Measuring and linking social network knowledge exchange and organisational performance

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Abstract *This paper deals with how to measure social network knowledge exchange and its link with organisational performance. First, it revises both social network analysis and performance measurement techniques, highlighting the main performance elements that may be used. Then, it categorises the main social knowledge network working levels and components from a performance management perspective. It presents the main dimensions of social knowledge networks (actors, knowledge exchange and performance elements) from the performance management point of view. Last but not least, it describes and categorises the main techniques that could be used in order to determine the current and future position inside the social knowledge network (Data Envelopment Analysis). It also emphases the characteristics and pitfalls of the subjective (Analytic Network Processes) and objective techniques (multivariate models), that tend to be used when analyzing the link between social network knowledge exchange and organisational performance.*

1. Introduction

Nowadays it seems clear that supply chain/network members can benefit from keeping diverse collaborative activities such as information/knowledge exchange, product/service design sharing, production planning methods and experiences sharing etc. [1]. Focusing on the information and knowledge exchange processes, it is widely accepted that the ideal conditions to carry out such a complex demarche are based on elements such as trust/distrust cycles, equity, coherence, visibility, commitment, reciprocity or power [2]. Further, it is possible to argue that exchanging knowledge within the supply chain is mainly favoured by trust and knowledge complementarities [3]. Collaboration and other knowledge exchange

activities aim to increase the common benefit of the actors involved [4]; but can this benefit be measured or quantified? From a pragmatic perspective, there should be different techniques and approaches available to decision-makers that will offer them not only the possibility to measure the benefits derived from collaboration and other knowledge exchange activities but also they should be able to link them to organisational performance. From a more realistic point of view, this is not an easy task since collaboration and other knowledge exchange activities have an intangible nature. Therefore, from a performance perspective, the intangible character of knowledge exchange is what makes it difficult to measure [4], to quantify or to label it.

Besides, due to technological advances the channels used for collaboration and interaction evolved significantly. The newest channel that starts to gain companies attention is represented by the social network. With the usage of such a channel, companies might access an entirely new world in terms of information and knowledge exchange. New challenges arise along this new capability and the rules of the game have somehow changed; what used to be used only for social interaction with friends, family etc (i.e. Facebook, Hi5) or, in the best of cases, for finding working contacts (i.e. LinkedIn, Xing, etc) has become a new intra and inter-organisational knowledge exchange channel.

Given this dynamic and progressive environment, how could the decision-makers measure and manage knowledge exchange? And last but not least, how could this be linked to organisation's performance? This is a difficult task that needs to be explored both theoretically and practically. It is necessary to analyse the techniques, frameworks, methods etc. that could be applied in order to "translate" the newly generated knowledge into recommendations and ways of action for decision-makers. The challenge is not only reduced to converting the qualitative, intangible character of knowledge into a quantitative one but also on emphasizing the importance of such an approach by linking it to organization's performance.

Hence, this paper deals with analyzing intra and inter-organisational knowledge exchange through social network interaction. It starts by presenting the main theoretical underpinnings regarding social network analysis and measuring, as well as performance measurement and management. Then, it brings forward the main components of the social network: actors (members), knowledge exchange and performance elements. It leads to a tri-dimensional approach in which all the social networks can be located. Then, the most suitable techniques to change the location of a certain social network within the approach as well as to link

organisational performance and knowledge exchange are highlighted. Finally, the main conclusions and future research directions are discussed.

2. Background

When it comes to performance measurement, there are many frameworks that, to some extent, try to measure and link intangible assets (where knowledge exchange could lie at some extent) and organisational performance. Both the widely known Balanced Scorecard [5] and the Strategic Maps framework [6] possess a perspective called Learning and Growth where decision-makers could define strategic objectives and associate key performance indicators at the intangible level [7]. There are many other frameworks (like, Calculated Intangible Value, Value Added Intellectual Capital, Intellectus Model etc.) that have dealt somehow with measuring, managing and even linking intangible assets and organisational performance [8] and [9]. They have also tried to emphasize the knowledge flow at both intra- and inter-organizational level.

However, this research field is still on an embryonic stage of development; none of previous models has demonstrated its capacity of being both effective and solid due to the fact that intangible assets and intellectual capital are difficult to measure and manage. Besides, there are few frameworks that offer the possibility of quantitatively linking these intangible assets with the organisation's performance. It is only possible to accomplish it by mean of subjective techniques, being especially adequate the so-called Multi Criteria Decision Aid techniques (MCDA). For instance, [4] applied the Analytic Network Process technique [10] in order to link organisational performance and intangible assets of a research centre. Different analysis models were designed and graphical tools were developed; these models and tools clearly showed the links between organisational performance and intangible assets from a quantitative point of view. In any case, more specific applications and analysis should be carried out when linking knowledge exchange and organisational performance. This issue is further developed later on in the paper.

Against the backdrop of technological progress, companies' interest in using social networks for internal and external activities has grown extensively. Nowadays, social networks are used internally (in processes of inter- and intra-departmental communication, recruitment, evaluation etc.) and externally (especially, in marketing activities). Based on these, the area of Social Network Analysis (SNA) started to develop and to capture organizations' and researchers' interest. But what is SNA?

SNA is a relatively new technique used in diverse social sciences disciplines. According to [11], "The social network analysis is the study of the relationship between a series set of elements (individuals, groups, organizations, countries and even events). Unlike traditional tests that explain, for example, the behavior in terms of social class and occupation, the analysis of social networks focuses on relationships rather than on the attributes of the elements" [11, p. 13].

The main elements of SNA are nodes, links and flows. Unlike other approaches, SNA aims to study the relationships among the nodes and their relational properties. As [12] stated, "conventional" social science data consist of a rectangular array of measurements. The rows of the array are the cases, subjects or observations. The columns are the scores (either quantitative or qualitative) on attributes, variables or measures.

It is possible to find SNA applications in knowledge networks [13] and in supply chains [14] since it evolves sharing tacit and explicit knowledge (experiences, emotions, past actions, values etc.) from one participant (actor) to another. The relationships established between these can be captured and analyzed using software packages like Ucinet, NetDraw, Anthropac, Classroom Sociometrics software, Fatcat, Java for Social Networks, MultiNet. The most used one is Ucinet with NetDraw tool which can also identify different performance indicators that aim to measure the social network performance at three levels or dimensions: rank, degree of intermediation (betweeness) and proximity. The rank is the number of direct ties of an actor (or node), ie how many other nodes are directly connected. It practically highlights the number of actors / persons / nodes that may gain knowledge from the same point (node). The degree of intermediation indicates how often a node appears in the shortest (or geodesic) section that connects two others. Last but not least, the proximity indicates how close is a node to the rest of the network, representing its ability to reach others. These three performance indicators are the ones that are generally used when applying SNA analysis and, more concretively, Ucinet.

From a performance measurement and management point of view, the indicators on which SNA concentrates offer valuable information about the efficiency of the knowledge flow and also on its structure. For example, it brings forward who is the best node to reach others. Based on these assumptions, we argue that these indicators can be used as starting point in order to collect data regarding the process of knowledge exchange through social networks.

3. Social networks from a performance management perspective

There are different working levels and components within each level of the inter-social knowledge network environment, as Figure 1 illustrates. Therefore, it is possible to observe individual organisations that share not only information but also knowledge at both intra and the inter-organisational level. Figure 1 represents these through the relationships established between F (Focal organisation of the network) and its different suppliers (S1, S2 and S3). Intra-organisational information and knowledge sharing within the boundaries of each organisation and how this is measured and managed is not going to be further discussed in this work. What it is important at the intra-organisational level, in order to link it later with other components involved in knowledge exchange inside a social network and also with organisation's performance, is the Performance Elements based on which the individual organisations have already decided to measure and manage performance; i.e. strategic objectives, key performance indicators, etc.

If we focus on social network inter-organisational knowledge sharing processes, then we notice that these are measured by mean of the earlier presented Knowledge Exchange Indicators (KEIs); i.e. KEI_{F-S1} measure different and important knowledge exchange features such as rank, betweeness and proximity between F and S1. Besides, at the inter-organisational level the members of a certain supply chain might have defined some performance elements as well in order to better manage the chain and make better decisions.

Synthesizing, looking out of the inter-social knowledge network environment and regardless of the industry, there are external events that cannot be fully (or even remotely well) predicted. These external events are without doubt impacting over both the supply chain and the individual's performance. For instance, in the insurance sector it is mandatory to daily monitor current and future weather forecasting as it directly impacts over a rather big part of their business performance. Even though it is difficult, quite complete quantitative models have been developed and are in use in order to link together external events (such as weather developments) and organisation's decisions and ways of action. The former would be the cause and the latter the effect variables.
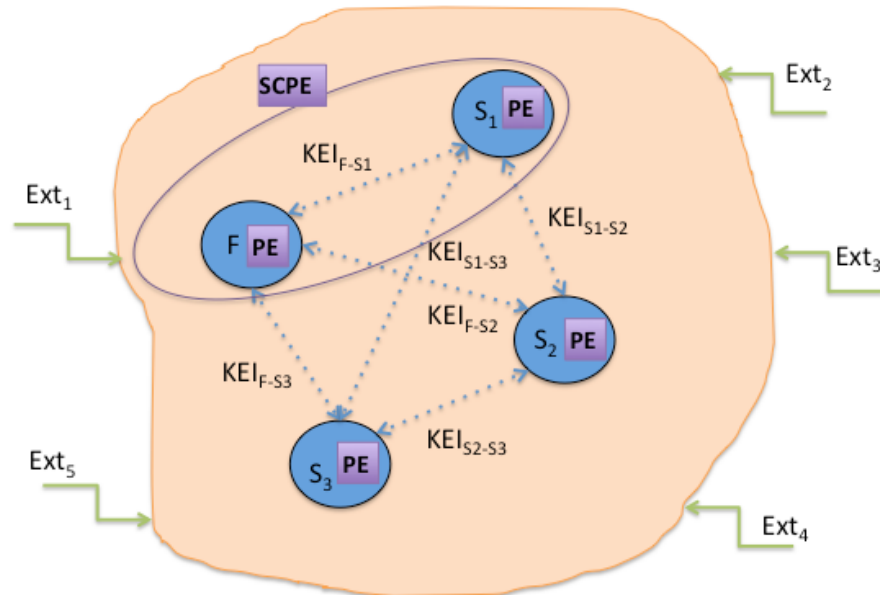
Figure 1.- Social knowledge network from a performance management perspective

As it can be concluded from the above, there are different possibilities and realities within a social knowledge network from a performance management point of view and, extensively, from a decision-making approach. Figure 2 brings together the main actors of the social knowledge network (internal and external), the social knowledge network exchange elements (KEIs and social knowledge strategic objectives, KSO) and also the performance elements developed (strategic objectives and key performance indicators).
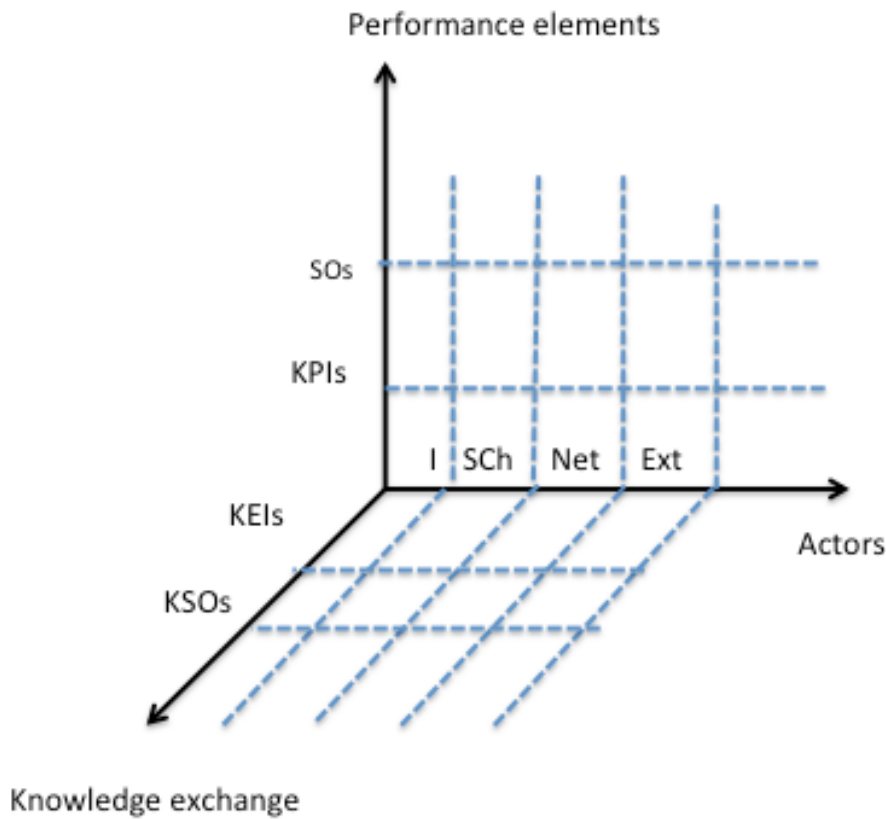
Figure 2.- Social Knowledge Network dimensions from a performance management perspective

If this tri-dimensional figure (Figure 2) is analyzed, a concrete social knowledge network may be defined from a performance management point of view. It actually takes into account its current members and their position based on their social media knowledge exchange decision-making capabilities. On the one hand, the main Actors taken into consideration are the individual companies (I), Supply Chain (SCh), Network (Net) and External events (Ext). On the other hand, the Performance Elements to be taken into account are represented by the key performance indicators (KPIs) and strategic objectives (SOs). It must be pointed out that these performance elements are the ones that the different actors might have established following a classic approach like Balanced Scorecard.

Just like the Performance Elements, the Knowledge Exchange dimension also focuses on key performance indicators (KEIs) and strategic objectives (KSOs). The main difference is that these KPIs are the KEIs (Knowledge Exchange Indicators) are dynamic and general accepted namely, rank, proximity and betweeness. Additionally, these SOs are the above-mentioned KSO (social knowledge strategic objectives).

It must be mentioned that classifying the elements defining the social knowledge network is crucial. Based on Figure 2, these will determine the position occupied by this social knowledge network. Starting from this, it would be easier to define a future desired position within this Figure and also the actions that must be taken in order to successfully achieve an aimed position. Besides, it would be better and easier, from a Performance Management point of view, to define performance elements, knowledge exchange knowledge elements and even to link organisational performance and social network knowledge exchange processes. For doing so, different quantitative and qualitative techniques are available. These techniques are reviewed and categorised in the next section of the article.

4. Suitable techniques

Regarding the techniques that could be used, it is important to bear in mind that these can be either objective or subjective ones. When possible, objective techniques are advised to be used, as they reduce to the minimum expression the subjectivity degree.

If we want to move the location of a certain social knowledge network classified within the Figure 2, the most appropriate technique will be the so called Data Envelopment Analysis (DEA). DEA is a quantitative technique that, based on the calculation of a frontier value, provides the values associated to the new position that must be reached in the three axes of Figure 2. DEA is a quantitative and objective technique that can be applied once that the initial parameters have been defined and it needs no subjective judgement from decision-makers/users. For instance, if a social knowledge network is classified, according to the axes of Figure 2 as follows:
- Axis X: Supply chain.
- Axis Y: SOs.
- Axis Z: KPIs (KEIs).

This means that this particular supply chain has developed some strategic objectives (and probably associated key performance indicators), and have also

developed/applied some KEIs. If this supply chain aims to define some KSOs, it should take into account not only its KEIs but also its own KPIs and SOs in order to make sure that the aimed KSOs are aligned with them. This seems logical, and DEA is, at first sight, of not much value. However, when there are many points (actors of the same social knowledge network) to be managed at the same time, which might have contradictory individual objectives, it might be necessary to find a global solution for all these members. By applying DEA, with the initial data being introduced, it will output a global point to be reached within the Figure 2 that will be the location for such a social knowledge network. Once this global point has been worked out, the individual actors of the social knowledge network (individual organisations, supply chains and the network entity itself) will know what values they must individually reach in order that the global social knowledge network is able to reach this point. It is necessary to bear in mind that, from a performance management point of view, organisations have their own individual strategic elements (especially strategic objectives), which are contradictories with the ones defined at higher levels (supply chain/network). A consensus must then be reached and negotiation tasks carry out. With the application of DEA it is possible to offer a guideline to be used in these processes.

Additionally, when dealing with external events, it will be necessary to apply further techniques that correlate possible/probable external events and their impact over the other actors (individual organisations, supply chain, network levels). The most adequate techniques are the so-called Partial Least Squares (PLS), which overcome the co-linearity problems and offer good results.

If it is aimed to link organisational performance and social network knowledge exchange, it will be necessary to look again at the classification of the network within the Figure 2. This link is not easy to be carried out and it is possible to apply both subjective and objective techniques.

When applying subjective techniques, it is necessary to question people what it is the link between organisational performance and social network knowledge exchange. In other words, to what extent they think that the resources invested in measuring social network knowledge exchange and the associated generated knowledge is affecting the organisational performance. At this point, different techniques might be applied MCDA being the most indicated ones. MCDA can be broken down into different categories, being the hierarchical techniques the most appropriate ones in our context. Applying the AHP (Analytic Hierarchical Process) will provide a network in which it will be possible to link together different elements defined within such a network. However, the AHP presents several problems:

rigidity, rank-reversal problem, etc. These problems make the AHP a suitable technique but not the most adequate one, especially if we want to remake the network and change the associated criteria. Then, the ANP is a technique that overcome these problems, as it is easily reconfigurable, refers to a specific variable regarding the impact of other two variables and it does not need to define any sort of hierarchical network. Therefore, the ANP gathers, by means of questionnaires, the opinion of experts and decision-makers about how important a variable respect to another is in order to achieve a third one. In our case, the application of ANP should highlight, in general, how important are, in order to achieve the defined organisational strategic objectives, the generation and measurement of social network knowledge exchange.

If objective techniques are used in order to to link organisational performance and social network knowledge exchange, historical data is needed. In our case, the data will be collected and stored by the key performance indicators (both KPIs and KEIs). Once that an adequate historical of data is available, different multivariate techniques could be applied to explore and find the existing relationships between KPIs and KEIs and, extensively, between the organisation's strategic objectives and social network knowledge exchange. The most adequate statistical technique are the Principal Component Analysis (PCA) and the Factorial Analysis (FA).

Once these techniques have been applied, if significant relationships between the KPIs and the KEIs have been found, it will be necessary to project them towards strategic levels (the SOs and the KSOs). It will be normal if no KSOs have been defined, as it is difficult to do so and, up to know, it is difficult to quantify the payback coming from defining such KSOs. In this particular case, and taking advantage of the discovering of causal relationships between organisational performance and social network knowledge exchange (via the relationships between KPIs and KSOs), decision-makers could define the KSOs for the specific network, following then a bottom-up approach. The process usually follows a top-down approach (first defining strategic objectives and then associated KPIs) but in this particular case, it seems a logical and suitable approach the bottom-up.

In any case, it is necessary to take into account that measuring and, extensively, managing organisational performance, social network knowledge exchange and the link between them is a difficult task, which must still be further developed and contrasted with empirical applications.

4. Conclusions

On the one hand, this paper has explored the components and social knowledge network working levels from a performance management perspective. It has also brought forward the main suitable techniques to link social network knowledge exchange and organisational performance.

It has been stated that there are three main dimensions regarding Social Knowledge Network from a performance management perspective: Actors (individual companies, Supply Chain, Network and External events), Performance Elements (key performance indicators and strategic objectives) and Knowledge Exchange (knowledge exchange indicators and knowledge strategic objectives). Any social knowledge network can be classified and located within this tri-dimensional approach. If a social knowledge network aims to move and change its location, it may apply the Data Envelop Analysis Technique. This is a quantitative and objective technique and it outcomes the values to be reached by all the members of the social knowledge network in order to achieve the desired new location.

On the other hand, the paper has explored and presented the most adequate techniques in order to link social network knowledge exchange and organisational performance. To this extent, and if there is enough real data stored by means of performance indicators of the two related dimensions (knowledge exchange and performance elements), it is advised to apply either Principal Component Analysis or Factor Analysis. The relationships identified will directly allow to link at the operative/tactical level, represented by the performance indicators, both social network knowledge exchange and organisational performance. Projection of these relationships towards the strategic levels will provide the link between strategic objectives and knowledge exchange strategic objectives. If subjective techniques are going to be used, the Analytic Network Process is the most appropriate technique, as it is powerful enough to both identify relationships between social network knowledge exchange and organisational performance and to be reconfigured when changes in either the criteria or the network take place.

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References

[1] Ing-Long, W., Cheng-Hung, C., Chien-Hua, H.: Information sharing and collaborative behaviors in enabling supply chain performance: A social exchange perspective. International Journal of Production Economics 148, 122-132 (2014).

[2] Kyung Kyu, K., Narayan, S.U., Joo Young, K., Fred, A., Beomsoo, K.: Knowledge complementarity and knowledge exchange in supply channel relationships. International Journal of Information Management 32 (1), 35-49 (2012).

[3] Verdecho, M-J., Alfaro-Saiz, J.J., Rodríguez-Rodríguez, R., Ortiz Bas. A.: A multi-criteria approach for managing inter-enterprise collaborative relationships. Omega 40, 249-263 (2012).

[4] Boj Viudez, J.J., Rodríguez-Rodríguez, R., Alfaro-Saiz, J.J.: An ANP-multi-criteria-based methodology to link intangible assets and organizational performance in a Balanced Scorecard context. Decision Support Systems 68, 98-110 (2014).

[5] Kaplan, R.S., Norton, D.P.: The balanced scorecard — measures that drive performance, Harvard Business Review 70 (1), 71–79 (1992).

[6] Kaplan, R.S., Norton, D.P.: Strategy Maps: Converting Intangible Assets into Tangible Outcomes. Harvard Business School Press, Boston, MA, (2004).

[7] Andriessen, D.: Intellectual capital valuation and measurement: classifying the stateof-the-art. Journal of Intellectual Capital 5 (2), 230–242 (2004).

[8] Bukh, P., Johansen, M., Mouritsen, J.: Multiple integrated performance management systems: intellectual capital and balanced scorecard in a software company. Singapore Management Review 24 (3), 21–33 (2002).

[9] Butler, A., Letza, S.R., Neale, B.: Linking the balanced scorecard to strategy. Long Range Planning 30 (2), 242–253 (1997).

[10] Saaty, T.L.: The Analytic Network Process: Decision Making with Dependence and Feedback, RWS Publications, Pittsburgh, PA, (1996).

[11] Molina, J.L.: The analysis of social networks. An introduction. Barcelona: Bellaterra Edicions, (2001).

[12] Hanneman, R. A., Introduction to the methods of social network analysis. Department of Sociology, University of California Riverside. (2007).

[13] Ramírez-Pasillas, M.: International trade fairs as amplifiers of permanent and temporary proximities in clusters. Entrepreneurship and Regional Development, 22(2), 155-187 (2010).

[14] Capó, J., Morales, X.M.: The role of universities in making industrial districts more dynamic. Higher Education 65 (4), 417-435 (2013).