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The role of causal maps in intellectual capital measurement and management

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Abstract

Purpose – The purpose of this paper is to investigate the measurement and the management of the dynamic aspects of intellectual capital through the use of causal mapping.

Design/methodology/approach – The study details the methods utilized in a single in-depth case study of a network-based business model

Findings – This paper illustrates how causal mapping can be used to understand how intellectual capital really works in the specific business context in which it is deployed. Moreover, exploiting the causal map as a platform for detracting a set of indicators can provide information on the length of the lag and the persistence of the effects of managerial actions. In addition, it can signal when and how to refine and update the causal map. The combination of these factors supports the dynamic measurement and management of intellectual capital.

Research limitations/implications – The paper presented has two main limitations. Firstly, the use of a single case study to provide in-depth and rich data limits the generalizability of the observations. Secondly, the proposed approach has not been implemented in practice. Future research opportunities include interventionist-type case studies that put the causal mapping approach into practice.

Practical implications – The paper highlights the need to build causal maps to enhance the measurement and management of intellectual capital, which is dynamic of nature. As a consequence, this tool can be useful for companies to monitor their intangibles and to better understand the contribution of their intellectual capital to the value creation process.

Originality/value – The paper openly questions the measurement of the fluid and dynamic aspects of intellectual capital. It proposes a tool in order to govern these aspects and it suggests that also the existing intellectual capital measurement systems can improve their usefulness by including these dimensions. So a shift in intellectual capital measurement is prescribed.

Keywords intellectual capital dynamism, measurement, causal maps, network-based businesses

Paper type Case study

1. Introduction

This paper investigates possibilities for creating more dynamic modes of measurement and management of intellectual capital performance. Several authors have recently argued that intellectual capital is an intensely complex web of company specific knowledge resources (cf. Dumay, 2009a; Dumay & Cuganesan, 2011). Because intellectual capital is a fluid and dynamic phenomenon, its complexity and ambiguity has to be analyzed in the specific company in which it is applied. Thereby, the objectives of this paper answers the call for ostensive research made by Mouritsen (2006) and more recently repeated by Guthrie *et al.* (2012).

The implication that the research above puts forth is that measuring and managing intellectual capital dynamism is essential for managers in order to govern the value creation process of their companies and the networks in which they are encompassed. However, the intellectual capital measurement systems (ICMS's) of today have been criticized for not fully being able to explain the value creation process triggered by intangibles (Mouritsen, 2006; O'Donnell, 2006; Dumay, 2009a). Intangible resources in existing ICMS's are extracted from the context in which they work and are then measured "on hold", not "in action" (cf. Chiucchi 2013). Hence, the dynamic aspects of intellectual capital are not fully measured and managed. Since the state of the art in this research area is still unable to provide exhaustive answers, we need further steps aimed at understanding which types of tools are suitable in order to dominate the real nature of intellectual capital, i.e. its complex and dynamic aspects. From this perspective, causal maps can help to fill this gap.

Specifically, this paper presents the case study of a network of companies that are working with developing and utilizing location data of mobile phones for commercial purposes. The aim of this paper is as such to represent the relations among the intellectual capital elements activated by companies in the network through a causal map. This visualization makes the dynamic aspects of intellectual capital accessible to managers, thereby enabling a more effective managerial intervention. The second aim of the paper is to explore how the causal map can be applied as a platform for detracting indicators thus supporting the measurement and the management of intellectual capital dynamism. The paper makes a contribution to the extant literature on the intellectual capital measurement by showing how to obtain additional information on the intellectual capital dynamism in order to improve its management and, as a consequence, its contribution to value creation.

The structure of the remainder of the paper is as follows: In section 2 we discuss the evolution of the concept of intellectual capital and the measurement hereof and also describe the causal mapping tool and its application to intellectual capital visualization. Section 3 describes the features of the case study network, called the Gemini network, while section 4 presents the methodology used to collect and to analyze the data on which the causal map is built. Section 5 discusses the findings of the paper and section 6 concludes the paper by presenting the main implications of the discussion for the dynamic measurement and the management of intellectual capital.

2. Intellectual Capital measurement and management

The concept of intellectual capital is closely related to the creation, sharing and management of knowledge within companies (Mouritsen *et al.*, 2005; Guthrie *et al.* 2012). Especially in the early stages of research concerning intellectual capital, many definitions and classifications associated have been proposed for understanding what it is and where it is located within the company (Catasús & Chaminade, 2007). Already in 1997, Edvinsson (1997) defined intellectual capital as "the possession of knowledge, applied experience, organizational technology, customer relationships and professional skills that provide […] a competitive

edge in the market". In the Danish Guideline for Intellectual Capital Statements (Mouritsen *et al.* 2003) the concepts of intellectual capital and knowledge management are intertwined as these intrinsic aspects are given a body from which management can be conducted (see also Mouritsen & Larsen 2005). Here intellectual capital is considered as a phenomenon that allows the "activation" of intangible resources, i.e. the knowledge resources connected to employees, customers, technologies and processes.

There is currently a broad consensus on the classification that identifies the following three categories within the intellectual capital: human capital, organizational capital and relational capital (Bjurström & Roberts 2007, Guthrie *et al.* 2012). However, attention has gradually shifted from categories to the dynamic aspects and multifaceted nature of intellectual capital (Kianto 2007), because these intellectual capital subcategories cannot be rigidly separated in a meaningful manner (Nielsen & Dane-Nielsen 2010). According to (Mouritsen 2006), it is not possible to identify a priori the features and functions of a company's intellectual capital because they depend on the original combination that is set up in the specific company context. Moreover, the relations among the intellectual capital elements are not stable; they do not always display the same features and they may even cease to exist or change intensity, direction and nature over time. Hence, the relations among intellectual capital elements are often fragile, ambiguous or merely potential.

During the measurement process, the different elements that give life to intellectual capital have to be identified, i.e. the intangible resources, the interactions among them and with the value creation. It is with reference to all these aspects that the measurement takes place. Indicators should be consistent with the mobilization of the resources aimed at achieving targets and financial success (Grasenick & Low 2004) and the choice of indicators to be associated with specific elements is not easy. Therefore, there's the risk of designing indicators that represent only partially the elements that make up the complex web of intellectual capital. The need to combine financial and non-financial indicators derives from the inability of the latter to adequately represent the complex web of intangible resources. The financial measures are symptomatic: they measure only the final outcomes, not allowing for the identification of the causes that generate the results (Kaplan and Norton, 1996). Eccles (1991) among others argues that using non-financial measures allows us to capture the causes of the company's success. In a sense, leading indicators "drive" the performance of lagging indicators (Eccles, 1991).

The measurement of intellectual capital for internal management purposes ensures the availability of information in order to support and guide decision-making process towards the value creation through an efficient and effective management of intellectual capital (Sveiby 1997, PAGE NUMBER). In particular, the measurement process should be mainly focused on the relations among the intangible assets that make up the complex system of intellectual capital, i.e. the real source of the value creation. This perspective would capture the dynamic nature of the phenomenon under investigation, allowing the managers to monitor the way in which the actions on intellectual capital contribute to the overall corporate performance. Thus, the measurement for internal management purposes produces knowledge on intellectual capital. It is not a mere representation of the past, but it allows for the identification of problems and risks in the present. Moreover, information attained from measures can be considered as a stimulus to make changes in the future, creating goals and weighing alternative courses of action (Mouritsen, 2004; Chiucchi, 2008). This entails that measurement and management are closely related terms.

Over the past 15 years, academics and practitioners have developed definitions, measures and frameworks, however, the use of static modes of intellectual capital measurement does not fit with the real essence of intellectual capital. A growing number of contributions have argued that the existing frameworks for

intellectual capital measurement are not able to fully explain the value creation process triggered by intangible resources (O'Donnell *et al.* 2006, Dumay & Cuganesan 2011). The relationships among intangible resources, among them and the value creation are not explicitly handled in the ICMS's, which have been proposed so far. Most of them are based on categories that have been identified as one of the main problems for intellectual capital measurement (Bjurström & Roberts, 2007; Mouritsen, 2009). In fact, categories create separations: intangible resources are mainly extracted from the context in which they are deployed and then they are measured "on hold", not "in action". In this way, categories hinder the full consideration of the dynamic aspects of intellectual capital.

2.1. Causal mapping: a tool to visualize and measure intellectual capital

Intellectual capital dynamism is here seen from the perspective of the individual, not only in terms of skills, experiences and competences, but also in terms of values, motivations, feelings and behavior (Jankowicz, 2001). These cognitive aspects affect the relationships among individuals and, as a consequence also the intellectual capital dynamics and the value creation process. Actors inside companies have many – often varying – aspirations, values and interests, which inherently complicates their coexistence and cooperation. As such, the relevance of these facets has been recognised not only in the field of psychology, but also in the fields of management, strategy and organization (see Narayanan & Armstrong 2005 for an exhaustive review).

Analyzing the mental models through which individuals filter information and make decisions (cf. Weick 1977) may prove to be a good platform for understanding the value creation process and the contribution of intellectual capital dynamism. Hence the knowledge on the way in which intellectual capital works in a specific operational context is stored in the mind of the actors who apply it every day. Therefore, gaining access to this knowledge can potentially provide an understanding of how intellectual capital is really used. Cognitive maps have the potential to facilitate this task, by making explicit individuals' knowledge of the way in which the company generates value. This tool can be defined as "a graphic representation that provides a frame of reference and locate people in relation to their information environments" (Fiol & Huff 1992, 267). In other words, cognitive maps are used to elicit the content of people's mental models.

There are different kinds of cognitive maps (Huff, 1990), but for the aim of this paper one typology appears particularly suitable, namely the causal map (Axelrod, 1976). This tool is a network of nodes and arrows, where the direction of the arrows means believed causality (Fiol & Huff 1992, Langfield-Smith 1992, Eden 2004, Montibeller & Belton 2006). It elicits the causal structure of the individuals' thought, highlighting the variables which influence the decision making process inside companies and organizations (Hodgkinson *et al.* 2004). Making this structure more visible means to identify the relationships among key actors and key knowledge, understanding how individuals perceive the stream of events.

In a sense, causal maps can be compared to geographical maps: following a certain "itinerary", made up of decisions and actions, can lead to a particular "destination", that is, the achievement of certain targets. This is a precondition to understand the reasons behind actors' behaviors as well as to identify alternative courses of actions. Causal maps are very suitable for analyzing context-dependent and dynamic phenomenon (Ambrosini and Bowman, 2002), as intellectual capital is. Its elements, in fact, find their meaning according to the relationships they develop with each other and with the other variables of the specific business context in which they are used (vision, mission, strategy, management challenges). Moreover, causal maps have the potential to clarify complex and ambiguous phenomenon. They can be

considered as ”a way of ordering and analysing something that is «fuzzy»” (Ambrosini and Bowman, 2002: p. 22) and they ”can facilitate organizational activities by simplifying inevitably complex domains” (Huff and Jenkins, 2002: p. 14). As highlighted above, intangible resources have several opportunities to develop and relationships can change direction or intensity over time. So effects of managerial actions are uncertain. Causal maps can clarify which intellectual capital elements and which relationships can potentially generate non-linear events or emergent properties. Visualizing multiple explanations and identifying potential problems is very relevant for an aware management of intellectual capital.

The features of causal maps match with the needs arisen in relation to the intellectual capital nature that is, on the one hand, to bring to the surface the way in which actors use the elements of intellectual capital and, on the other hand, to capture the dynamic dimension of intellectual capital, i.e. to understand which are the flows that connect together its elements in order to allow an adequate representation of them. The visualization of these aspects allows the managers to comprehend how the intellectual capital really works in its operational context as well as to realize how intangible resources are linked to value creation. So the action-oriented nature of causal mapping (Fiol & Huff 1992) can support the visualization of intellectual capital “in action” by creating knowledge about the relationships between managerial actions on intangibles and the impact on value creation. The information content of the causal map can considerably increase if it is used as platform to create an appropriate of key performance indicators to measure intellectual capital. However, some attempts to represent intellectual capital through visualization techniques have been made by previous contribution. These attempts are discussed in the next section.

2.2. Visualization techniques and intellectual capital measurement

In the field management accounting, the relevance of visualization techniques (the so-called strategy maps) is well-acknowledged. This is largely due to the development of multi-dimensional performance measurement systems and, in particular, of the Balanced Scorecard (Kaplan and Norton, 1992, 1996). In these multi-dimensional performance measurement systems, the measurement process is closely related to the management process (Ittner & Larcker, 2003). Nevertheless, Kaplan and Norton have proposed a tool specifically aimed at measuring and affecting the company’s strategy as a whole, namely strategy maps (Kaplan & Norton, 2001, 2008). Strategy maps, therefore, are not intended to measure and govern the whole intangible “legacy” of the company, but only the improvement in specific areas considered critical for strategic purposes, i.e. the intangible elements contained in the customer perspective, process perspective and in the learning and growth perspective. In this way, strategy maps may undervalue the relevance of other intangible elements that can potentially affect the competitive success of the company, like the relationships with other stakeholders (e.g.: suppliers). Despite a growing tendency, the use of these techniques is not so well-established In the field of intellectual capital.

Unlike the strategy maps, the contribution of Fernström *et al.* (2004) explicitly focuses on intangible asset interactions that take place in the R&D department of a pharmaceutical company. As such the map does not concern the business strategy as a whole, but a specific value creation process of the company. The aim of Fernström *et al.*’s study is to understand the role of the R&D department in meeting the company’s objectives. Through workshops and individual interviews, the authors are able to identify the bundle of resources (human, organizational, relational, physical and monetary) at the company’s disposal as well as the relationships among them. The authors stress the usefulness of the map in highlighting the efficiency and the effectiveness with which the resources are deployed as well as the deficiencies and malfunctions which can affect the value creation process of the company. As a consequence, the map is a relevant tool to identify areas of improvement, potential actions and alternatives. Even if measurement was not one of

the aims of the project, the authors state that the map helps to identify a set of indicators useful to measure the company's progress in fulfilling its strategic goals. In particular, the map allows identifying the relevant resources to be measured, supporting the selection of indicators and improving, as a consequence, the selectiveness of the measurement system.

Marr *et al.*'s (2004) study is similar to that of Fernström *et al.* (2004), because it contributes by producing an IC-map of a specific activity in a company, here in the form of a new product development department in a manufacturing firm. The building procedure of the map is based on a series of semi-structured interviews and focus groups, which involve middle-range managers and team leaders of the process under analysis. The main aim is to take into account the direct relationships between organizational resources and strategic objectives as well as the indirect relationships between organizational resources. Different arrow sizes are used to express the strength of the relationships according to participants' perceptions. From a measurement perspective, Marr *et al.* (2004) match the map only with two indicators relating to the process performance (time to prototype a new model and the number of iterations between design and production). The improvement of these indicators is supposed to generate a positive effect on time-to-market, which is argued by management to be one of the most relevant generators of success for the company. These indicators are not extracted from the map, but are already present in the performance measurement system of the company.

As the case with the present paper, a dynamic approach to intellectual capital measurement too is the foundation of Cuganesan's (2005) mapwhich is based on a case study of an Australian financial services company involved in the creation of software for customers. In particular, an "initial" map is built by the subjects participating in the project before the launch of the new software. This map contains the hypothesized relations among the intangible assets involved in the project and the related impacts on company performance (in terms of reduced costs, increased customer retention and improved profitability). After the software introduction, the subjects are asked to build another map. This new map does not coincide with the "initial" map, and as such the actual relationships among intellectual capital elements and the value creation are strinkingly different from the ones identified in the first map. Moreover, the final map shows multidirectional and complex relationships, while only linear relationships were originally assumed in the "initial" map. Performance measurement?

These issues are further explored in a paper by Cuganesan & Dumay (2009), whose objective is to visualize the relationships among intangible assets to managers. Compared to Cuganesan (2005), the building process of the map is analyzed in greater depth. Through a series of interviews with the managers and employees of a company in the Australian financial sector and using a software-based analysis solution, the authors extract a number of factors related to intellectual capital as well as the links among them. This leads to the development of two maps. The first one relates to the process of creating value for the company, while the second one concerns the value creation process for the customer. So the particularity of this contribution consists in adopting a double "perspective": i.e. the perspective of the company and the perspective of the customer. In fact, the combined analysis of these two maps shows that they are linked to each other, forming, as a consequence, two sides of the same coin. Performance measurement?

In the fifth paper of this section, Jhunjhunwala (2009) highlights the relevance of discovering the network of interrelated intangible assets for understanding the value creation process of a company. In particular, the author proposes three generic maps for the hotel industry, the software industry and the pharmaceutical industry. These models visually represent the key intangible variables as well as their interrelations, both of which would have to be managed in order to increase the overall value creation. For

example, for the hotel industry, the map identifies value drivers such as the chain brand or the service quality, in terms of reception, restaurant and room service. Moreover, the author proposes to match the graphic representations with a set of indicators in order to validate the cause-effect chain. The aim of this "matching" is to ensure that each intangible asset in the map is performing as desired. However, the proposed indicators are not directly extracted from the map. Rather, they are generic intellectual capital indicators. This entails that their applicability to single companies may be limited because they are not "tailored" for specific needs and features.

Although the studies analyzed above are heterogeneous in terms of features and building processes, a common denominator can be identified in their purposes. All of the maps are constructed for the sake of improving the management of tangible and intangible value drivers and tangible assets, increasing, as a consequence, the value creation related to the company as a whole or to a particular process or function. However, all of the above mentioned contributions undervalue the extraction of a set of specific indicators from the maps. Despite the fact that they in general suggest the identification of performance measures, they do not fulfill this aspect sufficiently. As a consequence, the usefulness of the map is limited and some of its potentialities are left unexploited. Even when there's an attempt to match some indicators to the maps, as in the contributions of Fernström et al. (2004), Marr et al. (2004) and Jhunjhunwala (2009), the effects of this action for managerial purposes are not fully utilized.

The identification of specific indicators from the causal maps would potentially allow for the measurement of both the static aspect of intellectual capital (the stock of intangible resources at company's disposal) and the dynamic aspect of this phenomenon (the way in which tangible and intangible resources combine with each other in order to generate value), much in line with the arguments put forth in the Danish guideline for ICS (cf. Mouritsen *et al.* 2003, Mouritsen & Larsen 2005). The theoretical contribution of this paper thus rests on the assumption that managers should learn to build and to refine causal maps for visualizing the company's intellectual capital. These maps should be enriched through appropriate indicators that can improve the existing measurement and the management practices of intangibles. These new skills could potentially improve the decision making process about the intellectual capital use in its operational context, avoiding the mere attempt to find a "fit" between the company's intellectual capital and one of the existing measurement frameworks.

3. Description of the case study: the Gemini network

The Gemini network is a network-based business model composed of four companies located in the Northern Jutland region of Denmark. The Gemini network has been a part of the International Centre for Innovation (ICI) project, a five year research project aiming at developing ten new network-based business models and working on improving the globalization potential of them. This particular network is concerned with the use of location data from tracking system which generates information about mobile devices with activated Bluetooth senders, i.e. the information about the geographic location of people at a given point in time. The companies involved in the network aim to use new technologies to develop new products and services to business enterprises and end users who can make use of the data. The data on people's movements is for example potentially useful for shopkeepers, retailers' associations and shopping malls in order to support their marketing.

This network includes four main actors, which we choose to call: Sensor, Engineer, Mall and Union. Sensor is a small and flexible company, which acts as the technology provider of the network. This company owns the technical competences needed to create and improve a technology solution able to track people's

movements. In particular, Sensor produces the Bluetooth units that detect mobile devices in a certain circumference. Engineer is a big and well-known consultancy company that acts as a bridge between Sensor and the customers, i.e. Mall and Union. The main task of this company is to understand the customer's needs through its commercial competences and to convert them into relevant solutions though its technical knowledge. In other words, Engineer has to explain the customers why they need Sensor's solution and to facilitate Sensor to put more intelligence in the system in order to meet the needs of the customers. From the perspective of Sensor and Engineer, creating value means attaining revenues from the Bluetooth units and from the consulting hours sold to support and maintain the system.

Mall is a shopping center, which has been test-pilot for the tracking system. In particular, the center manager would like to know how long people stay in the shopping center, how they move around the shopping center, how they get to the shopping center and where they walk to afterwards. This kind of information can improve the managers' decisions on advertising, staffing, shop location and mixture and leasing contracts, as a consequence increasing the value creation for Mall in terms of number of visitors, time spent by the visitors into the shopping center and shops' turnover (profit). Union is the association of retailers in the city. Union's manager would like to know where people start their shopping trip, how much time they spend in each area of the city and the effects of special events on the number of visitors and the duration of their stay. The availability of this information can provide a much more precise picture of which areas in the city people are visiting, improving the decision making process on events planning and shops location. As in the case of Mall, this improvement can affect Union's value creation process in terms of increasing member satisfaction and funds raised from sponsors (members, local government, companies etc.).

Empirical intellectual capital research focuses mostly on the value creation process of single companies. As such undervaluing the possibility that companies may generate value creation from a business network perspective. A network consists of specific roles and value interactions oriented toward the achievement of a particular task or outcome (Allee, 2008). Even if network analysis is becoming more and more important in intellectual capital research, only few studies have contemplated how the intangible resources of companies interact to create value for the whole network (Green, 2006; Andreou and Bontis, 2007; Allee, 2008; Solitander and Tidström, 2010; Peng, 2011). As such, the Gemini network studied poses an extremely interesting case because the interactions among the composing companies are very tightly knit. The existing knowledge resources and the relationships among them are fundamental for the development of the network itself. Sensor and Engineer are knowledge-intensive companies and their technical and commercial competences can enable the value creation for the whole network. The synergy between these companies is very strong: together they can reach collective goals they cannot achieve on their own. On the one hand, good relationships with customers are established through Engineer's reputation and image. This allows Sensor to access new customers and to further develop its business. On the other hand, Sensor is able to provide high quality solutions, which can satisfy the customers' needs. Engineer is aware that would be difficult to look for other companies delivering the same technology. As a consequence, aligning tangible and intangible resources of the single companies to meet the customers' expectations and understanding their contribution to the value creation of the whole network is essential for feeding the network itself. So measuring and managing intellectual capital activated in the network and its dynamism should be a priority for the companies involved.

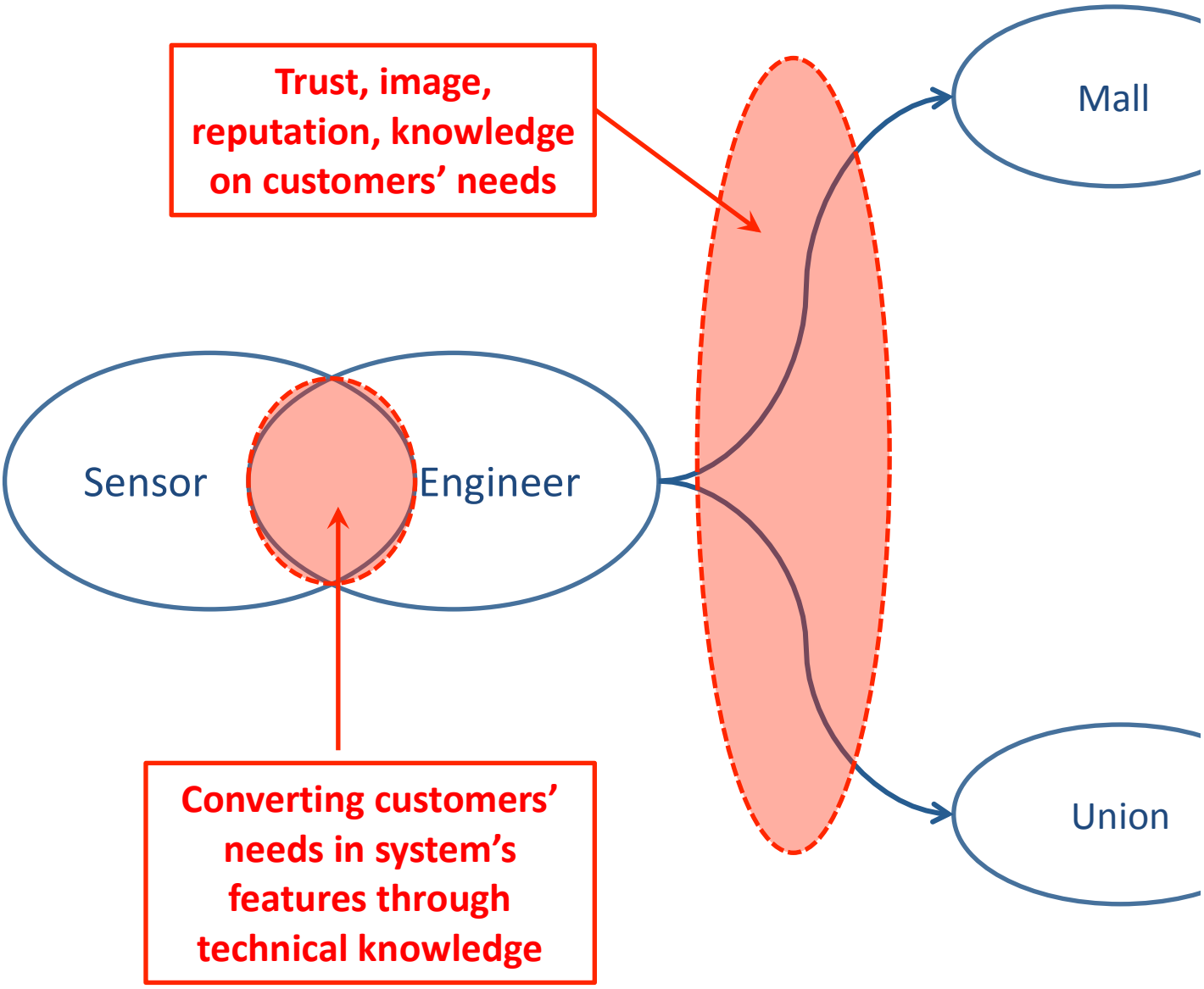

Figure 1 – The companies involved in the Gemini network

4. Methodology

The complex nature of intellectual capital makes the use of the case study research particularly suitable (Mouritsen 2006). This method, in fact, allows realizing a holistic and deep investigation of a complex phenomenon in the real-life context in which it takes place, especially when it is not possible, or even desirable, as in this case, to separate the phenomenon from the context (Yin, 2002; Lukka, 2005; Chiucchi, 2009). Through case study research, the researcher can directly observe the phenomenon investigated and come into direct contact with those who take part to the phenomenon. Moreover, the choice of a single case makes it possible to increase the in-depth nature of the analysis by getting a richer and thicker understanding of the phenomenon and the context.

4.1. Data collection and analysis

The building process of a causal map aims at eliciting mental models triggered by actors in certain situations. The nature of these models is mainly implicit because they are deep-seated in individuals (Fiol &

Huff 1992). The conversion from implicit to explicit is a very hard task because the concepts and the relationships are difficult to stimulate and communicate so that the individuals themselves consider the explanation of their decision rules particularly critical (Ambrosini & Bowman 2001). In management and organization research, several methods have been proposed in order to build causal maps. These methods differ mainly in two aspects: the technique used to elicit the cognitive material and technique used to identify concepts and relationships. Concerning the first aspect, a distinction can be drawn between direct and indirect elicitation procedures (Hodgkinson & Clarkson, 2005), where the indirect procedures use secondary data sources such as texts written by the author, minutes of meetings, reports or other company documents (Fahey and Narayanan, 1989; Fiol, 1989; Barr et al., 1992). In comparison, the direct procedures use primary data sources obtained specifically for the purposes of the research. The use of this data collection procedure allows building causal maps that represent the management thinking in a more precise manner than those built from secondary data sources (Eden & Ackermann 1998).

Semi-structured and unstructured interviews are the most widely used by researchers when building managers' causal maps (Eden & Spender 1998). Their high degree of flexibility allows the interviewer to deeply understand the conceptual categories used by the interviewee as well as his/her interpretations of the reality. Moreover, the opportunity to conduct the interview on the basis of the answers given by the interviewee enhances the comprehension of the motivations that drive his/her decisions. Interviewing managers allows them to reflect on the actions that they usually put in place. In this way, the researcher can discover aspects of behavior, which were tacit until that moment. The aim is to gradually uncover deeper and deeper layers of the managers' knowledge. For these reasons, this paper is based on five semi-structured interviews with the main actors of the Gemini network. These interviews were conducted at the individual level because tacit knowledge is typically personal (Polanyi, 1962). For the aim of the paper, the researchers identified 5 relevant themes, which also represented the main sections of the interview guide:

1. The respondent's tasks and company's overall business
2. Causes of organizational success and value drivers
3. Relationships with the main business partners
4. Indicators used for the decision making process
5. Specific information on the location data project

During the interviews the interviewers made sure to ask reflexive questions and to ask for examples along the lines suggested by Kreiner & Mouritsen (2005). Asking for examples, storytelling and anecdotes forces the interviewees to explain what really happens, stimulating them to provide detailed information and triggering, in turn, other stories and thoughts. Through story and language, in fact, individuals give meaning to events that occur and to their actions and they can organize their experience. In this way, it is possible to discover how the value drivers come "into action" in the company under analysis. Regarding the identification of concepts and relationships, Abernethy *et al.* (2005) draw a distinction between three options: computerized discovery of causal links, ethnographic analysis of interview data, interactive mapping by expert participants. The first one relies on qualitative database software in order to code the qualitative data and to detect relations among concepts in the database of interview transcripts. The second one is the traditional method used to analyze qualitative data, i.e. the ethnographic interpretation of the interviews and the interview context. In this way, the researcher can identify the concepts and the relations among them through his/her understanding of the context and by interpreting the perceptions of the interviewees. The third one directly involves the interviewees in the map building process by asking

them to the relations among the concepts detracted from their prior interviews. This option emphasizes the causality experiences of the interviewees so the researcher has just to support them to fulfill this task.

For the sake of this paper, the ethnographic analysis of interview data seemed to be particularly fruitful. One of the researchers, in fact, had a very good knowledge of the companies involved in the network, i.e. the context in which the intellectual capital is deployed. The deep understanding of the context from his current and prior experience helped to identify the relevant concepts as well as to interpret the nature and the intensity of the causal links among them. As intellectual capital is context-specific, the use of this method increases the chance that the causal map reflects the real way in which it is deployed in the network rather than mere associations discovered by software or the partial points of view of single interviewees. However, the chosen method presents also some drawbacks. On the one hand, the researcher runs the risk of giving more weight to confirming facts rather than on disconfirming evidence. As a consequence, he/she could push into the background information that does not conform to his/her interpretation (Nisbett & Ross 1980). On the other hand, building a causal map is a very complex task from a cognitive perspective and this could entail the risk to conduct a partial and incomplete analysis (Abernethy *et al.* 2005).

These drawbacks were sought minimized through the investigator triangulation (Ryan et al., 2002) in order to reduce the biases related to the personal convictions of the researchers and to enable a deeper analysis. All the interviews were transcribed in their full length, and the researchers applied a structural coding approach in the analysis of them (Krippendorff, 1980), through a coding tree reflecting the sections included in the interview guide. After coding the interviews, the researchers drew up a list containing the value drivers considered critical by the interviewees, i.e. the nodes of the map. The data-analysis was initiated by identifying the relations among the nodes and followed by identifying the causality types (positive or negative) among them. Finally, the resultant causal map was used as a platform to detract appropriate indicators oriented to measure the dynamic aspect of the intellectual capital deployed in the network.

5. Analysis and discussion

5.1. Visualizing and understanding the intellectual capital dynamism in the Gemini network

The creation of the causal map permits to visualize the tangible and the intangible flows established in the Gemini network. Figure 2 provides a representation of the map displaying the intellectual capital dynamism in the specific business context in which it is used. The nodes of the map are the value drivers considered relevant by the interviewees, while the arrows identify the relationships among the value drivers. The colors of the arrows describe the nature of the link: green arrows depict the positive relationships, i.e. one value driver positively affects another one; red arrows show the negative links, i.e. one value driver negatively affects another one. Moreover, green and red dotted arrows represent potential positive and negative relations. Analyzing the causal map allows the managers to understand how the intellectual capital really works in the Gemini network. The causal map represents the particular way in which value is generated or destroyed, i.e. it brings out strengths and weaknesses of the network. The map shows that the intellectual capital flows between Engineer and Sensor work quite well. There is a strong synergy because these two companies are highly integrated at both a commercial and a technological level. From the Sensor side, the relationship with Engineer is fundamental for its value creation process.

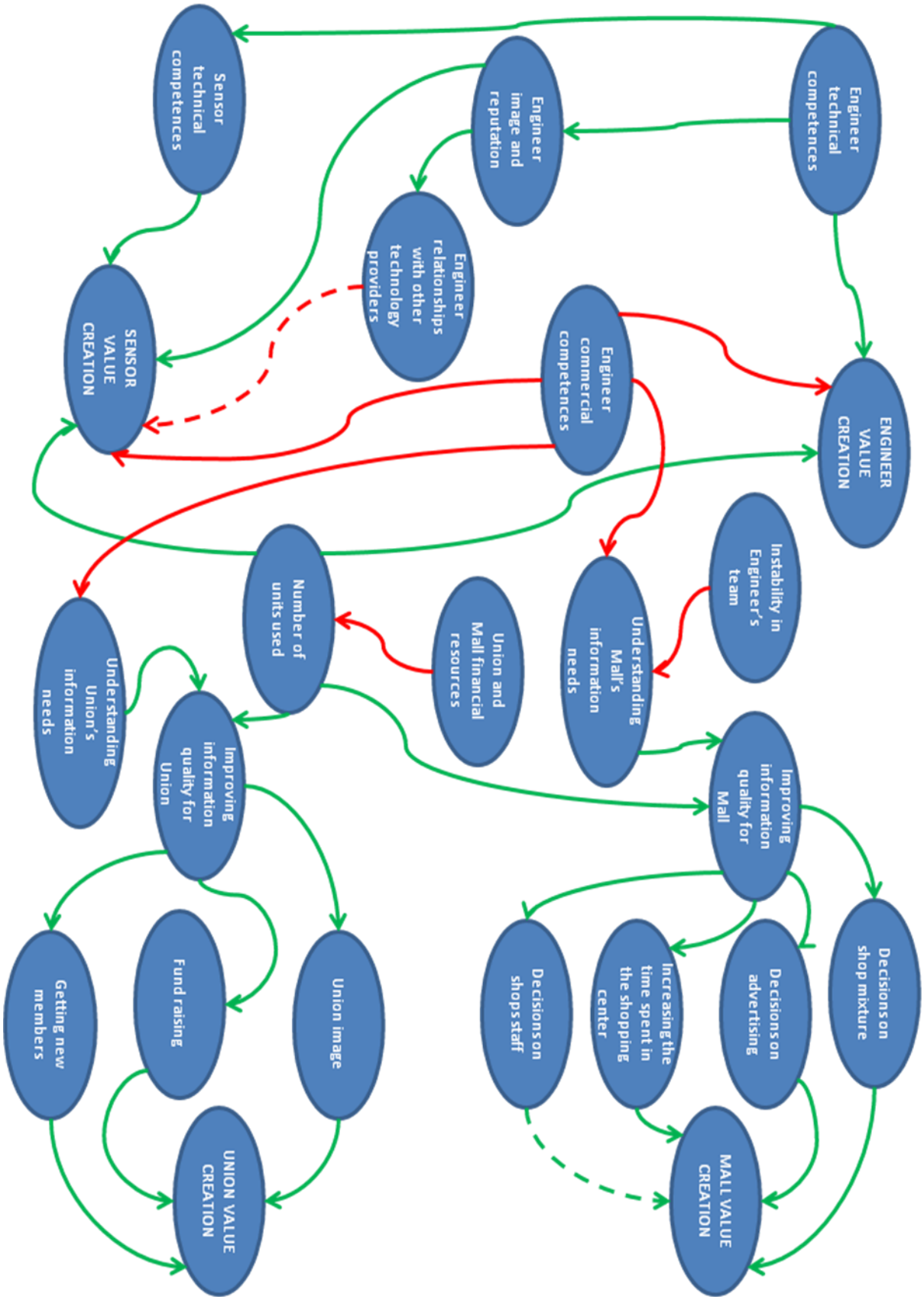

Figure 2 – The causal map of the Gemini network

Through the Gemini network, Sensor is able to access new customers and to further develop its business through the goodwill that Engineer brings into the network in terms of reputation and image. Thereby the exploitation of Engineer's intellectual capital element is profitable for Sensor too, which, otherwise, would be forced to build relationships with the customers from scratch. From the perspective of Engineer, deploying the technical competences of Sensor is very relevant in order to satisfy customer expectations. In particular, the technical knowledge held by Sensor makes it possible to convert customer needs into system features by including a greater degree of intelligence in the solutions. The managers of Engineer are aware that only Sensor's technical solutions have the necessary level of quality to be used in practice. So the intellectual capital interactions between these two companies are very intense, because they both know that the reciprocal exploitation of the respective intellectual capital elements is an advantage for both of them.

The causal map also highlights that the intellectual capital flows among Engineer and the customers do not work properly. Through its commercial competences, Engineer should be able to understand the customers' expectations in terms of information needs. In other words, Engineer should recognize how to improve the information quality for Mall and Union in order to allow Sensor to convert these needs into features in the solution. However, Engineer does not seem to be deploying its commercial competences in the right manner. There seems to be a misalignment between the perspective of Engineer, Mall and Union. The customers perceive the previous meetings with Engineer like sales-meetings rather than a network session focusing on their information needs. As a consequence, Mall and Union are not willing to pay (PAY FOR WHAT?) because they do not still have a clear view of the strengths and weaknesses of the solution being offered. Moreover, the understanding of the customers' information needs is also hindered by the relatively large turnover in the team of Engineer that is in touch with Mall and Union. The team has changed members from time to time and so the clients have noticed that they cannot identify a stable team with which getting a closer and frequent relationship. This problem could also be related to a lack of proper and timely communication between the parties.

In a sense, the commercial competences of Engineer are the weakest point in the network because they are not sufficiently able to show and explain to customers the value added which they can get from Sensor's solutions. As a consequence, this intellectual capital element locks the value creation for the companies involved. The awareness of the strong and weak points provides the managers with the opportunity to maximize the former and minimize the latter. In this way managers can make the network's value creation process less fragile and vulnerable. Moreover, the causal map stresses a potential non-linear effect that could destabilize the network as a whole. Engineer's image and reputation is also relevant in order to build relationships with other technology providers. The flow between these intellectual capital elements can potentially destabilize the entire system. The entrance of a new technology provider and the resulting exclusion of Sensor would mean to redefine all the tangible and intangible value drivers activated in the network as well as the relations among them. The map also shows that the intellectual capital "in action" creates emergent properties, which cannot be traced back to the individual value drivers (cf. Nielsen & Dane-Nielsen 2010). Value creation is thus related to the emergent properties that result from the coupling of the tangible and intangible value drivers, which take place in this particular context, i.e. the Gemini network.

5.2. Measuring the intellectual capital dynamism in the Gemini network

The analysis highlights that the building of a causal map can be very relevant for managers because by identifying problems, risks and opportunities it enables interventions. However, the usefulness of the map

for managerial purposes can increase even further if it is used as a platform for identifying indicators to measure the intellectual capital dynamics. Indicators can potentially reflect the value creation process because they are "tailored" for the specific value drivers and relationships that take place in the network. In particular, the indicators should be coupled to the nodes of the map, i.e. the value drivers. Table 1 contains the set of indicators derived from the causal map. First of all, using the causal map as the foundation upon which to detract a set of indicators improves the selectiveness of the measurement system. The map forces the company to focus only on the critical value drivers and the relationships among them. This makes it possible to provide a moderate number of indicators with high information content, avoiding the risk of focusing the attention of managers on secondary aspects. Moreover, detracting indicators from a causal map provides a balance between lagging measures, typically financial, and leading measures, typically quantitative-physical and qualitative. Lagging indicators are for example suitable for the nodes associated with the value drivers directly linked to the value creation.

Indicators for Sensor	***Indicators for Engineer***	***Indicators for Mall***	***Indicators for Union***
• Investments in R&D • R&D expenses/revenues • R&D expenses/total expenses • Level of technical competences • Revenues from location data project • Average earnings per unit • Men hours sold • Sales from Engineer's customers/total sales • Total revenues/men hours • Total revenues/units sold • Number of units sold to Engineer • Number of meetings with Engineer	• Training expenses • Hours spent for training on the job • Revenues from location data project • Level of commercial competences • Level of technical competences • Number of meetings with Sensor • Average earnings per unit • Men hours sold • Total revenues/men hours • Total revenues/units sold • Team turnover • Mall satisfaction about the location data project • Union satisfaction about the location data project • Number of interactions with Mall • Number of interactions with Union • Time spent at Mall/number of employees involved in the project • Time spent at Union/number of employees involved in the project • Number of days spent to visit Mall • Number of days spent to visit Union • Number of units sold to Mall • Number of units sold to Union • Number of interactions with other technology providers	• Financial resources to invest in the location data project • Number of features satisfied/number of features requested • Variation (increase or decrease) in number of visitors of the shopping center • Variation (increase or decrease) in time spent by visitors in the shopping center • Number of decisions taken with the support of the location data • Savings got from decisions on shops' staff • Turnover • Total amount of leasing contracts/number of tenants	• Financial resources to invest in the location data project • Number of features satisfied/number of features requested • Variation (increase or decrease) in fund raised • Variation (increase or decrease) of members • Members satisfaction about the location data project • Number of decisions taken with the support of location data

Table 1 – The indicators detracted from the causal map

Table 1 contains measures such as revenues from the location data project for Engineer, the average earnings per unit sold for Sensor and Mall's profits. These indicators express the bottom line of the value creation process, i.e. the final effects of the managerial actions. As a consequence, they are oriented to the past and they do not have the ability to measure the current actions. For this reason, the creation of leading indicators makes it possible to monitor and govern the causes that affect the value creation. In the Gemini network, Union's indicator "Financial resources to invest in the location data project" is leading compared to the measure "Number of units sold to Union". Similarly, Mall's indicator "Number of features satisfied/number of features requested" can potentially affect the trend of the measures "Variation (increase or decrease) in number of visitors of the shopping center" and "Variation (increase or decrease) in time spent by visitors in the shopping center". This happens because the improvement of the information

quality on people movements can support and improve the decision making process of Mall, enabling the shopping center manager to take decisions directed to increase the number of visitors and the time spent by visitors in the shopping center. However, the distinction between leading and lagging indicators is relative. For example, the “Variation (increase or decrease) in number of visitors of the shopping center” is lagging compared to the “Number of features satisfied/number of features requested”, but, at the same time, it is leading when related to Mall’s profits.

In addition, the indicators detracted from the map can provide the management with relevant information on the timing of actions on the value drivers. In particular, monitoring the trend of indicators over time can help to "capture" the length of the lag, that is the time it takes for an indicator of a value driver to begin to influence the indicators of related value drivers, first, and the financial performance, later. For example, a measure that "captures" Sensor’s technical competences (e.g. investments in R&D) is not likely to affect the financial performance in the short-term. Rather it would need a temporal lag of several months. In contrast, leading indicators related to the units sold (e.g.: number of units sold to Engineer) can influence the financial indicators with a shorter lag. Managers should pay attention to this aspect because the lack of an immediate effect on financial performance may simply mean that actions take time before generating an economic benefit. Therefore, management actions that may be deleted or changed because they generate no immediate effects, might instead be reconsidered when managers become aware of their potential effects in the medium and long term.

The indicators extracted from the map furthermore have the potential to provide useful information on the persistence of the effect of a particular action. In fact, the effect may be only temporary and affect the indicator trend of the value driver to which the action is directed only for a short period of time. Or, the effect may persist and influence the indicator trend for longer periods of time. For example, a managerial action directed to increase the level of the Engineer technical competences may affect this value driver and the trend of its indicators (e.g.: level of competences, hours of training on the job) for a long period of time. On the contrary, the effect of an action oriented to increase the number of units sold to Mall may persist only in the short term.

Finally, indicators can play a leading role in the refining and updating process of the map. Relations among intellectual capital elements are not steady by nature: they can change intensity or nature. So the bundle of indicators may help to test the existence of the relations as well as to understand if and how the intensity and the nature of the links vary over time. In other words, the trend of indicators may signal timing, persistence or intensity, which are not consistent with those considered in the “initial” causal map. This can provide useful information on possible changes to be made in order to refine and update the map over time. For example, Engineer commercial competences has been identified as the weakest point in the network because it negatively influences the value creation for Engineer and Sensor as well as the understanding of the information needs of Mall and Union. The effects of managerial actions directed to improve this value driver should be reflected in the trend of indicators like “level of Engineer commercial competences”, “Number of interactions with Mall”, “Number of interactions with Union”, “Mall satisfaction about the location data project” and “Union satisfaction about the location data project”. The improvement of these indicators over time would mean a change in the nature (from negative to positive) of the relation between the Engineer commercial competences and the other value drivers connected.

In the same way, the “initial” causal map displays a negative link between the instability in Engineer’s team and the ability to understand Mall’s information needs. A decrease of the indicator “Team turnover” would diminish the negative impact of the former value driver on the latter. This would provide, as a

consequence, managers with relevant information in order to update the map. The opportunity to refine the causal map over time provides the measurement system with a high degree of flexibility and adaptability, which is consistent with the intellectual capital dynamism, i.e. the real nature of intangible assets.

6. Conclusion

The analysis of intellectual capital dynamics represents a relevant research area, which is receiving growing attention in the literature. Measuring the dynamic aspects of intellectual capital is essential for companies to obtain information in order to govern their value creation process. However, the existing frameworks for intellectual capital measurement are not able to achieve this goal because they are mainly anchored to the static dimension of this phenomenon. The conceptualization of intellectual capital as a complex web of intangible assets entails a reconsideration of the tools by which it is visualized, measured and managed. For this reason, this paper has presented an empirical study into the intellectual capital dynamics of a network of companies through the use of the causal mapping. The creation of a causal map helps to visualize and understand how intellectual capital really works in the specific business context in which it is deployed. This permits to dominate the real nature of this phenomenon by understanding the relations among its elements and the value creation, its potential non-linear effects, its strengths and its weaknesses.

The causal map has also been used as the foundation for creating an intellectual capital measurement system. Exploiting the map as a platform for identifying a set of indicators contribute to fill our research gap in three different but linked ways: by giving the opportunity to reach a balance between leading and lagging indicators; by providing information on the length of the lag and the persistence of the effects of managerial actions; by signaling when and how to refine and update the causal map.

The combination of these factors supports the measurement and the management of intellectual capital dynamism. From a static perspective, the causal map allows the switch to a dynamic view by examining, first, the direct impact of managerial actions also on indicators of other related value drivers and, where possible, the indirect impact on value creation. This matching permits the measurement not only of the individual value drivers, but also of the relations among them, providing the opportunity to manage the links and to increase the positive impact of a value driver on the related ones. Such a measurement system is strongly oriented towards action as it can provide relevant and timely information to support the managers' decision making. The identification of indicators from the mental model of managers who manage the value creation process increases the overall quality as well as the signaling ability of the measurement system. This can lead to an increased likelihood that decisions cause a series of multiple effects consistent with the expected results.

In other words, detracting indicators from the intellectual capital causal map can increase the information content and improve the predictive ability of the measurement system, enhancing, as a consequence, the chances for managers' interventions. On the one hand, the building of the causal map makes it possible to "deconstruct" intellectual capital elements and to "reassemble" them in order to ascertain their identity and use in specific settings (Mouritsen 2006). On the other hand, detracting indicators from the causal map allows us to measure intangibles "in action", avoiding the "extraction" of the resources from the specific operational setting in which they are employed (Mouritsen 2009). Consequently one of the main implications of this paper is that the existing intellectual capital measurement systems may also improve their usefulness by including these dimensions. In closing, it is important to acknowledge the limitations of

this paper. First, the use of a single case study to provide in-depth and rich data limits the generalizability of the observations. Second, the proposed approach has not been implemented in practice.

So we call for further research to investigate the measurement of intellectual capital dynamism through interventionist case studies in order to put the causal mapping approach into practice. Compared to non-interventionist case studies, interventionist research makes it possible to reach a much deeper knowledge level on the individuals involved, the analyzed context, the attached meanings and the triggered effects (Lukka, 2005; Jönsson and Lukka, 2005).

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