Measuring Knowledge

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Abstract

Knowledge is a key to creating a sustainable competitive advantage. Measuring knowledge of an organization as a unit allows for, in addition to other things, benchmarking it against other organizations as well as comparing the development within the organization in the course of time. Additionally, measuring the knowledge of individuals and groups helps identify key workers and can also be used when recruiting a new work force, while evaluating employees' work performances, or to check the course of the adaptation of a new employee. Even though the field of measuring knowledge belongs, in comparison with other topics, among the lesser-developed fields in the management of knowledge, a number of approaches that can be used to measure knowledge have been introduced. The aim of this study is to present an overview of methods which can be applied when measuring the knowledge of organizations, groups or individuals and thus provide a practical list of methods which feature in literature mostly for practitioners and novices in this field. The study is based on a content-analysis of literature.

Keywords: measurement, metrics, knowledge, intellectual capital, knowledge management, knowledge sharing
JEL Classification: M1

1. INTRODUCTION

Numerous publications from various scientific fields are focused on studying knowledge. In principle, the authors of publications in the field of management agree that knowledge is a valuable asset for a company, for it has an impact on the performance of individuals and subsequently the performance of the whole organization. For example, Bock, Zmud, Kim, and Lee (2005) state that knowledge is the foundation of a firm's competitive advantage and the primary driver of a firm's value. Employees' knowledge influences the innovation process, quality and accuracy of work, it helps people solve problems and deal with unexpected situations.

Bose (2004) mentions that the least developed aspect of knowledge management is measurement. Partly it might be due to the fact that measuring knowledge is not easy, according to some authors, it is even impossible. Especially measuring knowledge based on experience that cannot be easily expressed by words, numbers or other symbols, belongs among the not-so-well elaborated fields in literature. On the other hand, measuring knowledge is very important. First, if we want to manage something, we have to be able to measure it. Furthermore, measuring the collective knowledge of organizations allows benchmarking it against other organizations as well as comparing development of the organization in the course of time. Benchmarking and the identification what works and what does not offer a space for learning and improvements. Moreover, Freeze and Kulkarni (2005) state that measurement of organizational knowledge assets is necessary to determine the effectiveness of knowledge management initiatives and Sveiby (2010) and Montequín, Fernández, Cabal, and Gutierrez (2006) point out that measuring can be important for external communication and reporting to stakeholders too. Additionally, meas-

uring the knowledge of individuals supports identifying key workers in an organization, their further development and stabilization in the organization. Finally, measuring knowledge can be also helpful for prediction of future performance of individuals, groups, or organizations.

The aim of this study is to review the approaches applied in measuring knowledge at organizational level, group level and individual level. The study is based on secondary sources and summarizes the findings of several scientific fields – though mainly psychology and management. The review is intended to provide a starting point for those interested in applying or developing knowledge measurement techniques, as well as for those more generally interested in exploring the scope of the methodology available. Furthermore, the findings might assist organizations in identifying the measures which are suitable for them, for improving the quality of metrics they use; and assist researchers in identifying future research needs related to knowledge measurement metrics as well as in deciding about the methods and techniques suitable for their research. There were done several similar reviews, e.g., Ragab and Arisha (2013), Sveiby (2010), Kankanhalli and Tan (2004), and Bose (2004), but this review combines their findings and offers a more comprehensive overview. Additionally, the group level knowledge measurement was not discussed in prior studies.

The article is organized as follows: First, a theoretical framing is introduced. Then, the used methodology is mentioned followed by findings about approaches to knowledge measurement at organizational level, at group one and at individual one. Finally, a discussion and conclusions are presented.

2. THEORETICAL FRAMING

This chapter deals with definitions of basic concepts which are necessary to understand the topic, namely knowledge, intellectual capital, knowledge management, knowledge sharing, measurement, and metrics.

2.1 Knowledge

Dvořák (2004) defines knowledge briefly as what we know. More specifically, McQueen (1999) describes knowledge as experiences, understanding and the comprehension of an environment or the context of a problem which governs our behavior in such a way to get a required response. Similarly, Davenport and Prusak (1998 as cited in Ipe, 2003) defined knowledge as a fluid mix of framed experience, values, contextual information, and expert insights that provides a framework for evaluating and incorporating new experiences and information. Many authors connect the definition of knowledge with information, e.g., knowledge is an understanding of information and their associated patterns (Bierly et al., 2000 as cited in Singh, 2008); knowledge is conceptualized as codified information including insight, interpretation, context, experience, wisdom, and so forth (Davenport and Volpel, 2001 as cited in Fong, Ooi, Tan, Lee, & Chong, 2011), or knowledge can be thought as information that is "contextual, relevant and actionable" (Bose, 2004). Krogh et al. (2000) highlight that knowledge is always linked to a specific context (e.g., a location). Likewise, Ipe (2003) says that knowledge is context specific and relational. In sum, knowledge is context-specific, because it is based on experiences and its formation and molding

is influenced by one's personality. Additionally, knowledge is related to one's understanding of an environment and regulates one's behavior.

Knowledge enhances a firm's value and the achievement of its objectives, mission and vision (Fong et al., 2011). From the perspective of an individual, job-related knowledge is an essential element determining the career success of an employee, together with her/his skills and ability (Fong et al., 2011).

Some knowledge can be documented in repositories (Rashid, Hassan, & Al-Oqaily, 2015). However, much more knowledge resides in the employees who create, recognize, archive, access, and apply knowledge in carrying out their tasks (Bock et al., 2005). Knowledge does not originate from a simple compilation of facts, but it represents a unique human process which cannot be reduced or replicated simply (Krogh et al., 2000). That is why knowledge relates to a human ability to align information one's experience or the experiences of others with the ability and experience to use information during decision making, performing activities and achieving results (Judicibus, 2002). As Nonaka and Takeuchi (1995 as cited in Ipe, 2003) mention: knowledge is about beliefs and commitment. Similarly, Grant (2007) says that at least a certain part of knowledge is based on an individual's judgement and experience. A consequence is that if knowledgeable employees leave the firm, e.g., following better opportunities offered by other firms, the employees will take, at least a part of, their knowledge with them (Fong et al., 2011).

In psychology, a distinction between declarative and procedural knowledge is made (see e.g. (Hartl & Hartlová, 2010; Sternberg, 2002). Declarative knowledge is knowing something that can be stated as a true statement. For example, facts such as date of birth, a name of a friend, what a rabbit looks like. It means "to know something". In knowledge management, declarative knowledge will indicate information or explicit knowledge (depending on the angle of one's point of view). Procedural knowledge is an ability or skill to do something (e.g., to tie a shoelace, drive a car), it means "to know how". In knowledge management, this type of knowledge is often labelled as tacit knowledge.

As it is evident from the above-stated definitions, knowledge is closely linked to one's personality, it is connected to behavior and perception and it is context specific. Such characteristics, which make thorough research difficult, present obstacles for experts studying knowledge, its formation, molding, sharing or its measurement.

2.2 Intellectual capital

In contrast to the subjective characteristic of knowledge, intellectual capital is a concept connected with an organization. According to Stewart and Ruckdeschel (1998), intellectual capital comprises of knowledge, information and experiences which can be used by an organization to generate wealth. Similarly, Edvinsson (1997 as cited in Montequín et al., 2006) defines intellectual capital as the possession of knowledge, applied experience, organizational technology, customer relationships and professional skill that provides a firm with a competitive edge in the market. This definition is broader, because it emphasizes also relationships. That is why it corresponds more with the fact that intellectual capital is often divided into human capital, structural capital and relational capital (Kwee Keong, 2008).

Human capital (or employee competence) is defined as the knowledge, competencies and mindsets of individuals and teams (Hendriks & Sousa, 2013). According to Luthy (1998), human capital consists of the abilities, knowledge and skills of employees and is an important source of an organization's innovation (Bontis, 1999). Carson et al. (2004) state that this type of capital is not in the ownership of an organization and therefore it is lost when an employee leaves the company. To gain and use human capital a company has to enter into a contract with the owners of such capital and furthermore it should provide suitable conditions for its development, because outdated human capital loses its value. Structural capital (or organizational capital, internal structure) refers to knowledge embedded in organizational infrastructures such as routines, databases, rules, procedures, values and norms (Hendriks & Sousa, 2013). In contrast, structural capital is, according to Kannan and Aulbur (2004), represented by supportive infrastructure such as information systems or organizational processes which a company provides for its employees. Finally, relational capital (or customer capital, relationship capital, external structure) concerns knowledge embedded in customer relationships, market channels, intra-organizational relationships and technological networking embedded in the organizational external relationships (Roos 1997 as cited in Hendriks & Sousa, 2013). In other words, it refers to the combined value of an organization's external relationships with stakeholders, such as suppliers and customers, who are valuable sources of both revenue and market knowledge for the organization (Ragab & Arisha, 2013).

According to Castilla-Polo and Gallardo-Vázquez (2016) intellectual capital is the sum of intangible assets not recognized by traditional financial statements and this definition is accepted in this paper.

2.3 Knowledge management

Knowledge management is a formal, directed process of determining what information a company has that could benefit others and then devising ways to making it easily available to all concerned (Liss, 1999 as cited in Singh, 2008). In other words, according to O'Dell and Grayson (1998 as cited in Singh, 2008), the aim of knowledge management is to ensure that knowledge reaches the right people at the right time, and that these people should share and use information to improve upon the organization's functioning. In contrast, Davenport et al. (1998 as cited in Singh, 2008) points out at processes related to knowledge management and define knowledge management as a process of collection, distribution, and efficient use of the knowledge resource throughout an organization. Likewise, Donate and Guadamilllas (2011) state that knowledge management comprises a set of processes through which knowledge is acquired, developed, gathered, shared, applied and protected by the firm in order to improve organizational performance. Additionally, Bounfour (2003 as cited in Singh, 2008) defines knowledge management as a set of procedures, infrastructures, technical and managerial tools, designed toward creating, sharing and leveraging information and knowledge within and around organizations. In sum, knowledge management can be understood as a set of processes formally set and directed by an organization to increase the probability that employees' knowledge is really used to ensure and further improve competitiveness of the organization. A similar opinion has Shin (2004) who says that organizations suppose that knowledge management will help them to increase organizational effectiveness, efficiency and competitiveness. Further, Haas and Hansen (2007) mention three

indicators of the productivity of knowledge work that are critical in many knowledge-intensive organizations: time saved by leveraging the firm's knowledge resources, enhanced work quality as a result of utilizing knowledge, and the ability to signal competence to external constituencies as a result of leveraging knowledge.

2.4 Knowledge sharing

One of the processes which knowledge management aims at is knowledge sharing. As said by Tuan (2012), knowledge sharing is a process which happens when employees pass information, ideas and experiences to each other either within a department or a whole company. Similarly, Sandhu, Jain, and Ahmad (2011) define knowledge sharing as a transfer of valuable facts, beliefs, perspectives, concepts learned through study, observation or personal experience from knower to knowee and McAdam et al. (2012 as cited in Yuliansyah & Alvia, 2016) describe knowledge sharing is an activity through which knowledge in various forms can be transferred or exchanged between different actors in an organization. According to Wang and Noe (2010 as cited in Seba, Rowley, & Lambert, 2012), knowledge sharing refers to the provision of task information and know-how to help others and to collaborate with others to solve problems, develop ideas, or implement policies or procedures. Likewise, Ipe (2003) points out that knowledge sharing between individuals is the process by which knowledge held by an individual is converted into a form that can be understood, absorbed, and used by other individuals. Examples of knowledge sharing include employee willingness to communicate actively with colleagues, i.e., donate knowledge, and actively consult with colleagues to learn from them, i.e., collect knowledge (H.-F. Lin, 2007). Haas and Hansen (2007) state that knowledge sharing has been conceptualized as involving two distinct ways of transferring knowledge across organization subunits, namely 1) personal advice usage (direct contact between individuals, when one person advises another about how to complete a specific task, in meetings, by phone, or via e-mail); 2) electronic document usage (document-to-people sharing when the receiver of the document does not have to contact or speak to the provider directly but can use the document as a stand-alone resource). In sum, knowledge sharing can be summarized as follows: (1) Knowledge sharing has two subjects: the sender of knowledge and the receiver of knowledge. The receiver might be unknown to the sender; (2) Knowledge sharing refers to the provision of work information and know-how to help other employees in their work; (3) The sender of knowledge tries to convert his/her "knowledge" into a form that can be useful for the receiver and increase the probability that the knowledge would be absorbed by the receiver.

Knowledge sharing has several benefits for organization. Knowledge sharing leads to improvement in innovation capability (Fong et al., 2011; Riege, 2005), better decision making by individuals and groups throughout the organization (Yuliansyah & Alvia, 2016), better and higher performance (Fong et al., 2011; Fugate, Stank, & Mentzer, 2009; Law & Ngai, 2008), better product and service offering to customers (Fong et al., 2011) that are brought faster to a target market (Riege, 2005), and increasing their ability to achieve individual and organizational goals (Seba et al., 2012). Thanks to knowledge sharing, people are able to quickly expand their knowledge, improve problem solving, increase work performance and improve work processes and create new business opportunities (Yen-Ku Kuo, Tsung-Hsien Kuo, & Li-An Ho, 2014; Yi, 2009). Knowledge sharing also contributes to reducing costs, for example the cost of training

new employees (Peet, 2012), and organizational learning (Riege, 2005; Seba et al., 2012). The concept "organizational learning" means a dynamic process of creation, acquisition and integration of knowledge aimed at developing the resources and capabilities that allow the organization to achieve a better performance (López, Peón, & Ordás, 2006).

2.5 Measuring and metrics

In the most general term, to measure means to label objects and phenomena by numerical symbols in accordance with certain rules (Pelikán, 1998). Hubbard (2007) defines measuring as "a set of observations that reduce uncertainty where the result is expressed as a quantity." Generally, there are 4 distinct levels of measuring based on their strength (Pelikán, 1998; Urbánek, Denglerová, & Širůček, 2011):

- *Nominal* (categorization) – is sorting data into mutually exclusive categories, for example male/female. Each item can be placed into a single category and all items can be categorized. The nominal level of measuring means simply numbering individual items or categories. Such numerical marks signify nothing but the names of given categories. So, instead of naming the genders by "male" or "female", the numerical marks of 0 or 1 are used.
- *Ordinal* – is not measuring absolute values of given variables but it means giving them a relative value in comparison with others. Apart from equality and inequality, a rank can also be examined (bigger than, smaller than). The size of the intervals between the neighboring numbers cannot be determined because these are not of the same width. Hubbard (2007, p. 23) states as an example a four-rating system for movies. A "4" on either of these scales is "more" than a "2" but not necessarily twice as much.
- *Interval* – aims to separate items (according to our existing knowledge) into categories on a scale with points which lay exactly same distance from each other. Numbers can be added and subtracted but not multiplied or divided. A typical example is measuring temperatures in °C.
- *Ratio* - assigned numeric values indicate the amount or level of characteristics which they in fact measure. There is a natural zero. For example, measuring length, weight, time. The values can not only be added but also multiplied and divided. For example, as states Hubbard (2007, p. 27), four kilometers is really twice as far as two km.

The argument of some authors who say that knowledge cannot be measured is questionable because, as Hubbard (2007, p. 27) notes, if we can observe it in some amount, then it must be measurable. Nevertheless, it should be understood that when measuring knowledge, the aim is not to use the ratio approach, even though some methods, mainly the ones for measuring at organization level, aspire to do so. In many cases, for example when identifying key workers or while recruiting new workers, the tools for ordinal measuring are sufficient. In connection with it, Sveiby (2010) points out that it is not possible to measure social phenomena with anything close to scientific accuracy. All measurement systems, including traditional accounting, have to rely on proxies, such as dollars, euros, and indicators that are far removed from the actual event or action that caused the phenomenon.

Finally, Kankanhalli and Tan (2004) explain the difference between a measure and a metric. A measure is a standard, unit, or result of measurement (IEEE 1983 as cited in Kankanhalli & Tan, 2004). A metric is a quantitative measure of the degree to which a system, entity, or process possesses a given attribute (IEEE 1990 as cited in Kankanhalli & Tan, 2004). A measure by itself does not provide much understanding unless it is compared with another value of the measure, i.e., it becomes a metric (Kankanhalli & Tan, 2004).

3. METHODOLOGY

The conceptual framework presented in this article has drawn on literature from fields such as management theory, strategic management, information and decision sciences, organizational communication, organizational behavior, psychology, and social psychology. These fields of study were identified through a search of scholarly literature available primarily through electronic databases, especially articles at Web of Science and Scopus were taken into account. The initial review of literature began with an examination of publications that discussed the concept of knowledge metrics and knowledge measurement. References in the found articles were further examined to find more relevant papers.

Once relevant publications were identified, the focus of the analysis shifted to isolating those ideas that specifically related to methods and techniques of knowledge measurement. The key findings that emerged from the literature were then synthesized to form the conceptual framework presented in this article. The conceptual framework presented in this article is an attempt to bring together all relevant ideas into one whole to provide a more comprehensive approach to understanding the phenomenon of knowledge measurement.

4. MEASURING KNOWLEDGE AT ORGANIZATION LEVEL

Based on the finding of Ragab and Arisha (2013), Sveiby (2010), Kankanhalli and Tan (2004), and Bose (2004), when measuring knowledge at organization level, it is possible to review the level (amount) of knowledge, which is at the disposal of an organization, or to focus on reviewing how effectively it is worked with knowledge, for example when evaluating the effectivity of sharing knowledge within the organization. It means the classification of methods of measuring knowledge at organizational level can be as follows:

- Knowledge level evaluation methods, which can be
    1. Financial methods, which quantify the total amount of intellectual capital on the basis of the accounting information, or
    2. Score-card methods based on the identification and a non-financial measuring of components of intellectual capital.
- Knowledge management evaluation methods, which measure the effects of knowledge management on organizational performance.

4.1 Knowledge level evaluation methods

According to Kannan and Aulbur (2004) a key reason for measuring intellectual capital is to recognize hidden assets and strategically develop them to achieve organizational goals. They listed the benefits of intellectual capital measurement, e.g., better identification and mapping of intangible assets; recognition of knowledge flow patterns within the organization, acceleration of learning patterns within the organization. It is possible to use financial or score-card methods to evaluate knowledge or intellectual capital which the organization has at the disposal.

Financial methods quantify the total amount of intellectual capital on the basis of the accounting information. Sveiby (2010) mentions that the financial methods are useful in merger and acquisition situations and for stock market valuations, as well as, for comparisons between companies within the same industry. However, as Ragab and Arisha (2013) points out, financial methods do not always clarify where problems exist and the value-adding contribution (or lack) of different intellectual capital components. Kannan and Aulbur (2004) add that intangibles such as staff competencies, customer relationships, business models, and computer and administrative systems receive no recognition in the traditional financial methods. Financial methods could be further divided into:

- M*arket Capitalization methods* calculate the difference between a company's market capitalization and its stockholders' equity as the value of its intellectual capital (Sveiby, 2010). Examples of these methods are Market-to-book Value, Tobin's q, The Invisible Balance Sheet, Investor Assigned Market Value (IAMV), Calculated Intangible Value.
- *Return on Assets methods* (ROA). Sveiby (2010) explains that average pre-tax earnings of a company for a period of time are divided by the average tangible assets of the company. The result is a company ROA that is then compared with its industry average. The difference is multiplied by the company's average tangible assets to calculate an average annual earnings from the intangibles. Dividing the above-average earnings by the company's average cost of capital or an interest rate, one can derive an estimate of the value of its intellectual capital. Examples of these methods are: Knowledge Capital Earnings, Value Added Intellectual Coefficient, Economic Value Added (EVA).
- *Direct Intellectual Capital methods*. Sveiby (2010) describes that these methods estimate the money-value of intellectual capital by identifying its various components. Once these components are identified, they can be directly evaluated, either individually or as an aggregated coefficient. Examples of these methods are: Human Resources Costing and Accounting, Citation-Weighted Patents, Technology Broker, The Value Explorer, Inclusive Valuation Methodology (IVC), HR statement, Total Value Creation (TVC), FIMliAm, EVVICAE, The Dynamic monetary model, Intellectual Asset Valuation, Accounting for the Future (AFTF).

For example, EVA is defined as the difference between net sales and the sum of operating expenses, taxes and capital charges where capital charges are calculated as the weighted average cost of capital multiplied by the total capital invested (Bontis, 2001). Another example is Technology Broker which defines intellectual capital as the combined amalgam of these four components: market assets, human-centered assets, intellectual property assets and infrastructure assets (Bontis, 2001). The organization answer 20 questions (like "In my company we know the value of our brands.", "In my company there is a mechanism to capture employees' recommen-

dations to improve any aspect of the business.") that make up the intellectual capital indicator (Bontis, 2001). Bontis (2001) explains that each component of the model is then examined via a number of specific audit questionnaires that ask questions specific to those variables thought to contribute to that asset category. Once an organization completes its Technology Broker audit, three methods of calculating a dollar value for the intellectual capital identified by the audit are offered: 1) the cost approach, which is based on assessment of replacement cost of the asset; 2) the market approach, which uses market comparables to assess value; and 3) the income approach, which assess the income-producing capability of the asset.

Score-card methods are based on the identification and a non-financial measuring of components of intellectual capital. The various components of intellectual capital are identified and indicators and indices are generated and reported in scorecards or as graphs (Sveiby, 2010). In cases where metrics measure a qualitative attribute (such as motivation) scale-based surveys are used to convert qualitative values into quantitative figures (Ragab & Arisha, 2013). A composite index may or may not be produced (Sveiby, 2010). The advantages of the score-card methods are, according to Sveiby (2010), that they can create a more comprehensive picture of an organization's health than financial metrics and that they can be easily applied at any level of an organization. Since they do not need to measure in financial terms they could be useful for non-profit organizations, internal departments and public sector organizations and for environmental and social purposes (Sveiby, 2010). However, Ragab and Arisha (2013) highlight that these methods are critiqued for only providing a 'snapshot' evaluation of an organization's knowledge, and so only reflecting its static knowledge stocks without considering the dynamic element represented in its knowledge flows and that future measures should reflect the dynamics of knowledge creation and transfer within organizations.

Examples of these methods are: Business IQ, IC–Index, National Intellectual Capital Index, Holistic Accounts, IC Rating, Intangible Asset Monitor, Value Creation Index (VCI), Knowledge Audit Cycle, ICU report (an IC report for universities), Intellectual asset-based management (IAbM), Value Chain Scoreboard, MAGIC, Skandia Navigator, "Dynamic Valuation of Intellectual Capital" (IC-dVAL), Balanced Score Card, Danish guidelines, Meritum guidelines, MMRIC (Measure, Manage, and Report Intellectual Capital), Regional Intellectual Capital Index, SICAP (an IC model for public administrations), Public sector IC, Intellectus model, Intangible assets statement (an IC model for public sector). Interestingly, Montequín et al. (2006) suggest a model which is suitable for measuring intellectual capital within small and medium-sized enterprises.

One of the most often used method is Balanced Scorecard (BSC). BSC has multidimensional nature because of comprising quantitative, qualitative, financial and non-financial measures. BSC evaluates, according to Bose (2004), four key perspectives: financial ("How can we add value to our shareholders?", e.g. profitability and cash flow); customers ("What do our customers value from us? Are we meeting their needs and expectations?", e.g. customer satisfaction and market share); internal processes ("What do we need to do well in order to succeed? What are the critical processes that have the greatest impact on our customers and our financial objectives?", e.g. tender success rate and safety incidents); and learning and growth ("Orientation to future success, how can we continue to add value?", e.g. unit costs and new products launched). In each field, the goals are documented and key performance indicators are measured.

Similarly, Skandia's value scheme contains both financial and non-financial building blocks that combine to estimate the company's market value (Bontis, 2001). The Skandia intellectual capital report uses up to 91 new intellectual capital metrics plus 73 traditional metrics to measure the five areas of focus making up the Navigator model (Bontis, 2001). The areas of focus are as follows: financial, customer, process, renewal and development, and human (Bontis, 2001).

Another example is Intangible Asset Monitor proposed by Sveiby (1997 as cited in Bontis, 2001) which is based on three families of intangible assets: external structure (brands, customer and supplier relations); internal structure (the organization: management, legal structure, manual systems, attitudes, R&D, software); and individual competence (education, experience). In his conceptual model, Sveiby identifies three measurement indicators: growth and renewal (i.e. change), efficiency and stability for each of the three intangible assets. The choice of indicators depends on the company's strategy but should include only a few of the measurement indicators for each intangible asset.

Interestingly, some of the methods, such as Human Capital Readiness, Human Capital Index or Human Capital Monitor, concentrate only on human capital measurement. For example, Human Capital Readiness evaluates 5 sectors of human capital: strategic skills and competence, leadership, cultural and strategic awareness, commitments to the goals and incentives, strategic integration and learning (Skyrme 2003 according to Ragab & Arisha, 2013).

4.2 Knowledge management evaluation methods

Knowledge management evaluation methods measure the effects of knowledge management on organizational performance. However, these methods, as Ragab and Arisha (2013) mentioned, can suffer from being built on the questionable assumption that changes in organizational performance are solely due to knowledge management disregarding the other possible influences on firm performance. Similar to the previous case, these methods can be divided into the following categories:

- Financial methods which use quantitative financial metrics such as stock prices, profitability and return on investment to evaluate the benefit of knowledge management. For example, Chen and Chen (2005) suggest a metric approach to evaluate knowledge management performance with the use of the Black-Scholes model based on option pricing.
- Non-financial methods which evaluate the benefit of knowledge management to organizational performance based on the answers of respondents at interviews or via questionnaire surveys and relies to a large extent on respondents' perceptions of knowledge management. Examples could be 1) The Knowledge Management Scan by Hooff, Vijvers, and Ridder (2002), which aims to provide an organization with concrete recommendations concerning its strategy, tactics and operations with regard to knowledge management, or 2) The Knowledge Management Capability Assessment instrument by Freeze and Kulkarni (2005), which capture a firm's knowledge management ability and status in four Knowledge Capability Area (Lessons Learned, Knowledge Documents, Expertise, and Data), as well as 3) Organizational Learning Scale by López et al. (2006) with the following dimensions: external knowledge acquisition, internal knowledge acquisition, knowledge distribution, knowledge interpretation, and organizational memory, or 4) the questionnaire by Rashid

et al. (2015) who concentrate on tacit knowledge management and in their questionnaire they examined Tacit Knowledge Culture, Tacit Knowledge Conversion, and Tacit knowledge Measurement in two colleges in Universiti Tenaga Nasional in Malaysia. Interestingly, Chen and Chen (2005) combined a traditional BSC framework with knowledge management and made a balanced knowledge management scorecard.

Some analyses could be connected with the above mentioned methods. Examples of such analyses are mentioned by Kannan and Aulbur (2004), e.g. needs analysis which reviews and maps organizational information need, creation, use, flow, and storage, identifies gaps, duplication, costs, and value, and uncovers the barriers to effective knowledge flow; cultural analysis which might show cultural barriers that need to be addressed; commitment to intellectual capital development analysis.

Some of the performance methods presented in literature focus on evaluating and monitoring particular knowledge management system implementations, e. g., on system level measures for electronic knowledge repositories or measures for electronic communities of practice (Kankanhalli & Tan, 2004). Others aim at some knowledge functions like knowledge sharing.

Methods Focusing on Knowledge Sharing

Methods which are aimed at knowledge sharing, can be divided into:

- hard data measurement,
- opinion-based surveys which examine such constructs like willingness to share knowledge, knowledge-sharing behavior and factors which can influence it, or identify potential knowledge holder and a potential for mutual knowledge sharing,
- combination of hard and soft indicators.

Hard data measurement

When evaluating knowledge sharing within an organization it is possible to focus on measuring hard data such as amount, frequency or length of something. Indicators which can be used are the following: the number of hits on personal postings, the number of documents submitted or consulted, the number of contributions to meetings, the number of written reports, the rate of contribution to knowledge data bases, the number of new ideas, the number of improvement suggestions made, the number of presentations made, the number of communities within an organization, the rate of reusing knowledge, the frequency of sharing of various kinds of knowledge (e.g. work experience, information gained at training courses, information about business partners) or the frequency of utilizing various information technologies such as bulletin boards, e-mails, webpages, chat rooms (Ragab & Arisha, 2013; Smith & McKeen, 2003; Yi, 2009). This approach supports utilizing computer-based knowledge sharing, as individual's contributions to knowledge bases or online discussions are readily observable (Yi, 2009). For example, the Samsung Life Insurance company measures sharing knowledge, which is registered in a knowledge bank, by employing a point system, as explained by Hyoung and Moon (2002). An employee receives 10 points every time he signs into the database, 1 point for every search and 200 points for adding his own material into the knowledge database. The points gained can then be transformed into rewards, for example international training.

Opinion-based surveys

Opinion-based surveys are often based on the use of scenarios or questionnaires with statements evaluated by the informant on a Likert scale. For example, an interesting approach to evaluate the willingness to share knowledge was chosen by Chow, Deng and Ho (2000). In their research, they used, in addition to other things, two scenarios to which informants were to respond – they had to state how a typical employee of their organization would respond in a given situation and at the same time indicate on a scale 1 to 9 how likely it is that he/she would share his/her knowledge in such a situation. As well Seba et al. (2012) focused at attitudes towards knowledge sharing. They used a questionnaire-based survey. Respondents' attitudes and opinions were measured using five-point Likert scale questions (5 = "disagree strongly"; 1 = "agree strongly"). Their study measured eight constructs: intention to share knowledge, attitude towards knowledge sharing, leadership, organizational structure, reward, trust, time, and information technology. All constructs were measured using multiple items. Likewise, Lin and Lee (2004) measured perceptions toward knowledge-sharing behavior, but they focused on perceptions of senior managers and five constructs: knowledge-sharing behavior, intentions to encourage knowledge sharing, attitudes toward knowledge sharing, subjective norms about knowledge sharing (perceived social pressure to encourage knowledge sharing), and perceived behavioral control to knowledge sharing (perceived ease or difficulty of encouraging knowledge-sharing behavior). All constructs were measured using multiple items. All items were measured using a seven-point Likert scale (ranging from 1 = strongly disagree to 7 = strongly agree). Similarly, Quigley, Tesluk, Locke, and Bartol (2007) concentrated in their research, among others, on norms supporting knowledge sharing and they used a 10-item questionnaire. Items were evaluated on a seven-point Likert scale.

Yi (2009) created a tool for measuring the behavior of employees aimed to share work-related and professional knowledge. Her 4-dimensional model consists of 28 items/statements. Respondents evaluated the described behaviors on a five-point Likert scale. The dimensions of behaviors aimed to share knowledge were the following: written contributions (contribution of knowledge to organization's database), organization communications (sharing knowledge in formal interactions within or across teams or work units), personal interactions (sharing knowledge in informal interactions), and communities of practices (sharing knowledge within communities of practice). Similarly, Guo-bao (2013) measured knowledge-sharing with the use of 20-item questionnaire. However, in this study the items examine sharing of common knowledge (accessible knowledge, ordinary information, ordinary skills, knowledge that don't affect employees' direct interests) and key knowledge (significant skills, knowledge affecting employee's position in organization, core work experience, knowledge affecting employee's immediate interests and so on). Additionally, the questionnaire evaluates both knowledge donating and knowledge collecting. Knowledge donating and knowledge collecting were evaluated also in the study made by Sandhu et al. (2011) who examined in their study knowledge sharing in public sector. Their questionnaire contained items divided into the following parts: 11 items designed to ascertain general views towards a) importance of knowledge sharing and awareness of its benefits; b) existence of knowledge sharing initiatives; c) employees' willingness to share knowledge (knowledge donating); and d) colleagues' willingness to share knowledge (knowledge collecting); 15 items eliciting

views towards knowledge sharing barriers; 17 items eliciting views of respondents towards type of knowledge sharing initiatives that should be promoted. The data was collected on a five-point Likert scale where 1 represented "strongly disagree" and 5 represented "strongly agree".

Yang (2007) explores in his study how organizational culture with a focus on collaboration, and certain types of leadership roles affect knowledge sharing. He examined three constructs: knowledge sharing, leadership roles, organizational culture with a focus on collaboration. In the framework of this study knowledge sharing was measured by a 10-item scale. The items were evaluated on a seven-point Likert scale.

Combination of hard and soft indicators

Naturally, the hard approach to measuring knowledge sharing and the soft one can also be combined. For example, Usoro et al. (2007) measured knowledge sharing in on-line communities via a questionnaire. In their research, they examined three aspects linked to knowledge sharing: how often an employee takes part in a process of the knowledge sharing (quantity of sharing), usefulness of shared knowledge (quality) and the degree to which an individual feels that they engage in knowledge sharing.

5. MEASURING KNOWLEDGE AT GROUP LEVEL

A smaller part of studies deals with measuring knowledge at group (team, organizational unit) level. They try to evaluate or predict the influence of group knowledge on group performance. An example of techniques used for such an objective is proxy measures. Proxy measures are based on the fact that some knowledge cannot be articulated and a substitution is needed for its measuring. For instance, Berman et al. (2002) used data from the National Basketball Association (NBA) and claim that their measure is a reasonable proxy for the sort of tacit knowledge at team-level. Years of player team experience was weighted by the minutes played in the games that season by that player and an average was then calculated for each team year. In another study, Edmondson et al. (2003) used a performance measure of efficiency as the proxy measure for tacit knowledge in cardiac surgical teams in 15 hospitals.

Another example of techniques for group knowledge measurement is the Team tacit knowledge measure for software developers by Ryan and O'Connor (2009). Ryan and O'Connor (2009) used repertory grid to construct their inventory and this technique was used for example by Herbig, Büssing, and Ewert (2001) too. Repertory grids provide information about an individual's personal constructs (Muir, 2008 as cited in (Jafari, Akhavan, & Nourizadeh, 2013). This is ideal for examining how an individual thinks about an issue (Jankowicz, 1990 as cited in (Jafari et al., 2013). Ryan and O'Connor (2009) explain the basic idea of repertory grids as follows: There are three important constituents to the repertory grid: elements, constructs and links. The repertory grid provides a two-way classification of information in which relationships are uncovered between a person's observations of the world (called elements) and how they construct or classify those observations. These constructs are made up of similarity-difference dimensions or bipolar constructs, describing how some elements are similar and yet different from another. The third component of the grid links the elements and constructs, where each element is rated on each construct. Cooke (1994) adds that as the ratings along

each construct for each element are gained, a grid is constructed in which the constructs and elements are listed respectively as rows and columns of the grid. Overall relatedness can be derived from the grid by computing the summed difference (or correlation) between ratings for either the constructs or the elements (Cooke, 1994).

Repertory grid as such can be used for an identification of experts and measuring knowledge structure development in novice employees too. Similarly, multidimensional scaling can be used for such an aim (Bradley, Paul, & Seeman, 2006) as well as network scaling, e.g., Path-Finder technique (Bradley et al., 2006; Rose, Rose, & McKay, 2007). Multidimensional scaling procedures use pairwise proximity estimates of a set of concepts and generate d-dimensional spatial layouts of those concepts (Cooke, 1994). According to Cooke (1994) dimensions reflect features along which the concepts vary, and metric distance between points in the space corresponds linearly or monotonically to psychological proximity. Network scaling involves the generation of a graph representation based on the proximities (Cooke, 1994). The Path-Finder technique includes the conversion of a set of relatedness judgments into psychological distances, resulting in a fully connected, weighted network of concepts and relationships (Bradley et al., 2006). It provides a direct measure of a decision maker's knowledge structure that can be employed in deterministic and non-deterministic decision environments (Rose et al., 2007). An algorithm is applied to this network to generate a reduced network containing only the shortest paths (Bradley et al., 2006). Cooke (1994) explains that the Pathfinder procedure takes pairwise proximity estimates for a set of items and generates a graph structure in which the items are represented as nodes and relations between items are represented as links between nodes. Each link is associated with a weight that represents the strength of that particular relationship.

Another reason for group level measurement of knowledge is to map the likely diffusion of knowledge (Busch, Richards, & Dampney, 2001). A social network analysis (SNA) can be used for such an objective – see, e.g., Busch et al. (2001). Busch et al. (2001) claimed that those individuals found as being popular were possible holders or charismatic conveyors of the (organizational) knowledge. Examples of social network measures are presented by Kannan and Aulbur (2004), e.g., span of control (average number of lower links per manager), or density (the number of actual links in a network divided by the number of all possible links in the network).

There are also relatively simple methods, which can be used for measuring the potential for mutual knowledge sharing in the group, such as River Chart mentioned by Collison and Parcell (2005). It is based on a self-evaluation of managing the competencies on a five-point Likert scale. The results are then depicted as a "river" diagram. The edges of the river are defined by maximum and minimum point values stated by subjects for each competence. The width of the river provides clear information on the potential of knowledge sharing in each given field. Where the river is narrow the majority of subjects have roughly the same level of competence, therefore there is less opportunities for them to learn from one another. Areas where the river is the widest suggest a wide spread of competencies, which represent opportunities for sharing and improving existing competencies. Similarly, a spider diagram can be used for the same purposes.

6. MEASURING THE KNOWLEDGE ON AN INDIVIDUAL LEVEL

Measuring knowledge at individual level can be used, in addition to other things, when evaluating work performance and predicting future individual's performance, during the process of identifying training needs or checking the level of adaptation of a new employee, as well as when selecting new employees from job vacancy candidates, or, on the other hand, when deciding who is to be made redundant.

To assess individual's attitude towards knowledge sharing and his/her willingness to share knowledge, questionnaire with items evaluated on a Likert scale can be used. To check the process of adaptation, techniques like repertory grid or PathFinder could be used. When measuring amount of knowledge at individual level, the differences between the various types of knowledge became more apparent. While for measuring some knowledge (knowledge that can be made explicit – so called explicit knowledge) a classic knowledge test can be quite effectively used, as it is common for example at schools, but for measuring other knowledge such an approach would be rather ineffective because, apart from other reasons, numerous knowledge is acquired subconsciously, is based on experience, is used spontaneously and using such knowledge is often influenced by a given context (so called tacit knowledge). An individual therefore may not be aware of such knowledge, it can be difficult to express it by words, numbers or other symbols or it can be described only in general terms (while omitting the context which is conditional for using such knowledge). When measuring such knowledge, the aim is not so much to express it in some kind of numerical form but rather to determine who has more and who has less of such knowledge. However, some studies do not try to examine the amount of tacit knowledge, but the attitude of an individual towards knowledge sharing and his/her willingness to share knowledge.

For an evaluation of individual's amount of tacit knowledge (or the influence of tacit knowledge on performance), three basic approaches are described in literature: 1) monitoring the performance of individuals during simulated situations – usually model work situations (Kerr, 1995; Sternberg, 1995), undertaken, for example, in assessment centers; 2) situational judgement test (Choi, 2001; Colonia-Willner, 1999; Edwards & Schleicher, 2004; Fox, 1997; Richard Kenneth Wagner, 1985); 3) questionnaire evaluating behavior.

A situational judgement test (SJT) has been being used for several decades, but an increase in popularity of the test has been noted in recent years. McDaniel et al. (2007; 2001) perceive the increasing popularity of it as a result of an adequate criterion-related validity of the test for predicting work performance. SJTs are also reported to be a useful component of a selection battery to predict task performance (O'Connell, Hartman, McDaniel, Grubb, & Lawrence, 2007). However, some studies have appeared too which are skeptical about the usefulness of SJTs because of its coachability (e. g. Cullen, Sackett, and Lievens 2006). A SJT usually consists of several situations (scenarios), which can be closely linked to a given profession and the solution of which requires the application of certain knowledge. In some cases, a situational judgement test offers possible behavior strategies and respondents evaluate the probability of such reactions in the light of attempting to solve the situation. In other cases, the respondent is not presented with a list of possibilities regarding how to react and he/she has to describe the reaction himself/herself. The presented situations try to evoke respondent's knowledge stored in his/her subconscious mind and make him/her apply the knowledge in the given situation (Sternberg & Wagner,

1992). SJTs were used to measure tacit knowledge of students (Peeters & Lievens, 2005), military leaders (Horvath, Sternberg, Forsythe, Sweeney, & Bullis, 1996), or managers (Colonia-Willner, 1999; R.K. Wagner & Sternberg, 1991), or nurses (Fox, 1997).

A questionnaire based on evaluating behavior presents several statements related to behaviors of a given individual. These statements often depict how a person who has certain knowledge should behave. This questionnaire can be useful for self-evaluation. Respondents state how often they behave in a given manner – see e.g. a test used in research by Somech and Bogler (1999) or Leonard and Insch (2005), or they evaluate to which level a described activity is characteristic of them – see e.g., Williams and Sternberg (Torff & Sternberg, 1998).

Sometimes it is welcome to capture expert knowledge too. For such an aim, cognitive maps can be used (Noh, Lee, Kim, Lee, & Kim, 2000). Noh et el. (2000) explain that a cognitive map is composed of nodes, signed directed arcs, and causality value. Nodes represent causal concepts, and signed directed arcs causal relations between two concepts. Causality value means ` + ' and ` - '. Therefore, a cognitive map can represent experts' beliefs and cognition about illstructured social relationships (Huff, 1990 as cited in Noh et al., 2000). Some other techniques for capturing knowledge are mentioned by Milton (2007) and by Cooke (1994).

7. DISCUSSION AND CONCLUSIONS

Nowadays knowledge is viewed as a potential source of organizational competitive advantage (Cabrera, Collins, & Salgado, 2006). Achieving competitive advantage depends upon a firm's ability to exploit existing knowledge and to generate new knowledge (Laursen & Mahnke, 2001). When knowledge is properly used and leveraged, it could drive companies to become more innovative through the development of better products that are brought faster to a target market (Gourova, 2010 as cited in Lee & Wong, 2015; Riege, 2005).

The aim of this survey study was to highlight and summarize the methods used for measuring knowledge at organizational level, group level and individual level. The knowledge measurement is important, because it can highlight the value of organizational knowledge, point out the necessity of knowledge management, or give additional value to some activities related to human resource management (like selecting a new employee, training and development). Additionally, because what gets measured, gets managed and it is possible to learn from it, management attention should not be any more exclusively focused on financial results to the detriment of innovation, customer relationships, employee engagement and process development among others.

The study was based on content analyses of secondary sources, mainly in the fields of psychology and management. The fact that this study includes more than one scientific field and furthermore, it combines measuring knowledge at organizational, group and individual levels, which makes it potentially beneficial mainly for novices and practitioners in the field of measuring knowledge who need to orient themselves quickly in these matters. The reason is that one of the first steps to be taken after making a decision to measure something is to review if someone has already undertaken a similar study and what approach they have used. It is expected that this review will also be a useful starting point for future applications and research using knowledge measurement techniques. The basic methods used for measuring knowledge are depicted in Tab. 1.

Tab. 1 – Methods to Measure Knowledge. Source: Own elaboration.

ORGANIZATIONAL LEVEL			
A. Methods to evaluate knowledge level to report, benchmark, …			
├	**Financial methods** that quantify the total amount of intellectual capital		
│	├	Market Capitalization Methods (Market-to-book Value, Tobin's q, The Invisible Balance Sheet, …)	
│	├	Return on Assets Methods (Knowledge Capital Earnings, Value Added Intellectual Coefficient, Economic Value Added, …)	
│	└	Direct Intellectual Capital Methods (Human Resources Costing and Accounting, Citation-Weighted Patents, Technology Broker, …)	
└	**Score-cards methods** based on a non-financial measuring of components of intellectual capital (IC-Index, IC Rating, Intangible Asset Monitor, Skandia Navigator, Balanced Score Card…)		
	└	Methods measuring Human Capital (Human Capital Readiness, Human Capital Index, Human Capital Monitor, …)	
B. Methods to evaluate work with knowledge to examine value addition of knowledge management to the organization			
├	**Financial methods** that use financial metrics (Black-Scholes model, ...)		
└	**Non-financial methods** based on respondents' perception (The Knowledge Management Scan, The Knowledge Management Capability Assessment, Organizational Learning Scale, ...)		
	└	Methods to evaluate knowledge sharing	
		├	Hard data (amount, frequency, length of something) measurement
		├	Opinion-based surveys about attitudes or behaviour related to knowledge sharing that use scenarios or items evaluated on a Likert scale
		└	Combination of methods

GROUP LEVEL	
├	Methods to evaluate the influence of knowledge on group performance (Proxy measures, Team tacit knowledge measure, …)
├	Methods to identify the potential for mutual knowledge sharing within a group (River Chart, Spider Diagram, …)
└	Methods to identify the holder of knowledge in a group (Social Network Analysis, ….)

INDIVIDUAL LEVEL	
├	Methods to evaluate the attitude and willingness to knowledge sharing (items evaluated on a Likert scale, …)
├	Methods to measure the amount of explicit knowledge (knowledge tests, …)

├	Methods to measure the amount of tacit knowledge (simulations, situational judgment tests, items connected with behaviour that manifests the knowledge owning evaluated on a Likert scale)
├	Methods to predict the future performance (simulations, situational judgment tests, items connected with behaviour that manifests the knowledge owning evaluated on a Likert scale)
├	Methods to evaluate knowledge structure development (repertory grid, multidimensional scaling, network scaling, …)
└	Methods to capturing expert knowledge (observation, interviews, task analysis, process tracing techniques, conceptual techniques like cognitive maps, …)

It is obvious that each approach has its advantages and disadvantages, which is why researches have to think carefully about why they want to measure knowledge, what the result of measuring knowledge will be used for and how they want to work further with it. Moreover, Ragab and Arisha (2013) claim it is necessary that intellectual capital measurements ensure a higher degree of objectivity and transparency in identifying and reporting the value of knowledge assets. They also add that knowledge measurement frameworks must incorporate embedded adjustments to organizational environment and strategy.

According to Bose (2004), the challenge for organizations today is how to match and align performance measures with business strategy, structures and corporate culture, the type and number of measures to use, the balance between the merits and costs of introducing these measures, and how to deploy the measures so that the results are used and acted upon. Bose (2004) also mentions that the future usage of knowledge management is heavily dependent on both the quality of the metrics and whether output generated by these metric management would provide tangible value addition to the organizations. That is why knowledge metrics development and implementation will be one of the main thrusts of knowledge management. Additionally, it is necessary to convince management that the use of the developed metrics is important. Therefore, a key part of every corporate strategy should be developing a better understanding of the nature of intellectual capital and knowledge assets, and how to measure, manage and leverage them (Bose, 2004).

In sum, there is an arsenal of techniques from which to choose when faced with the task of knowledge measurement. The techniques differ in many ways and many of these differences trade-off. More empirical work that addresses questions such as the validity of the techniques is needed. Furthermore, it seems sensible to combine methods of knowledge measurement. For example, Kannan and Aulbur (2004) suggested a three-step model for intellectual capital measurement. The three steps include: identification and awareness, systems and output measures, and outcome measures of tangible financial returns. More research of this type would be welcomed. Also Kankanhalli and Tan (2004) mention that there appears to be a relative paucity of knowledge management evaluation studies at the group and team levels except for a few virtual team studies. Possibly more research on team, project, and business unit level knowledge evaluation may serve to bridge the gap between the micro level assessment studies (user and system level) and the macro level assessment studies (organization level). According to them, future research can also investigate suitable metrics for evaluating electronic communities of practice.

This contribution enhanced the theoretical knowledge of knowledge measuring and contributed to the classification of suitable methods and techniques used for knowledge measuring. Although limited by the fact that a complete review of literature cannot be claimed, this study throws light on the existing research on knowledge metrics.

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