lack of aggregation and financial valuation
Knowledge Assets Map (Marr et al., 2004)	Stakeholder Resources Stakeholder Relationships Human Resources Structural Resources Human Resources Physical Infrastructure Virtual Infrastructure (culture, routines, and IP)	Does not propose specific metrics States that indicators should be identified by top management team according to their organization's unique competencies and strategy	No numerical aggregation is suggested, however, managers have the flexibility to present their selected indicators in the manner they find most appropriate to evaluate their company's knowledge assets	No financial valuation	Lack of aggregation and financial valuation
Technology Broker (IC Audit) (Brooking, 1996)	Market assets Human-centred assets Intellectual property assets Infrastructure assets	IC components are audited using: Surveys Interviews Quantitative analysis Market research Documents auditing Evaluation of return on investment Based on the audit, each aspect is compared with the optimal state and is rated with an index score from one to five	Results are visually represented on a target diagram (bull's-eye chart) to depict the score, importance and trend of each aspect (Wickham, 2008) No numerical aggregation	Uses cost, market or income valuation methods (as described in HRA)	Like HRA, its financial valuation model is criticised for vagueness and dependence on assumptions

measurement and applies HRA methodologies to value its unconsolidated components financially.

In addition to the aforementioned frameworks, a few more recent efforts are also noteworthy. In Germany, the Ministry of Labour and Economics supported the *Wissensbilanz* project, which aimed to instruct German SMEs on how to systematically evaluate and capitalise on their IC to enhance the competitive advantage of German companies (Edvinsson and Kivikas, 2007). The project used *The German IC Business Model* as a framework that provides a systematic process by which companies would be able to visualise intangible factors that create value. It also provides a platform for decision-making that considers both tangible and intangible assets. The project and its associated website (www.akwissensbilanz.org) are acknowledged by German companies as a good tool to use for higher returns and cost savings (Edvinsson and Kivikas, 2007). In Spain, Viedma-Marti integrated the concept of benchmarking into KM by introducing the Intellectual Capital Benchmarking System (ICBS) in which companies would not directly measure IC, but rather benchmark their IC against ''world class best competitors'' within the same business using a set of criteria and questionnaires (Marti, 2001, 2004, 2007). The ICBS framework has been validated and implemented successfully in a number of European enterprises.

For further literature reviews on knowledge and IC measurement, the authors recommend the comprehensive works by Skyrme (2003) and Andriessen (2004). In his report *Measuring Knowledge and IC,* David Skyrme presents more than 30 measurement models in addition to measurement case studies from over 35 organisations worldwide. Similarly, Daniel Andriessen's book *Making Sense of Intellectual Capital* reviews 25 valuation methods and provides a detailed account of a project in The Netherlands aimed at the development of a new method for valuing intangibles. His work is described by renown IC Scholar Goran Roos as ''one of the most synthesising books on this important but challenging topic'' (Andriessen, 2004).

3.5.3 Human capital methods. Adopting the view that HC is the most important form of IC, and the antecedent from which the other forms evolve (Baron, 2011), human capital models focus solely on measuring HC as a subset of IC. The following are a few examples:

Human Capital Readiness (HCR). The HCR report was developed as an extension to the Balanced Scorecard with a focus on HC, and so is also referred to as the HR Scorecard (Norton, 2001). Using a set of metrics, the report assesses five HC areas: strategic skills and competencies, leadership, culture and strategic awareness, alignment of goals and incentives, and strategic integration and learning (Skyrme, 2003). It also aims to evaluate the relationship between an organisation's HR strategy and its overall corporate strategy, and how the former contributes to the latter.

Human Capital Index (HCI). Based on their work with 750 organisations over a period of three years, HR consultants Watson Wyatt identified a correlation between 46 HR practices and growth in shareholder value (Wyatt's, 2001, Wyatt, 2001). They grouped practices into five dimensions, and noted that influence on financial performance varied from one dimension to another. Their HCI uses a questionnaire to measure and evaluate each practice within organisations they advise. This cannot not be considered as an explicit measure of HC, but rather an assessment of HR actions that increase HC, and so result in an increase in financial value.

Human Capital Monitor (HCM). Mayo (2001) describes his proposed Human Capital monitor (HCM) framework as a ''means of recognising the vital contribution of people to value creation.'' The model is based on the following equation:

$$\text{People as Assets} + \text{People Motivation and Commitment}$$

$$= \text{People Contribution to Added Value}$$

The first parameter is measured as follows:

$$\text{Human Asset Worth} = \text{Employment Costs (EC)} \times \text{Individual Asset Multiplier (IAM)}/1000$$

where EC = Base Salary + Value of Benefits + Employer Taxes, and the IAM is a weighted average assessment of an employee's capability, potential, contribution and values alignment. Five factors are assessed through a mix of metrics and surveys to measure ''motivation and commitment'': leadership effectiveness, practical support, nature of the workgroup, culture of learning and development; and systems for rewards and recognition. The ''contribution to added value'' is measured though a set of financial and non-financial metrics. The HCM has been criticised for making certain assumptions and a degree of subjectivity, but has the advantage of being one of very few frameworks that attempt to measure human capital at the individual employee level, rather than collectively.

3.5.4 Performance methods. Although a number of researchers affirm that knowledge is measurable by developing appropriate frameworks, others adopt the view that it cannot be measured by arguing that its intangible and multifaceted nature would thwart any measurement technique (Liebowitz and Wright, 1999, Huang *et al.*, 2007). Instead, they recommend that efforts should be directed towards measuring the impact of knowledge when applied (Carrillo *et al.*, 2003). They note that the bulk of KM literature hypothesises a causal link between KM and improved performance, despite the fact that very little research has made an explicit correlation between them (Kalling, 2003, Andreeva and Kianto, 2012). Even those who conclude empirically that KM does create value are unable to quantify that value (Ibrahim and Reid, 2009). Hence, the fourth and final type of knowledge measurement research aims to measure the effects of KM on organisational performance.

Frameworks in this domain measure the performance either of KM *processes* or of their outcomes (Goldoni and Oliveira, 2010). Process performance measures are a type of 'leading' measure that monitor the performance of a KM initiative and provide immediate feedback on KM implementation allowing management to take actions in 'real-time' (Vestal, 2002). Examples of process metrics include statistics on KMS usage and the number of communities of practice. Usage metrics are more oriented towards IT-based KMS, and assume that the more people use a KMS, the more knowledgeable they become, which in turn improves organisational performance. But significant KMS failure rates indicate that such simplistic assumptions may be highly misleading (Khalifa *et al.*, 2008). Process measures are only useful in providing an insight into the engagement of employees in a KM initiative, but do not establish any tangible linkage between KM activities and corporate performance.

Output performance measures, on the other hand, are 'lagging' indicators that demonstrate the results of KMS implementation in retrospect (Vestal, 2002). Their underlying logic is the comparison of performance before and after the implementation of a KM initiative to examine its effect on the organisation. Research in this area links Performance Management (PM) to KM, because the main emphasis is not on the KMS, but rather on determining how performance should be evaluated. In light of the taxonomy suggested by Huang *et al.* (2007), KM performance measurement methods are presented in the following classification:

Quantitative methods. Classic PM methods measure performance using quantitative financial indicators, such as stock price, profitability, or return on investment from data taken from financial statements and annual reports. For example, Feng *et al.* (2004) compared historical financial data of KMS adopters and non-adopters and established a link between KM and stability of financial performance, while Chang Lee *et al.* (2005) reported an empirical correlation between KM processes and stock prices. Petra and Annelies (2012) used the financial data of 705 Belgian firms to demonstrate that KM has an ''indirect positive impact'' on financial performance that exceeds the costs associated with KM on the long term. Quantitative methods have also been used to measure non-financial indicators such as reductions in cycle time or complaint numbers.

These numerical methods have the advantage of minimising subjectivity, as no human opinion is involved. Nevertheless, the causal links they construct have still been criticised for obscurity in assuming that positive effects – such as sales increases – could be attributed

particularly to KM, an assumption that is viewed as untenable because it overlooks the array of exogenous factors that may be affecting an organisation simultaneously (Yu *et al.*, 2007).

Qualitative methods. A number of KM studies use such qualitative methods as surveys, questionnaires or interviews to measure performance improvements. KM performance is evaluated based on respondents' opinions and relies to a large extent on their perceptions of the improvements KM has made to their organisations. The influences of various KM factors and processes on performance suggested by such qualitative studies are quantified using analysis techniques including Analytic Hierarchy Process, the more general Analytic Network Process (Wen, 2009), Partial Least Squares (Sangjae *et al.*, 2012) and Structured Equation Modelling (Fugate *et al.*, 2009). Zack (1999), for example, surveyed 88 executives and established a relationship between KM and both organisational and financial performance from the results. More recently, Mills and Smith (2011) surveyed 189 managers and used the same technique to assess the links between specific KM resources and performance. Despite being perceptual, qualitative methods are widely accepted in this type of research, as they provide stronger indications of causality between KM and corporate performance than quantitative methods (Yu *et al.*, 2007). Nevertheless, they have been criticised for their dependence on individual judgements, with the associated dangers of subjectivity and bias (Kannan and Aulbur, 2004).

Balanced Scorecard. The Balanced Scorecard (BSc) is presented in a category of its own because of its multidimensional nature in comprising quantitative, qualitative, financial and non-financial measures. Pioneered by Kaplan and Norton (1995), the BSc is one of the most popular and widely cited PM frameworks (Roy *et al.*, 2003). It offers a systematic methodology that uses strategy-linked leading and lagging key performance indicators (KPIs) to measure performance from four perspectives: financial, customer, internal business processes and learning and growth. Goals and objectives are documented and KPIs are measured for each of the four dimensions in the light of the corporate strategy. While the BSc is one of most comprehensive and effective frameworks to measure performance, it still cannot provide explicit links to KM. It should be noted also that the learning and growth component of the BSc – which measures aspects such as innovation and employee development – has led some KM authors to classify the BSc as an IC measurement tool in itself (Hong Pew *et al.*, 2008).

The previous examples demonstrate that despite the numerous attempts, a convincing KM performance measurement method has yet to be developed leaving a gap in the literature that needs to be filled with a clear technique (Zack *et al.*, 2009). This gap is clearly felt in industry as a recent study has shown that only 4 per cent of executives rate their company's performance as good in measuring the impact of KM (Harlow, 2008).

4. Discussion

Based on an in-depth review of the literature, a few trends emerge. First, there is a lack of consensus on elementary issues in KM. While disagreements on theoretical, and rather philosophical, concepts are present in every domain, the KM community has failed to agree on the core concepts that could act as foundations for the field's further development. Authors disagree on KMS approaches, on terminology and even on the main elements and processes of a KMS. Hazlett *et al.* (2005) once stated that KM is stuck in a state of ''pre-science'' because of the disagreements about fundamental issues within KM that

hamper the progress of the field, and their proposition continues to remain valid. It is noted however that, unexpectedly, there is a higher level of agreement on secondary issues, such as the role of IT in KM and the factors that contribute to the success of organisational KM.

Furthermore, the KM domain seems to be currently challenged by a theory-practice gap. This gap has several indicators, one of which is that the vast majority of KMS frameworks are presented in conceptual form, and do not offer action plans for actual implementation. The fact that they are characterised by a high degree of theoretical abstraction creates a gap between the proposed concept and its pragmatic application in the real world (Booker *et al.*, 2008), which could be attributed to the minimal engagement of business professionals in KM research. An extensive study of 2,175 journal articles revealed a significant drop in practitioners' contributions to KM literature, from 33 per cent in 1998 to only 10 per cent in 2008 – and more shocking is that only 0.33 per cent of KM research involves field studies (Serenko *et al.*, 2010). As a consequence of this 'disconnect', KM practitioners face difficulties in using academic KM findings in their organisations, and perceive a significant portion of KM research as ''irrelevant'' (Booker *et al.*, 2008). This puts KM at risk of being seen as a purely theoretical field with limited practical applicability.

Overcoming these issue calls for efforts in two parallel directions. The first is in the building of the KM theoretical foundation in a manner that accommodates the current diversity in KM paradigms. A number of authors, such as McIver *et al.* (2012), have proposed conceptual models that integrate the ''divergent streams'' of KM research. Agreement on core theoretical concepts should be coupled by a degree of standardisation in KMS parameters that could act as a foundation on which authors could build universal frameworks. A general opinion seems to be forming that single-approach KMS have proved futile, and so future KMS designs should adopt a holistic approach that amalgamates technology-based and people-oriented practices.

The second direction of research should be towards more practical work to address an existing gap between KM theory and practice. The drop in practitioner contribution and field study research reported by Serenko *et al.* (2010) is a critical trend that has to rectified by more engagement with industry in the KM domain. Managers' contribution to KM framework development is crucial to ensure a degree of applicability and to avoid the development of purely theoretical models that would only be of interest to academics. Furthermore, the scope of new KM models should be extended to incorporate detailed guidance to practical implementation and, where possible, accounts of precedent cases where such models where already validated and produced viable results. New models should be comprehensive yet straightforward enough to be understood by all those who will apply them, who will not necessarily be KM experts. Analogously, research should aim to produce a framework targeted at acquiring widespread acceptance and becoming a global standard for KM, in the same manner the Balanced Scorecard is for PM.

When focusing on knowledge measurement, it is evident that this area has received deserved attention over the last decade from the Accounting, HR and Performance Management perspectives. Financial models can provide succinct and unbiased overviews of an organisation's IC and are beneficial in investment decisions and benchmarking. However, they do not always clarify where problems exist and the value-adding contribution (or lack of) of different IC components, so do not provide clear roadmaps of what corrective KM actions should be implemented (Kannan and Aulbur, 2004). Performance models provide some indications of correlations between KM and performance, but can suffer from being built on the questionable assumption that changes in organisational performance are solely due to KM disregarding the (perhaps many) other possible endogenous and exogenous influences on firm performance (Yu *et al.*, 2007). IC models, and their subset of HC models, provide deeper insights about an organisation, but are critiqued for only providing a 'snapshot' evaluation of an organisation's knowledge, and so only reflecting its static knowledge stocks without considering the dynamic element represented in its knowledge flows (Lerro *et al.*, 2012). Future IC measures should aim to assess knowledge flows along with knowledge stocks by reflecting the dynamics of knowledge creation and transfer within organisations to avoid drawing only a static picture of IC.

The literature also elucidates that IC models are confronted by few trade-offs. The first is between internal monitoring and external presentation as objectives of knowledge measurement. Ideally, knowledge measurement models should be suitable for both, assuming that organisations would disclose the value of their IC voluntarily, even if not required to by current accounting standards. But a company would never publish information about its IC if it was declining in value for fear of the harmful consequences for both its corporate image and stock price. This is probably why Skandia has not published an IC report since 2002, when its share price dropped significantly (Dumay, 2012). Moreover, accounting fraud scandals – like those at Enron and WorldCom – have made it very unlikely that accounting standards will change in the near future to incorporate intangibles, due to fear of biased valuations being used to manipulate financial information (Martin, 2004). One could therefore conclude that IC measurements for external reporting are still unreliable. This is not to demean the importance of the financial valuation of knowledge, but to suggest they should be oriented towards internal management to avoid the previously-mentioned pitfalls and to ensure a higher degree of objectivity and transparency in identifying and reporting the value of knowledge assets.

The second trade-off is between generalisability and adaptability. Standardised frameworks that are designed to be generic (to allow benchmarking) have been criticised for not being adaptable to the particular circumstances of certain industries, markets or organisations. On the other hand, models that offer innate methods by which they can be tailored to a particular organisation's nature, industry and strategy are criticised for lacking generalisability, since cross-firm comparisons become impossible or at least inaccurate. Since, knowledge that is priceless in a certain contextual setting may be irrelevant in another, the second approach is still viewed as more effective because it considers the highly contextual nature of knowledge (Iske and Boekhoff, 2002). It is therefore proposed that knowledge measurement frameworks must incorporate embedded adjustments to organisational environment and strategy. If also only aimed at internal assessment, as previously recommended, the lack of model universality would no longer be a major drawback.

Finally, a common feature of all knowledge measurement approaches is an exclusive emphasis on knowledge measurement at the organisational level. In their classic work more than a decade ago, Nonaka and Takeuchi (1995) stated that ''an organisation cannot create knowledge on its own without individuals.'' Since then, there has been widespread agreement that knowledge is created and resides within individuals (Ajmal et al., 2010), yet only very few measurement models are aimed at the foundational wellspring of knowledge: the knowledge worker (Kannan and Aulbur, 2004). Individual knowledge measurement is hence identified, as a central subdomain in KM, yet remains relatively under-explored.

5. Conclusion

This research offers a birds-eye view of the KM landscape through taxonomy of KM research providing researchers with a map (see Figure 6) of the current literature and insights into future research. The paper presents a classification of KM publication into five areas: Ontology of Knowledge and KM, Knowledge Management Systems, Role of IT, Managerial and Social issues, and Knowledge Measurement.

The scope of this research study does not cover KM research in its entirety due to the vast nature of the field and thus has the limitation of being restricted to articles retrieved from the *Emerald Insight* and *Science Direct* databases. Accordingly, a number of KM publications may fall outside the proposed taxonomy. Content analysis was conducted by the authors using the theoretical saturation approach and may include a degree of bias with respect to the categorisation of publications. Yet, overall the authors find it reasonable to assume that the review process covered a significant and representative proportion of KM published studies. In the area of knowledge measurement, the proposed taxonomy could be further developed to offer a deeper understanding of research in this cluster.

Despite the limitations, the taxonomy developed in this paper provides an integrative and comprehensive review that can assist future research. Disagreements on fundamental

Figure 6 KM literature map

issues and a theory-practice gap are major issues that confront KM researchers and practitioners and need to be further explored. There is an urge for KM research to reach a consensus on KM core concepts and, in parallel, provide today's business world with simple and pragmatic solutions to current KM challenges. In the subdomain of knowledge measurement, several areas of potential improvement have been identified for most knowledge measurement models. There is a need for new knowledge measurement models which incorporate measures of dynamic knowledge flows, embedded adjustments to organisational environment and strategy, and be directed more towards the individual knowledge worker and not focus solely on the organisational level.

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