International Business Management 1 (2): 12-19, 2007

The ANCOM-2 Solution to Support Knowledge Work

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Abstract: A knowledge worker today spends more than 70% of his time working collaboratively and not necessarily face to face, the team work often becomes asynchronized in time and place. Group support and a shared vision in this context become extremely important for an overall performance. The ANCOM-2 (Analysis and Comparison of Maps) solution based on the causal mapping technique contributes in many ways to existing research on eliciting knowledge from a group of experts. It combines the strengths of the idiographic approach used to capture the individual knowledge of experts in a form of causal maps and the nomothetic approach used to validate variables and relations between them through a final consensus causal map. The ANCOM-2 solution also proposes a segmentation of a group of experts analysing their reasoning paths. Another advantage of the method worth mentioning is the capacity to elicit knowledge from a group of experts without relying on group interaction and minimizing therefore biases associated with group decision-making. In addition, collective causal maps built by means of ANCOM-2 solution turn into a valuable tool in theory building. The results of several cases illustrate the ANCOM-2 solutions to support knowledge work in management studies.

Key words: Knowledge work, causal mapping, dispersed groups, virtual teamwork, theory building

INTRODUCTION

Support of knowledge work by means of causal maps: A knowledge worker today spends about 70% of his time working collaboratively and not necessarily face to face. Group support and a shared vision in this context become extremely important for an overall performance. It is not always possible for a group to have an in person meeting and the group work is often asynchronized in time and place.

We observe such groups in consumer behaviour marketing studies, in interdisciplinary projects, in expert groups, in joint work on theory building, in collaborative teamwork, etc. People who form the group have different experiences, come from different cultures and possess different background. How to benefit of their rich individual experiences and support the knowledge work and the process of knowledge sharing? Our research focuses on elaborating the support solution that could assist in this process.

Mapping as a tool for eliciting knowledge: Mapping becomes one the indispensable tools in management studies to elicit and represent domain knowledge of individuals. Cognitive maps themselves are just one of a broad category of methodologies termed "content analysis" which are used to reveal patterns in quantitative and categorical data or text (Franzosi, 2004). Cognitive maps illustrate a subset of content analysis referred to as "relational analysis" and comprise concepts and the relationships among them (Franzosi, 2004). An individual cognitive map is a representation of an individual's perception of a particular topic and can help the individual better organize, structure and understand a topic. They are said to improve organizational action (Cossette and Audet, 1992). When cognitive maps from multiple individuals are combined into a consensus map, the group can use this map to find differences and build a shared understanding of the topic (Scavarda *et al*., 2006).

A causal map represents causal concepts and causal connections (or links) revealing the important variables that make up a domain; causal connections represent causal relationships between the variables. The individual beliefs combined into a consensus causal map aim to obtain a comprehensive view on the studied matter. The detailed analysis of causal maps makes available a rational aggregation of individual causal maps into one consensus causal map to reach the prolific understanding of the problem.

Numerous methodologies and software packages can be used for creating cognitive maps. The basic process for creating a cognitive map based on principles of content analysis is: Defining the models and content (sources of data) to be examined; defining the content domain and variables of interest (to create a common language for the team and establish internal validity

between the data and the team's conceptualization of the data); data coding; establishing the reliability of the coding process and finally a tabulation of results in a visual map (Neuendorf, 2001).

Group knowledge or how to present consensus in a collective map: In the cognitive literature, a group is considered either as a unit separate and independent from the units of individuals forming this group or as a sum of individuals who form this group. We explore the later definition using a cognitive mapping approach; numerous research studies have proven its efficiency (Ackermann *et al*., 1994). Maps render thinking visible. A collective vision on a problem exposed by means of a causal map reveals various ways of reasoning through cognitive linking and thus leads to a better understanding of the problem.

A collective causal map of a group can be an assembled or aggregated or average map constructed in two stages: Building individual maps of group members followed by the comparison of these maps and constructing of a collective map of a group based on the results of the performed analysis. For that reason it is becoming apparent to have a feasible methodology for a comprehensive analysis of individual causal maps.

Deriving a consensus causal map based on individual perceptions puts forward a question of analysis and comparison of the individual maps and the appropriate level of their aggregation or filtering. The ANCOM-2 methodology (Analysis and Comparison of Maps) used in the studies discussed below combines qualitative and quantitative measures of hierarchical cluster analysis and multidimensional scaling for the analysis and comparison of causal maps. Both procedures, aggregating and filtering, prove to be compelling. A choice of a relevant procedure depends on a research focus and research objectives of each particular study.

THE TWO STREAMS OF COLLECTIVE CAUSAL MAPPING TECHNIQUES

Causal mapping is well-known as a technique that is used to elicit and represent domain knowledge in the form of a causal map (Eden, 1988; Cossette and Audet, 1992; Valette-Florence, 1998). A map represents causal concepts and causal links to reveal the important variables that make up a domain while causal links represent causal relationships between the variables.

A broad range of research has investigated a collective perception reflected in a causal mar using the ideographic approach (Eden *et al*., 1992; Eden and Ackermann, 1998; Brown, 1992). Another large stream of researches based their studies referring to the nomothetic approach (Nadkarni and Shenoy, 2001; Sheetz and Tegarden, 2001). Following Tan and Hunter (2002) the idiographic approach "focuses on the subjective experiences of the individual and presents results in expressions and terms used by the individual" whereas the nomothetic approach "necessitates the use of a common set of elements and/or constructs to permit comparisons to be made."

Several recent research studies suggest systematic procedures and methodologies that combine these two approaches (Nadkarni and Nah, 2003; Scavarda *et al*., 2006). An idiographic approach used for building a causal map is consent to capture unique, subjective knowledge and individual perception using in-depth interviews and it is not bound by predefined variables. The obtained causal map can be validated further on by the use of nomothetic methods with a purpose to confirm a priori determined, widely accepted and generalized assumptions relating to a specific domain (Nadkarni and Nah, 2003).

The ANCOM-2 methodology used in our studies refers to this stream of research that use both the nomothetic and idiographic approaches. The basic process for creating a cognitive map is based on principles of content analysis (Neuendorf, 2001): Defining the research question, a framework and content (sources of data) to be examined; defining the content domain and variables of interest (to create a common language and establish internal validity between the data and the conceptualization of the data); data coding; establishing the reliability of the coding process and a tabulation of results in a final set of variables. Using this common set of variables the individual knowledge of subject-matter experts is captured in a form of a causal map elicited individually. The variables linked by arcs represent beliefs of experts about the causal relationships among the concepts.

Each causal arc is assigned a weight evaluated at the range from 1 (extremely weak) to 7 (extremely strong) to indicate relationship's strength. Causal maps can include cyclic arcs between two elements, showing a dual causal relationship a feature which represents strong advantage of the method. Once causal relationships are evaluated a causal map can be represented by a diagram or an association matrix, which represents the set of causal weights for all pairs of variables.

The use of a common set of variables (the nomothetic approach) permits to perform comparisons among the individual beliefs. Finally, individual maps are combined into a consensus causal map to obtain a comprehensive

view on the studied matter. Deriving a collective causal map based on individual perceptions puts forward a question of analysis and comparison of the individual maps and the appropriate level of their aggregation or filtering (Wang, 1996). This question is in the focus of our research studies.

ADVANTAGES OF THE ANCOM-2 SOLUTION

The idea of the ANCOM methodology (ANalyse and COmpare Maps) applied in several management studies (Chameeva *et al*., 1996; Bouzdine, 2005; Scavarda *et al*., 2006) consists in building a collective causal map on the basis of a comparative analysis of individual causal maps.

A systematic procedure integrates both the idiographic and nomothetic approaches in eliciting, aggregating, comparing and validating the knowledge of individual experts in a form of several consensus maps. The idiographic approach is used to elicit and aggregate the individual knowledge of subject-matter experts and the nomothetic approach to validate the elicited knowledge in a form of a final consensus collective map. This three-phase methodology is described in Table 1.

Each of the three phases of data collection and analysis (Prepare, ANalyse and Compare Maps) has the three Steps (Prepare, Analyse and Conclude) presented in Table 1.

The purpose of the Prepare Phase is to capture the individual knowledge of subject-matter experts to create and define a preliminary set of variables. An ideographic approach used at this point has proved to have good success in exploring new domain and expressing the new issues that the study question addresses. The purpose of the Analyse Phase is in the analysis of relationships among the variables reflected in the individual causal maps. The purpose of the third and final Compare Maps Phase is to construct and interpret consensus causal Map to answer the fundamental study question.

The ANCOM-2 combines the individual beliefs of all respondents into a consensus causal map which is constructed on the basis of a comparative qualitative and quantitative analysis of individual causal maps. The four dominant consensus causal maps are built: An aggregated map (that is a sum of individual maps); a map of unanimity with concepts and links chosen by all participants; a map of majority: Including concepts and links chosen by the majority of participants and a map of enlightened majority that contains concepts and links chosen by the majority of respondents and the concepts that are the most important for each respondent in terms of the domain centrality principle, the variables of the highest rank in the individual maps and the links of the highest weight in each individual map (Fig. 1).

The divergence of experts' opinions is reflected in a consensus collective map by means of a threshold value which is arbitrarily pre-determined at the mean value between the lowest and highest ratings by the ANCOM-2 software. Different values of thresholds can be used to filter the aggregated consensus maps and analyze the convergence/divergence in experts' views.

The Similarity Concepts Analysis (SCA) implied in the ANCOM-2 is a kind of a Multidimensional Scaling Technique (MDS) technique: For a given threshold all links of all concepts in a chosen map are analyzed in order

Table 1: The description of the ANCOM-2 methodology

Phase 1: prepare (define variables)	1.1. Prepare-Identify potential expert respondents. Interview respondents in a semi-structured format about the fundamental research question.
	1.2. Analyse-Analyze the data to define variables (associations) for further analysis
	1.3. Conclude - Create a set of variables to be used at the Phase 2
Phase 2: analyse variables (analyse relations)	2.1. Prepare-Form a group of experts who will evaluate the relations among variables in a set (basing on the results of Phase 1)
	2.2. Analyse-Experts analyze individually the relationships and evaluate the strength of these relationships between a limited set of and present these relations in a map form keeping causality of relationships in mind.
	2.3. Conclude-Create the individual maps.
Phase 3: compare maps (aggregate/filter and interpret maps)	3.1. Prepare-Compute the causal weights and if necessary experts' weights for each arc for a consensus causal map.
	3.2. Analyse-Draw and analyse the four types of a consensus causal map. Perform filtering and segmentation if needed.
	3.3. Conclude-Interpret the final consensus causal map.

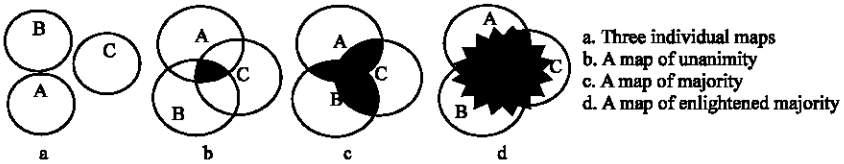

Fig. 1: The conception of the four types of a consensus collective map

to reveal similarities and, in result, construct a scale-conjunctive graph; then distance ratios between concepts are calculated and similar concepts form the classes based on a distances ratio found.

Hierarchical Cluster Analysis (HCA) is applied in the ANCOM-2 to reduce the number of nodes. However, in order to apply cluster analysis the similarity between the nodes must be defined before. To complete the HCA, the ANCOM-2 builds sets of strong ties/ moderate ties/ weak ties respectively for each concept in an indicated map and defines further three important/average/less important concepts for each concept in an indicated map (the number of occurrences for the links is used as a criterion). As a result, subsets of concepts are created. Intersection of subsets with an upward test on the belonging property is produced. The established independent clusters lead to the last step of analysis: The verification of the compatibility of the SCA results with the results of HCA. The coherence of results is due to the two validation procedures implied in the ANCOM-2 methodology:

Procedure 1 consists in performing the HCA and the SCA in the 3D space of "concepts/links/participants" to reveal the clusters of close elements making a cut-off in the dimension of participants. As a result, the subsets of concepts, "Groups", are formed. Then the projection of the 3D space into the 2D space ("concepts/links") is made and the distances between Groups are calculated. The final resulting map is presented in a graph format with a simultaneous verification of distances between Groups.

Procedure 2 focuses first on reducing the 3D space of "concepts/links/participants" into the 2D space (concepts /links) using the aggregation functions in order to obtain an aggregated collective map. Then the SCA analysis is performed for each consensus map followed by the HCA and the subsets of concepts, "Groups", are formed. The final resulting map in a graph format is build with a simultaneous verification of distances between Groups (similarly to the Procedure 1).

The interpret step of the Phase Compare Maps makes available a rational aggregation of several causal maps into a final consensus collective causal map to reach the prolific understanding of the problem.

THE ANCOM-2 SOLUTIONS IN MANAGEMENT STUDIES

In the last 5 years, several management studies have been performed using the presented ANCOM-2 tool. These studies focused on the aggregation of individual knowledge on the understanding of business relationship value, in the operations management domain (Hayes *et al*., 2005; Scavarda *et al*., 2006) in organizational studies for the SMEs recruiting policies, in the analysis of strategies in wine sector (Bouzdine, 2005; Bouzdine *et al*., 2006) in examining the sponsoring effects in brand core's identity of a sportive event (Ferrand *et al*., 2006) and filtering this individual expert's knowledge to develop a consensus map addressing the research question. Below the contributions of the ANCOM-2 solutions are followed by the discussion of the perspectives of the tool.

The ANCOM-2 applications: The research focused on the understanding of a relationship value seen from a customer's perspective (Bouzdine *et al*., 2004) applied the ANCOM-2 methodology to capture individual differences of the value perceptions, aggregate them and visualize in a map to present the collective perception of the value. The value of the same business relationship had different meanings for experts (managers of one of the major French firms in the space industry). The divergence in the value perception manifested in the individual causal maps built using the common set of concepts (Fig. 2).

This divergence could be partially explained by the diversity of the professional activities of experts and their individual domain knowledge. A final consensus map, a map of enlightened majority, prompted this variety of views.

Another research study where the ANCOM-2 technique has had a success was undertaken in collaboration with Hayes *et al*. (2005), Scavarda *et al*. (2006).

The developed inductive Delphi-like, Evocative Causal Mapping Methodology (CMM) or a web-based asynchronous data collection technique employed a data-based approach for building a normative model by evoking "if-then" statements from a group of subject matter experts. The ANCOM-2 technique proved to be efficient in the construction of a final collective map to answer the fundamental research question "What should students learn in an MBA-level introductory operations management course?" 262 managers and academics participated in this study.

The ANCOM-2 produced their individual causal maps and performed a complete analysis of these maps. The consensus maps have been built using several different cut-offs (Fig. 3).

The ANCOM-2 methodology has been enhanced in the research study examining the effects of sponsoring in brand core's identity of a sportive event (Ferrand *et al*., 2006). The focus was on the extraction a collective perception of a brand core's identity in the form of a consensus causal map. A preliminary set of variables elicited by a group of subject-matter experts was used by a group of 30 fans meeting the audience profile to

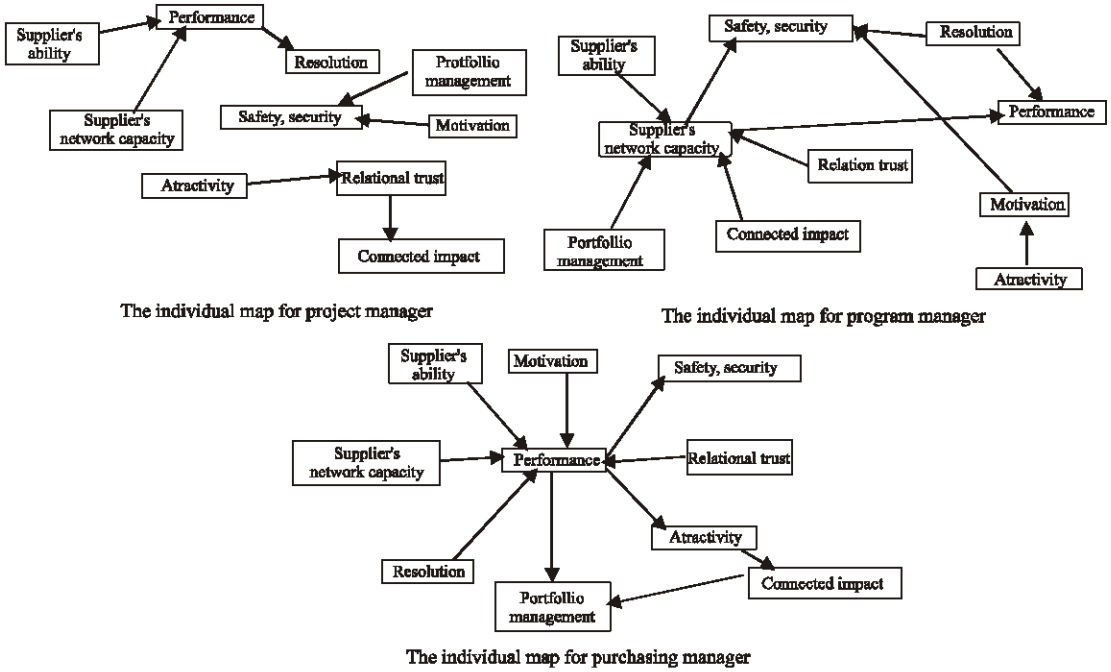

Fig. 2: Divergence in individual representations of value phenomenon

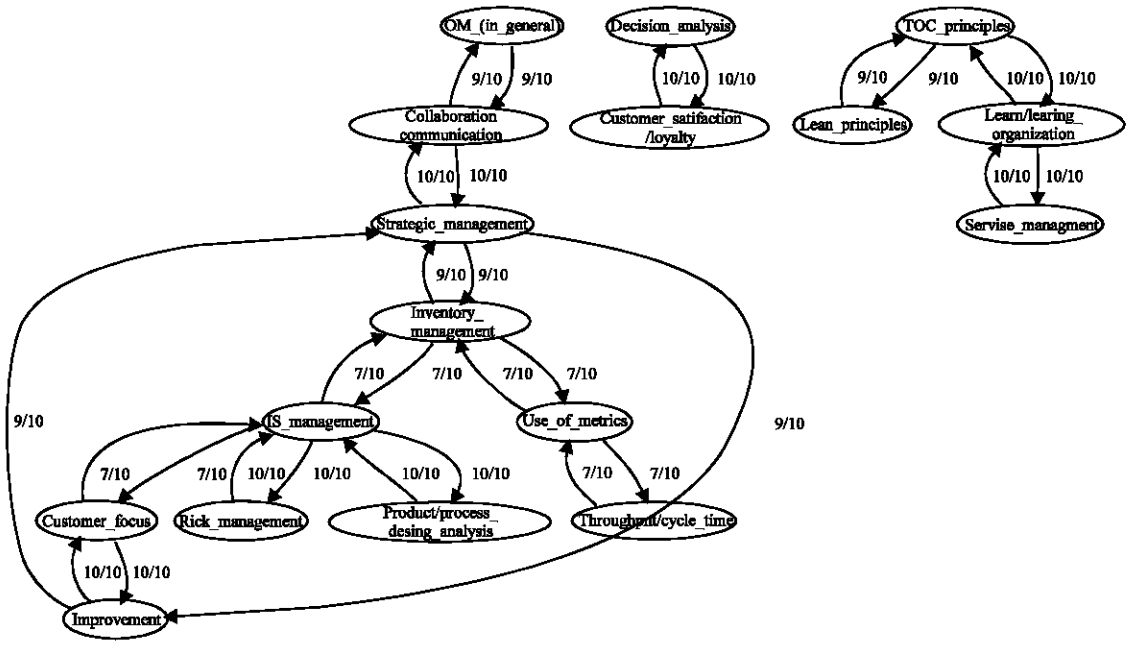

Fig. 3: The ANCOM-2 solution in the operations management study: A majority map

evaluate the 3 brands, Sony Playstation 2, Ford and Master Card and build individual brand causal maps. The ANCOM-2 was used to construct a final consensus map for each brand. These brand causal maps were then matched with a similar map built by the fans for a sportive event, the UEFA Champions' League. The different cut-off values were used to filter the aggregated consensus maps (of the 4 types) in this study.

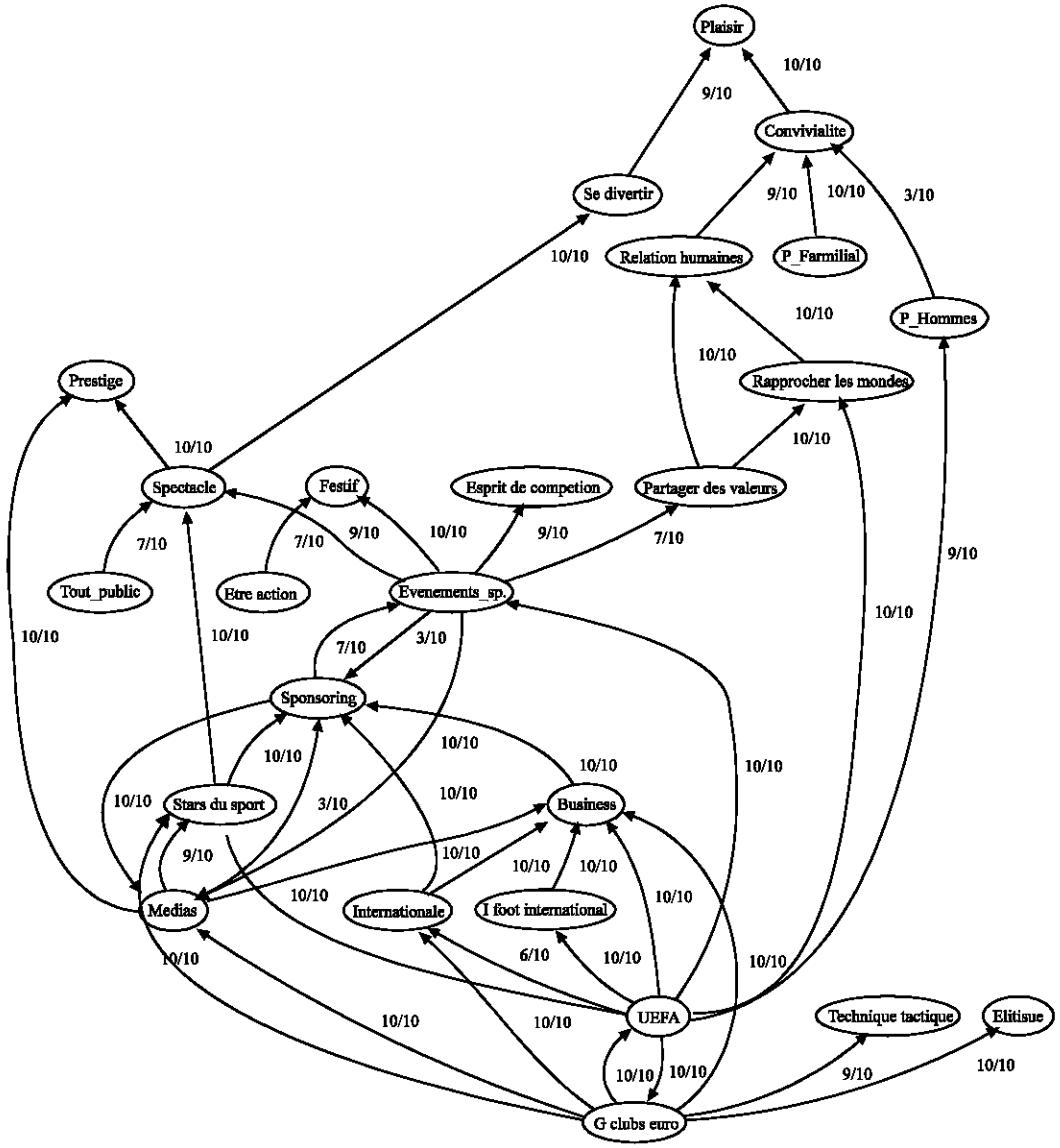

Fig. 4: The enlightened majority map for a sponsoring study of brand image of a sportive event (built using segmentation)

The filtering allowed observing the evolution of the consensus maps and analyzing the convergence between individuals and the divergences among the groups of fans (clusters).

Segmentation of groups based on the causality cognition appeared to be a fascinating tool in addressing sponsoring effects and in understanding of sponsoring phenomenon (Fig. 4).

The limitations of the ANCOM-2 methodology: The ANCOM-2 methodology has several limitations. First bias may be introduced through the selection of experts in Phase 1. Second it is limited by the reliability of the coding process. It is impossible for the coders to be completely unbiased in the coding process. Validity, including the definitions of concepts, influences the generalization of the resulting causal map. Using multiple coders helps ensure validity, but it is not failsafe.

The complete process of applying the ANCOM-2 methodology can be time consuming. In addition, participants must be apprehensive about the meanings of each association and able to determine the existence and the strength of theirs links. Like other types of cognitive maps, causal maps can be "extracted" from

experts' beliefs and opinions (Franzosi, 2004). This limit is common to most of the existing mapping techniques.

Further research could provide additional insight and guidance to meet these limitations.

CONCLUSION

This study suggests a map-based solution to support knowledge work of experts. Using of consensus causal maps to tackle a fundamental research question and reflect the experts' knowledge has proved to provide a valuable support to the development of a shared foresight on the studying problem. Capturing the key issues and structuring the major lines of reasoning, analyzing and comparing individual views via causal maps and finally exploring the four different types of consensus causal maps using different thresholds results in an enhanced understanding of the problem setting. The process of developing and refining the final consensus causal map applying the ANCOM-2 solution can be compared with a diamond cut process when a jeweler cuts the excess to reveal the fundamental nature of a stone.

The causal mapping methodology ANCOM-2 presented in this study contributes in many ways to existing research on eliciting knowledge from a group of experts. It combines the strengths of the idiographic approach used to capture the individual knowledge of experts and the nomothetic approach used to validate variables and relations between them through a final consensus causal map. Another advantage of the method worth mentioning is the capacity to elicit knowledge from a group of experts without relying on group interaction and minimizing therefore biases associated with group decision-making. The creating of the four consensus causal maps of a group's view on the studying problem, the use of different cut-offs to ensure the richness of the collective perception of a studying question in a final consensus collective map, the possibility to perform a segmentation of a group of experts based on their reasoning paths present one of the major advantages of the ANCOM-2 that have been confirmed in a broad range of the performed managerial studies.

It is the hope of these authors that the ANCOM-2 solution presented in this study will become standard faire for many researchers to help them build a stronger initial theory for their empirical research.

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