Management and Production Engineering Review
Volume 9 • Number 4 • December 2018 • pp. 129–137
DOI: 10.24425/119553

THE DEGREE OF AGILITY IN A TECHNOLOGY COMPANY'S STRATEGY, MANAGEMENT, AND LEADERSHIP

Hannu Vanharanta[1,2], Jussi Kantola[1,2], Evangelos Markopoulos[3], Markku Salo[2]
Jarno Einolander[2], Tero Hanhisalo[4]

[1] *Poznan University of Technology (PUT), Faculty of Engineering Management, Poland*
[2] *University of Vaasa (UVA), Department of Production, Finland*
[3] *Hult International Business School, UK*
[4] *Research Team Member of Evolute LLC, USA*

Corresponding author:
Hannu Vanharanta
University of Vaasa (UVA)
Department of Production
Vaasa, Finland
phone: (+358) 40 826 2759
e-mail: hannu@vanharanta.fi

Received: 26 April 2018
Accepted: 17 August 2018

Abstract
Agility is a concept and practice with significant importance in managing and leading added value in products, services, projects, and organizations, although it's usage can also be very risky due to its degree of fuzziness, if not properly understood and defined. This research re-defines agility, emphasizes the need for ontologies for its management and leadership applications and uses a new type of fuzzy logic-based software to measure the degree of agility inside a technology company. In our agility research, various definitions of agility were first gathered and presented for the creation of an agility ontology through a mind map, revealing the main characteristics of agility. Then as part of the Co-Evolute theory and methodology, the first agility ontology was developed as well as the first software application that evaluates the degree of agility in an organization. The application includes statements on which the respondents give opinions in their situation concerning the current and future desired states of agility and its importance in an evaluative way. Today the application has been fully tested in the real world and we have obtained the first test results. The positive verification and validation of the method are shown in this article.

Keywords
agility, application, innovativeness, leadership, management, ontology, validation, verification.

Introduction

The Co-Evolute theory and methodology created by our research group gave us a strong background to understand human involvement as well as business objects and concepts in real-world context. Starting from the scientific background, we developed a good theoretical management and leadership base which allowed us to enter into a solid methodological view of how to tackle the many-faceted agility constructs but also the many concepts inside the construct. Co-evolution suits very well to study agility because companies have to meet real-world changes, adapt themselves to their current situation but also to see the options they have in the future.

At the beginning of our research, together with our cross-scientific team, we found that when thinking and speaking about agility, one has to be very cautious. Many believe that agility is a trendy concept, a tool for all cases, an easy way out that can be implemented anytime, anywhere, but that might not actually be an appropriate way to think. A complex construct and many concepts inside make the holistic way of thinking of agility difficult and fuzzy and also that there are many concepts inside, which are more important than others.

The concept of responsiveness seems to be one of the most important characteristics of agility. Organizations are trying to be more flexible and dynamic in the face of our changing world. On the other hand, companies are looking closely at added value concepts so that they can really see that they are continuously serving their customers. Agility can also be described with other adjectives like 'adaptability', 'customer-compliant', 'flexible', 'responsive', and even 'yielding'. For agility to be conceived properly it is important to understand that the world and business, any business, is agile in many ways and that all the people inside the organization understand these different dimensions of agility in practice. Managers in particular, who are called upon to apply agility, must understand that agility starts from people and ends with innovative new management practices, solutions, products, and services for the organization and their customers. However, in some cases, making changes too quickly towards obtaining agility in management and leadership may be too risky.

To reduce the misconception of the term agility, it is important to re-define it using an ontology that can cover the areas and limits of the term in a specific environment. Ontology originally derives from philosophy and refers to the science of being. Recently, the term ontology has also been used in information technology, where it is a specification of a conceptualization. For this case study, we have created an ontology application and tested it first with student test subjects on how organizations understand agility in companies. This second paper from our international research group views agility primarily from the ontology point of view for its utilization and application in a business context. The paper presents agility test run results with the created application in a technology company in Finland.

Defining agility

The term agility has become very popular and trendy over the last two decades in almost all types of business and engineering activities, operations, and strategies. What is interesting is the fact that today's meaning of agility differs significantly from the dictionary definitions and the ones used prior to its adoption by the software engineering industry.

By definition, agility means "being gently rolling, light, flexible, witty and nimble. It can be contrasted to rigidity". In practice, the term has a totally different meaning, as it stands for flexibility and adjustability. The agile concept became popular through the software engineering discipline and communities, as a solution to bypass bureaucratic complexity in the software development efforts imposed by strict software development processes, tools, and structures [1].

The problem that agility aimed to solve was quite clear but slightly contradictory. On the one hand, software development needed structured methodologies and a process to assure the engineering quality of the software produced, but on the other hand, technology constraints (continuously changing), client constraints (unstable requirements), project constraints (schedule and budget limitations) were considered obstacles in developing software within budget, on time, and with quality [2]. The challenge was to bypass bureaucracy in software development processes and standards without being accused of development anarchy. To solve this challenge, the agile concept was invented or reinvented to be more precise. The logic behind agile software development is to adjust the software development best practices based on the environment, context, project constraints, goals, and objectives. Thus, software development on small-sized projects could avoid, for example, long design, testing, and documentation processes. On large projects, the processes could be adjusted accordingly. The concept is that in such projects no standard methodology is used. It is the adjustability of any existing method that can fulfill the critical implementation requirements and conditions per case [3]. Therefore, agility can be seen as the "Lego-type" adjustment per case of the software development process. The results of applying agility in software development were very successful and all parties involved were satisfied, as the software was developed with less process overhead for the engineers and much faster for the clients.

Agility, however, is very difficult to design and very risky to apply. Reducing and adjusting the number of processes from a methodology requires high capability and maturity from those who attempt to select which processes are needed, which are to be removed, and which are to be changed in order to achieve agility. The same applies in management and leadership, as acting outside the box to bypass a problem requires significant expertise in order to make the right moves [4].

In software engineering, many agile methodologies have been developed over the last two decades, some of which were successful and others less successful [5]. The Ariadne Methodology is one of the first agile software engineering and project management methodologies [6]. It was developed based on the "Agile Lego", i.e. 'build it yourself' concept according to project constraints. The ARIADNE set of processes has made the methodology compatible

with 108 international project management and engineering methodologies, while it supports more than 15 different software development types such as waterfall, spiral, incremental, rapid prototyping, etc. [7] (Fig. 1). Markopoulos [3] takes agility a step further by defining a continuous agile environment in software engineering, and not only, calling it mutational which handles agility in a dynamic way against continuous and unpredicted project or organizational constraints.

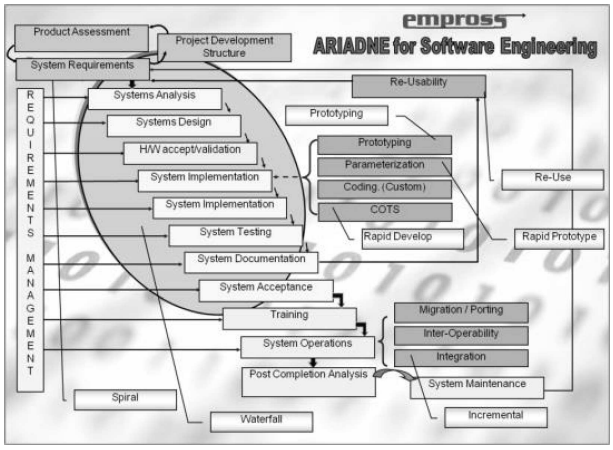

Fig. 1. Methodological approaches supported by the ARIADNE agile software engineering methodology.

Agile processes are not for everyone to follow. They need significant management expertise to be aligned with the organizational culture, capability and maturity for their proper execution.

Defining ontology

Ontology derives from the Hellenic 'on' (όν), genitive 'ontos' (όντος): "**of being**", neuter participle of 'eine' (είναι): "to be", and 'logia' (λογία): science, study, theory.

Based on the above definition of the term 'ontology', it is obvious that ontologies are live and not static entities. They contain elements that have identities that affect and are affected by the environment they are used for and from [8].

The Stanford Encyclopedia of Philosophy [9] divides ontology into two different categories: firstly, ontology is the study of what there is, and secondly, it is the study of what is involved in settling questions about what there is in general. According to Effingham [10], ontologist splits things into two categories, i.e. the abstract and the concrete. Osterwalder [11] has studied business model ontologies and has developed practical ontologies through a theoretical approach. However, his approach is derived from an ICT approach; which also shows that ontologies in practical life are widely used in information technology, business process modeling, and related activities.

Dietz [12] has studied enterprise ontology from his ICT background and point of view. In his mind, there has to be a conceptual model that is coherent, comprehensive, consistent, and concise. Such a model can be considered as an ontological model. He takes the example of the World Wide Web, which serves to provide a common basis for common understanding of some area of interest among a community of people. Vanharanta and Kantola [13] have taken some steps towards more practical approaches in ontology, although in many of their approaches there is an application in the background.

Agility in creating ontologies

Even though agility in ontologies can be considered their natural behavior, it is often hard to see this dimension when using them and much more when creating them. To enable agility in the creation of ontologies, one must understand the relationship of the elements that comprise an ontology. All ontologies have passive and active elements that define a microcosm of activities, operations, and goals. This microcosm affects and is affected by other ontologies, based on the way they interact. Therefore, well-designed ontologies are those that can be used the best and the most, meaning that they must be agile in order to achieve the desired flexibility and adjustability.

Furthermore, the elements in an ontology can also be characterized as the imports and exports of information in the ontology. They are the elements that collect the information to be processed in the ontology and the elements that export information after being processed in the ontology. Figure 2 presents the elements of an agile ontology.

The challenge in the creation of agile ontologies can be seen as a double one. First, it is important to properly identify the ontology elements and their relationships in order for the ontology to be agile, i.e., to be used with flexibility and adjustability on the maximum number of occasions. The second challenge is not actually based on the ontology itself but for the designer of the ontology to use it properly in the design of systems, processes, methods, and practices. Having a great tool does not make it great unless it is also used well. Besides the proper definition of the identities of the ontology elements towards achieving agility, the taxonomy of the elements also has a great significance for agility. An ontology can be designed to include sub-ontologies, which are actu-

al taxonomies of the ontology elements. This breakdown of the ontology elements into taxonomies can define the range of usage of the ontology and greatly affect its behavioral identities.

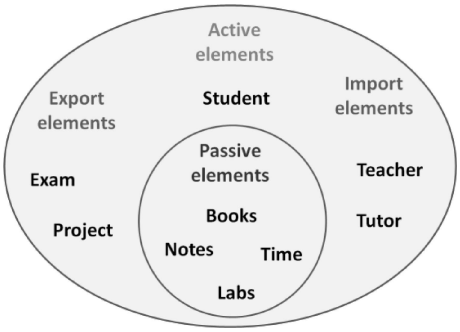

Fig. 2. Agile 'Teach' ontology with relationships between elements.

The ontology 'teach', for example, and the ontology 'learn' seem to have a direct link and meaning, but agility is achieved in the ways teaching is done and the ways learning is achieved. The degree of agility is based on the number of ways that such combinations can be satisfied. One way to achieve this is if the two ontologies can be viewed as taxonomies of a greater 'Teach-Learn' ontology that defines variations of teaching and learning within the ontology (Fig. 3). These variations define agility in the terms in the use of the ontology.

Agility is not only a practice, a method, a process, or a trend, but more of an art of understanding real work and trying to satisfy its continuous changing needs. Agile ontologies are very important towards developing agile systems, processes, methods, and practices. The agility resides in the ontology and not in the methodology, which is composed of ontologies that drive and support the process and practices of the methodology. Once such a view can be conceived, then obtaining agility can be very easy, but it is not easy to think easy.

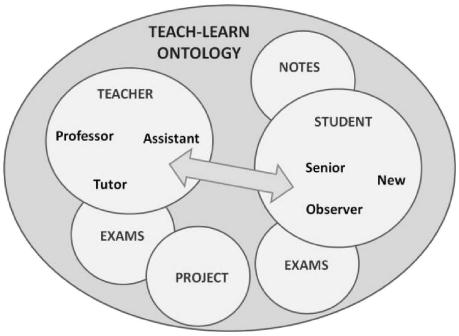

Fig. 3. Taxonomies within ontologies for maximum ontology agility.

Ontology application

An ontology application exists on the Evolute platform [14]. The platform has various other applications to assess and follow up the development of an organization within its various operations and functions. The test application is called Catenary (Fig. 4).

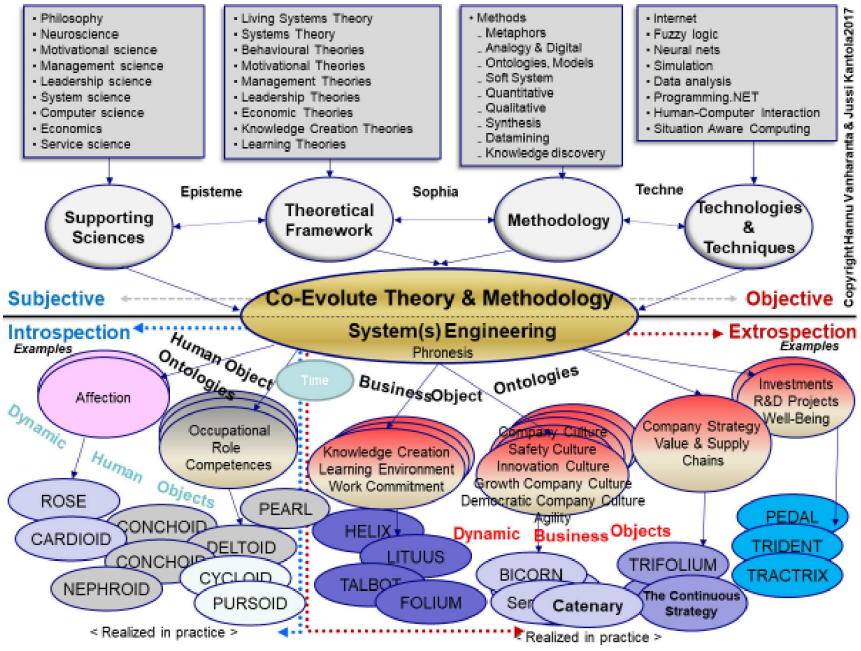

Fig. 4. The evolute platform [14].

The Evolute approach follows a modular process involving individuals and stakeholders, where their perception and understanding of organizational resources are sought and collected with the help of statements, one by one. The Evolute system [14, 15] is a platform that computes and visualizes the meaning of the knowledge input collected from stakeholders. The computing in the Evolute system is based on soft-computing methods and algorithms in order to cope with the imprecision and uncertainty embedded in natural language and human knowledge inputs. Management uses the computed current and future meaning of organizational resources to make a development analysis of the organization. The analysis can be made of the whole group and sub-groups. Stakeholders can be involved in this management step, according to the modular process.

Research study

A research study was conducted in September 2017 – May 2017 with 24 test subjects, representing a Finnish technology company. The researchers had created ontology statements that were entered into the Catenary application [16]. The number of statements was about 110, varying from the understanding of the term agility to its implementation and control in organizational operations, strategy and leadership. There were several sub-categories as well.

Since this was just the first real-world test of the application, the number of participants was limited to 24 test subjects. Hence it is difficult to draw final scientific conclusions from this study alone, but it certainly provides a very good validation for the application. More research, of course, is required to further validate and verify with multi-dimensional analysis the results of this kind of study. An example of how the statements are organized is shown in Table 1. In the sample, there are 17 of the total 110 statements.

Results

The Catenary application itself worked in this real-world test perfectly as expected, with the same success it had from its previous test runs with students. The results reflect the status of the respondents' organization, i.e. the Finnish technology company and are taken as such. After the test runs the company has continued its internal thinking and de-

Table 1
Example of agility ontology statements in catenary.

High Level Concept	Sub-Concept	Indicators	MIN	MAX
General concept	Agility awareness	- I understand the term agility	not at all	completely
		- Most people in our organization understand the term agility	not at all	completely
		- Our organization has to be agile	not at all	definitely
		- We have no need for agility in our organization	not at all	definitely
		- Our company is "fast"	not at all	absolutely
		- We understand our company strategy	not at all	completely
		- I understand our company strategy	not at all	completely
	Agility suitability	- Agility is suitable for our organization	not at all	definitely
		- We know how to utilize agility in our organization	not at all	absolutely
		- Agility has helped our organization	not at all	totally
		- We have to plan our things better	not at all	absolutely
		- Our organization's innovativeness is at a high level	not at all	definitely
		- We have an organization culture that encourages innovations	not at all	completely
	Innovate	- Our organization's innovativeness is at a high level	not at all	definitely
		- We have an organization culture that encourages innovations	not at all	completely
		- We have facilities that promote innovations	not at all	completely
		- We have daily meetings where we can share our innovative ideas	never	always

velopment based on the achieved results. The aggregate results can be seen in Fig. 5 and it shows the summary by the main categories, while the detailed results are presented by topic are presented in Fig. 6. The general numerical results show, clearly, that the investigation of problems category is in the best state within the company (current states over 0.57), whilst the target state means that there is a lot of development work in sight (target states over 0.7).

In Fig. 6 the individual concepts in the ontology have been sorted by their current state "ranking".

The current state seems to be best in Delivery management, General, KPI Awareness and usage, Performance, and Communication implementation. The opposite is true for instance for TPM, 5S, Agility software, Lean management, General knowledge about Agility tools, etc. One cannot say whether the results are right or wrong but they show a direction for the company to develop its activities and opens really fast the Agility concepts for management and leadership purposes. In Fig. 7 the individual concepts are sorted by their "ranking" according to the future state.

Fig. 5. Summary of agility study results by main categories in the Finnish technology company.

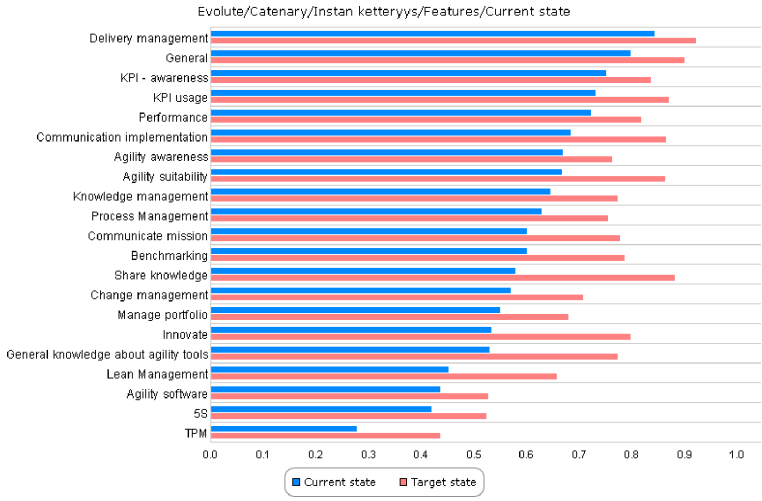

Fig. 6. The concepts of agility in a Finnish technology company sorted by current state.

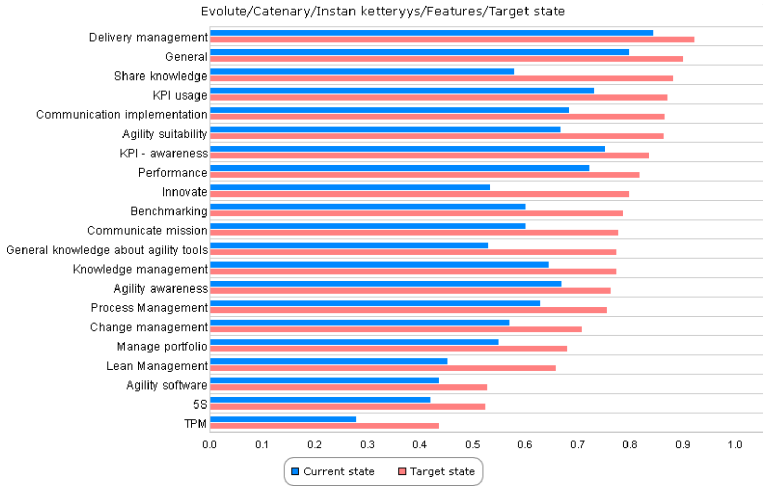

Fig. 7. Concepts of agility in a Finnish technology company sorted by future state.

The most important point in Fig. 7 is 'Delivery management', followed by 'General' and 'Share Knowledge'. It is also possible to obtain an index from the system describing the ratio of the future to the current state. This index is called the Evolute Index. From the data, we can get, the following, Fig. 8 where the concepts are sorted by the Evolute Index.

From the results in Fig. 8 we can see that the highest index is in TPM issues, followed by the concept 'to share knowledge', and after that, it is the important 'innovation' concept. In this index, the lowest concepts are 'KPI-awareness' and 'Delivery management'. The high index tells that the concept needs attention and improvement in a company according to the respondents. Figure 9 shows a simple statistical summary of the case. It shows that average values and standard deviation of the concepts in the ontology.

It is important to see in the above analysis that people understand and experience agility very differently in their company, however, the mean values provide a good picture how the sub-concepts have been perceived and understood as well as what is it now important to be developed (Fig. 9). It is clear as well that the company cannot develop all the sub-concepts simultaneously. This kind of development needs from company's management and leadership a lot of experience, capability, competence, and know-how. Certain priorities may lead to good solutions, but as mentioned, agility is a fuzzy concept and decisions on what to do next and how to make progress with each concept must be carefully made. This needs a lot of teamwork with the company's work-force.

Figure 10 shows the summary of the agility research results by different topics in the Finnish technology company sorted by creative tension. We can

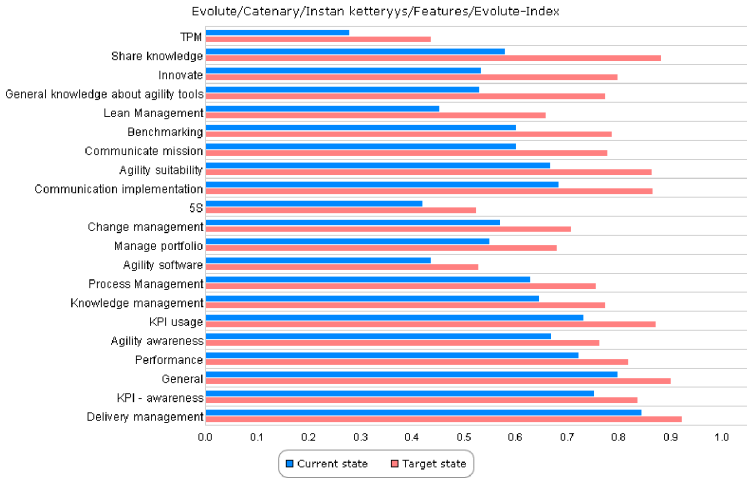

Fig. 8. Concepts of agility in a Finnish technology company sorted by Evolute Index.

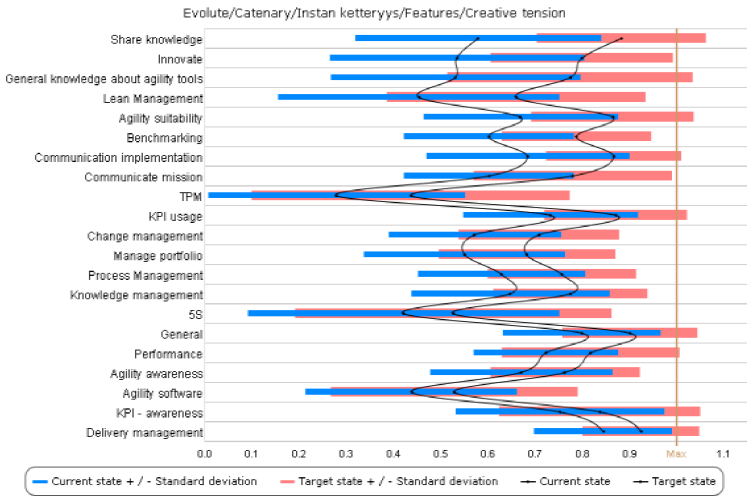

Fig. 9. Average values and standard deviation of agility concepts in a Finnish technology company sorted by creative tension (Target-Current).

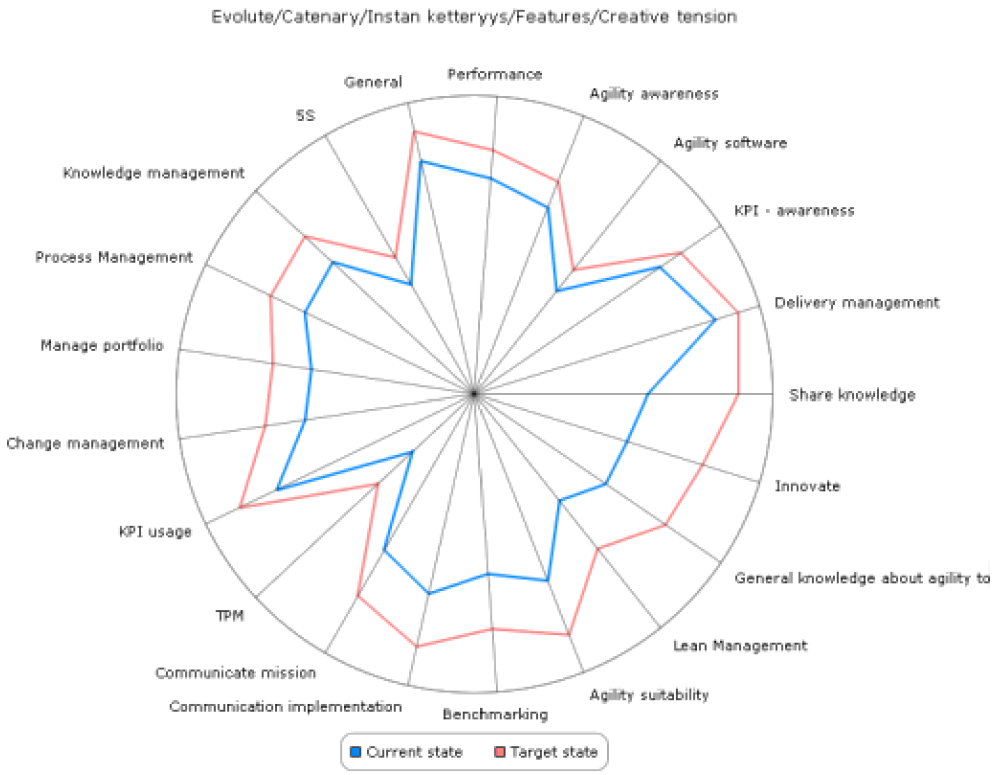

Fig. 10. Summary of agility concepts in a Finnish technology company sorted by creative tension (start reading from 3 o'clock > share knowledge).

see visually that there is a clear need to improve the perceiving and understanding agility concepts. The application also reveals the main sub-concepts to be developed immediately such as "to share knowledge", and others.

The statements in the application should be further developed. However, and in contrast for instance to the applications that are closer to psychological tests, it is fair to say that there is no need to compare the results of our application with other similar applications. On the other hand, and despite our extensive research, we did not find any similar practical agility application currently available on the global market.

Discussion and conclusions

Ontology is not very common in business, apart from applications for the information and communications technology sector, which invented the concept. Even to understand what ontology means is not easy for most people as it integrates a deep philosophical dimension. Philosophy is a difficult subject and most business people understand very little of it. Hence easy methods need to be created and taught in order to give the necessary help for understanding such concepts. Tools that have been developed by EMPROSS or Evolute LLC support this thinking in the agility area.

The agility created in the plans and strategies of many businesses obliges managers and leaders to be very careful when implementing it. Agility can suit some businesses, but not necessarily all of them. For instance, should governments be agile or not? How about many heavy industries – can they be agile? and to what degree? In our opinion, agility is well suited for the software business, and electronics-related businesses like mobile phones, electronic components, computers, etc. where innovation cannot be controlled with a static structure and non-flexible management and leadership. Agility in companies are using also according to Trzcielinski S. and Trzcielinska J. short lifetime opportunities and therefore it is important to take care of a certain type of typology of opportunities and the structure of a company when designing effective agility applications [17].

The agility/ontology tool developed during this research is very practical and can be used in any organization for management and leadership purposes. It clearly shows the status of agility, i.e. the degree of agility, in a Finnish technology company and its development needs. We can find many similar areas,

functions, and disciplines in organizations to develop ontologies. Developing an ontology by using the application is not a very complicated task and can be used by everyone. To achieve the effective development of such applications, a minimum set of research statements is required. There are nowadays so many questionnaires that many organizations and individuals have to participate in. This creates a common dissatisfaction towards large questionnaires and repeated processes, and therefore less motivation and interest, meaning less valid or complete results.

Time will show whether ontologies will be used more in practical business life and especially for management and leadership purposes. One can assume that they will be used more and more when developing information systems and business processes for managing innovation effectively, but we have to think more broadly, as innovation does not only exist in the technology sector. Ontologies can help this thinking, as they provide all the potential needed to support agile thinking in organizations with processes and tools.

The whole research team thanks Insta Group Oy, Finland, that gave us the possibility to make agility research with the developed application inside the company.

References

[1] Beck Kent et al., *Manifesto for agile software development. Agile alliance*, Retrieved 14 June 2010, Manifesto for Agile Software Development Available at: http://agilemanifesto.org/ (accessed 14 December 2015), 2001.

[2] Markopoulos E., Panayiotopoulos J-C., *A Project Management Methodology Selection Approach based on Practical Project and Organizational Constraints*, WSEAS Transactions on Computers, 4, 8, 934–942, 2005.

[3] Markopoulos E., Bilbao J., L., Stoilov T., Vos T., Reschwamm K., *Project management stage mutations within agile methodological framework process transformations*, WSEAS '05 International CSCC Conference, 12–16 April 2008, Beijing, China, 2008.

[4] Markopoulos E., *ICT Process Development and Evolution Models and the First Financial Bank of Montenegro Case*, The Bankar – Montenegro Bank Association Journal, 1, 1, 2008.

[5] Markopoulos E., Bilbao J., L., *An evaluation, Correlation and Consolidation of Information Technology Project Management Processes*, 1st International Conference on Engineering and Mathematics, Bilbao, Spain, 2006.

[6] EMPROSS, *The Ariadne Methodology*, http://www.empross.com/en/the_ARIADNE_Methodology (accessed 14 December 2015), 2002.

[7] EMPROSS, *The Ariadne Methodology*, http://www.empross.com/en/methodological_approaches (accessed 14 December 2015), 2002.

[8] Oberle D., Guarino N., Staab S., *What is an ontology?*, [in:] Handbook on Ontologies, International Handbooks 1 on Information Systems, Springer-Verlag, Berlin Heidelberg, 2009.

[9] http://plato.stanford.edu/index.html, March, 2016.

[10] Effingham N., *An introduction to ontology, polity, press*, Malden, MA, USA, 2013.

[11] Osterwalder A., *The business model ontology – a proposition in a design science approach*, l'Ecole des Hautes Etudes Commerciales de l'Universite de Lausanne, Switzerland, 2004.

[12] Dietz J.L.G., *Enterprise Ontology*, Springer-Verlag, Berlin, 2006.

[13] Vanharanta H., Kantola J., *Strategy needs structure: Structure needs ontologies – Dynamic ontologies carry meanings*, [in:] Proceedings of the International Conference on Knowledge Management and Information Sharing, Liu K., Filipe J. [Eds.], Portugal: SCITEPRESS – Science and Technology Publications, p. 261–264 (International Confer-ence on Knowledge Management and Information Sharing) Barcelona, Spain, 2012.

[14] https://www.evolute.com, March, 2016.

[15] Kantola J., *Organizational resource management: theories, methodologies, and applications*, CRC Press, p. 138, 2015.

[16] Hanhisalo T., *Agile practices and their development in a technology company*, MSc. Thesis, Tampere University of Technology, Pori, Finland, p. 76, 2017.

[17] Trzcielinski S., Trzcielinska J., *Some Elements of Theory of Opportunities*, Human Factors and Ergonomics in Manufacturing & Service Industries, 21, 2, 124–131, 2011.