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ORGANIZATIONAL FACTORS AFFECTING PRODUCT INNOVATION CAPABILITY: FINDINGS FROM THE MED-TECH INDUSTRY

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ABSTRACT
Research in innovation has resulted in much applicable knowledge in terms of tools, methods and processes. However, the challenge of allowing "space", time and competence for innovation capability development is sparsely reported. The purpose of this research is to identify how organizational and behavioral factors affect product innovation capability and its development in organizations. The research sets out to explore and elaborate on the research question: *How can product innovation capability among organizations and individuals be improved by identifying and changing organizational factors?* The individual and organizational factors need to be considered in relation to the product innovation. Theories of innovation capability, innovation and learning, innovation and creative climate are all used as a basis for this research. Interviews and a creative climate questionnaire have been used in five med-tech companies for empirical input. The qualitative result elicits six factors that influence the innovation capability and its development in organizations; brings out the two most important factors from the survey and elaborates a cross analyses from the qualitative and quantitative input.

Keywords: Innovation capability, organizational factors, creative climate, product innovation, learning & innovation

1 INTRODUCTION
Over the last twenty years the research, practice and knowledge concerning efficient processes for product development has increased dramatically and there is now a lot of knowledge available concerning tools, methods and processes. This is clearly shown, for example, in the themes at ICED conferences. However, as an effect of the recent rationalization and effectiveness efforts in industrial organizations, a further challenge has been identified which threatens long term competitiveness for several companies and communities. The challenge is the one of the "space", time and competence for innovation capability development. Tidd et. al [1] identify innovation as a highly strategic issue to organizations and the need for an innovative mind-set of the whole organization is called for. A movement for the development of innovation capability, addressing change and learning for a better innovative climate in the whole system is therefore needed.
In the same vein, several research projects and publications have highlighted organizational issues and learning matters as important and necessary for the understanding of the area of innovation capability. Ernst [2] for example, points out the lack of understanding in the relationship between organizational culture and the ability to develop successful products. In the interface of innovation and learning, Bharadwaj and Menon [3] further elaborate on the relationship between the support of creativity and learning, and the innovation capability in organizations, while Lynn, et al. [4] argue that learning in teams could increase innovation and speed to market for new products. Research in the areas of learning, organizational studies and behavioral studies therefore indicate a relationship between organizational aspects, behavior and knowledge among individuals of the same organization. However such a holistic approach to innovation research including these factors is sparsely found in previous literature.

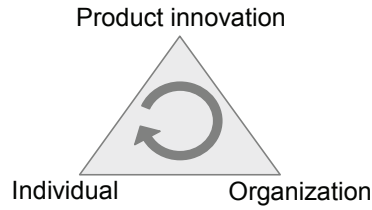

Figure 1: Model of the relations of important key factors for innovation capability.

Based on this background, the overall purpose of this research is to identify how organizational and behavioral factors are affecting product innovation capability and its development in organizations. Individual factors as well as organizational factors need to be taken into account in relation to the product innovation task as visualized in the model (Figure 1). The focus of this research is the identified factors that affect the relationships between the individual, the organization and the innovated product offering and their effects on the total innovation capability. The model can also be seen along a time axis, where the features and requirements for the product, the individual and the organization change over time. One example of this is the competencies an individual has and how it changes over time - and in turn how it affects the organization as well as the innovations. This study will explore and elaborate around the research question: *How can product innovation capability among organizations and individuals be improved by identifying and changing organizational factors?*

2 INNOVATION CAPABILITY

Innovation capability is a dynamic process which is influenced by the organizational climate and the learning attitude within an organization. An organization has to continuously evolve innovation capability through change in methods, processes and competencies when changing business environments require it. Innovation capability should be understood as developing the capacity to create innovative solutions such as products and services for new business opportunities. Furthermore it is about developing long term innovation capability in the organization as a core skill for competitiveness. The concept of innovation capability includes work procedures, organizational and technical learning, and adapting to new contextual environment [5]. The most visual outcome of an organizations innovation capability is the product innovation system. However, the ability to evolve its innovation capability depends on its fundamental preconditions at different levels, as visualized in Figure 2.

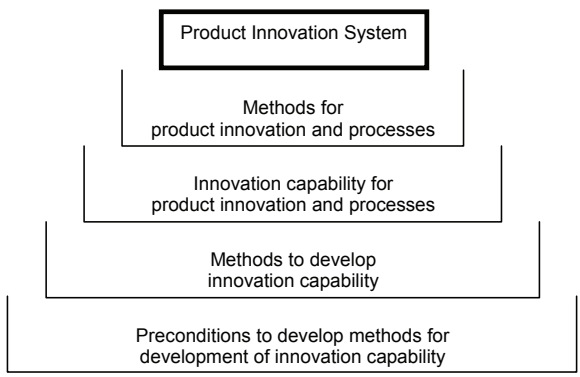

Figure 2: Description of the relationship between the product innovation system and development of innovation capability influenced by fundamental preconditions for organizational factors.

Awareness of organizational factors (e.g. leadership, employee participation, distributed strategic reflections) can help organizations create methods to develop their own innovation capability. Development of innovation capability can be viewed as a social process rather than an instrumental-

rational one where you know from the start exactly what you want to do and set up detailed goals, objectives and plans for what you want to accomplish. Accordingly, the development process of innovation capability is not primarily about making decisions and solving well-defined problems but rather about clarifying and understanding what the problems are [5].
According to Sandberg [6] when individuals perform specific tasks in an organization, learning can be described by different levels of understanding. On the first level, the individual acts and understands a direct relationship between input and output. This level includes aspects as if a product change in one parameter will affect the characteristics of the product in a predictable way. On level two the individual understands the relationship between several product parameters and how they influence the total outcome. An understanding at level three means that the individual can see the relationship between customer satisfaction and the changing of specific product parameters. This can be connected to an understanding of preconditions for development of innovation capability in an organization, as shown in Figure 2.

2.1 Innovation and learning

The relationship between innovation and learning is by nature also related to knowledge. Knowledge is something that develops in the minds of people when they are exposed to stimuli (competence/knowledge) that make them reflect on their present situation. According to Schön [7] reflection can be seen as a process where the object/content, the preconditions and the effects/consequences are analyzed. According to Kolb [8] learning involves transactions between individuals and their environment. Thus a distinction can be made between arranging learning occasions and organizing for learning in everyday settings. Döös [9] describes a concept called "relatonics", which can be defined as interactive processes between individuals who bear the competencies of the workplace. Illeris [10] argues that experiential learning predominantly takes place in actions and interactions between individuals rather than within one single individual. One reason for this view might be that experiential learning is often referred to as being a cyclic process consisting of steps of action *and* reflection, based on Kolb's [8] framework [11,12]. Kolb's [8] theory of experiential learning is an important source of inspiration in this research.

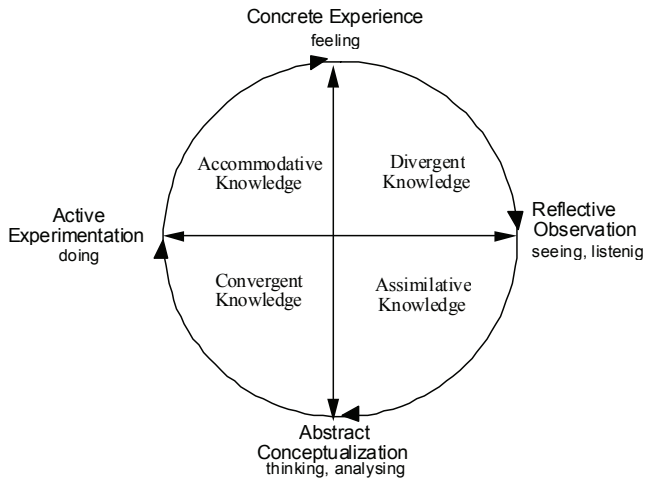

Figure 3: The experiential learning cycle adapted from Kolb [8].

The central idea according to Kolb [8] is: "learning, and therefore knowing, requires both a grasp of figurative representation of experience and some transformation of that representation. Either the figurative grasp or representative transformation alone is not sufficient." This can be compared to Cohen and Levinthal [13] who presented a model for the relationship between learning and innovation. They argue that a company or an organization has to develop not only new processes and products, but also a capability to assimilate and exploit externally available information. This can be

connected to the phase between reflective observation and abstract conceptualization in the Kolb learning cycle. This leads to innovation capability being connected to accommodative knowledge (which is developed by convergent processes), and the capability to exploit external information being connected to assimilative knowledge. Accommodative knowledge is developed by convergent processes and assimilative knowledge, (which is developed by divergent processes).

2.2 Innovation and creative culture

According to Ekvall [14], the creative climate can be regarded as an attribute of the organization. Climate plays the part of an intervening variable in the context of organizational processes, meaning that the organizational climate influences the processes that deliver innovative outcomes, which in turn affect operational results of the organization. An example of one such effect, with regard to the innovative outcome, is whether an organization produces radically new products or only small improvements in the existing products. Ekvall [14] means that the climate should differ in organizations that are regarded as innovative when compared to those that are conservative or stagnated. Innovative organizations are those who deliver profitable and innovative products or services and thereby secure survival on the market.

Thus Ekvall [14] highlights that the climate in innovative organizations delivering profitable and innovative products or services (and thereby securing their survival in the marketplace) should differ when compared to those that are conservative or stagnated.

Ekvall [14] developed the Creative Climate Questionnaire (CCQ) for analysis of organizational units where the respondent acts as an observer of life within the organization. The instrument assesses the organizational climate according to ten (10) dimensions:

- Challenge
- Freedom
- Idea-support
- Trust
- Dynamism
- Playfulness
- Debates
- Conflicts
- Risk-taking
- Idea-time

Of these, Ekvall [15] argues that risk-taking and idea-time are the most important factors. The risk-taking dimension represents the tolerance of uncertainty in the organization [14]. In the innovative organization, decisions and actions are rapid and prompt in the innovative organization and concrete experimentation (as related to Kolb [8]), occurs frequently, whereas risk avoiding organizations where committees, investigations and analysis precede every decision are often governed by a hesitant and cautious mentality [14].

The idea-time dimension refers to the time available within an organization for people to use to elaborate on new ideas that are not related to existing projects. Impulses can be tested and discussed in organizations with idea-time, while in organizations with no idea-time all working time is specified and occupied by operational matters [14]

3 METHODOLOGY

The aim of this study was to identify the organizational factors which influence the innovation capability of an organization. An explorative multiple case study method was selected, based on three considerations. Firstly, as previously stated, the concept of innovation capability is hard to define and difficult to demarcate. Accordingly, multiple perspectives on innovation capability within the organization studied were needed in order to highlight this concept. Respondents were therefore selected to represent different functions in the organization (i.e. not only R&D). Secondly, to further increase the likelihood of capturing the concept of innovation capability, different data collecting instruments, (qualitative and quantitative) were used. This opened up the possibility of capturing different aspects and also of triangulating the findings. Thirdly, to capture a variety of innovation settings, three different types of companies were included in the study; mature companies with existing line(s) of products, start-up companies and a technical consultancy company. In addition, the study was restricted to the Med-tech industry only.

The main body of the research was conducted by two pairs of researchers, who were responsible for 2-3 company descriptions each. Two additional senior researchers were involved in the design and analysis. The research process included four phases; selection of companies, creation of single case

descriptions, elicitation of key organizational factors for innovative capabilities, and a creative climate survey.

3.1 Selection of Companies

Table 1 presents the key characteristics of the investigated companies, which - although all active in the Med-tech Industry – represents three different types of organization:

Mature companies – established, with a history of development including a portfolio of products on the market, plus an established structure for how product innovation is managed within the company;

Start-ups – newly created, often on the basis of a patent (with the challenge not only of commercializing the idea but also to create a robust company), often bearing a strong resemblance to development projects run in a corporate setting;

and a technical consultancy company – providing engineering services to the above mentioned categories of companies, rather than developing their own products.

Table 1: Key characteristics of the investigated companies.

Company	*Start-up A*	*Start-up B*	*Established* A	*Established* B	*Consultant*
Founded/incorporated	f. 2003	f. 1999	i. 2003	f. 1957	f. 2005
Product area	Treatment of tumors	Riding Helmet	Respirators	Health care, with focus on mobility	Business/product development
Key customers	Hospitals	Retailers of horseback riding equipment	Hospitals	Hospitals	Industrial companies
Turnover	Clinical tests – no sales	3 MSEK	1.300 MSEK	3.200MSEK	110 MSEK
# employees	5	2	200	1730	190
Key competitive advantage	Unique product to identify and treat tumors	Unique system for protection of the brain	World leading products	Great experience within product area Large and well established org. Market leader	Customer specific solutions. Competence in product dev. management and finance.

3.2 Creation of Single Case Descriptions

Three types of data sources were used when developing the case studies: interviews, a questionnaire and secondary material such as company policies and documents.

The first data collection strategy was interviews with relevant individuals in each organization. All interviews were based on semi structured questions with an explorative purpose in order to achieve an overview of the innovation processes and the behavioral aspects of these processes in each company. All in all, 16 people were interviewed in person by a pair of researches. Several of the interviews were taped and all respondents were later contacted by telephone and sent a follow-up e-mail confirming their interview. Each interview lasted about two hours and started with a description of the purpose of the study. An interview guide was used which contained questions regarding future challenges in the companies as well as the concept of innovation capability and where it is located, characteristics of innovative behavior, competence and learning in innovative work, underlying organization and methods, evaluation of innovation projects, promotion of engineers in the company. Each interview concluded with a discussion of two dilemmas in product innovation: the relationship/conflict between creativity and structure and the relationship conflict between efficiency and innovation.

The respondents (listed in Table 2) were chosen with respect to their competence in terms of innovation strategy and processes, and to their role in the studied companies.

Table 2: Number of interviewees and their role in the selected companies

Company Position	*Start-up A*	*Start-up B*	*Established* A	*Established* B	*Consultant*
CEO/Management*	1	1		1	1
R&D Manager	1		2	1	1
Product/marketing manager				1	
Project leader				2	
Engineer, specialist	1	1		2	

*In the startup companies the founder or innovator (”carrier of company culture and history”)

The interviews were analysed following the logic in the interview guide. Under each main heading in the interview guide the core answers and discussions were described. When this process was done the researchers, responsible for the company added their own reflections or observations - for example be additional observations on what constituted innovation capability at that particular company.
The second research strategy was to use the Creative Climate Questionnaire (CCQ) developed by Ekvall [14], which analyses the creative climate in the organizations with regards to the ten dimensions. In this case study, the results of the questionnaire were used to indicatively profile each organization on an innovative/stagnating scale, and to relate these findings to the results from the interviews. In addition a seminar was held with Professor Ekvall, in order to better understand the relationship between a creative climate and an innovative organization, and specifically to identify which factors are most important. All the investigated companies took part in this survey except start-up B. The established companies were split into smaller organizational units in accordance with the advice from Ekvall (2008). Taken together, the ten dimensions from the instrument create a profile of the organization studied. The main focus in this study was analysis of innovative versus stagnating organizations.
The third data source was secondary material such as company presentations, corporate policies and project descriptions. This type of data source was mainly used to describe the formal organizational background of innovative efforts within the companies.

4 ELICITATION OF KEY ORGANIZATIONAL FACTORS

The study presented in this paper was performed to investigate five successful med-tech companies, their perception of their innovation capability and their views on how to increase this capability further.
All data collected from the interview study was categorized during a one day face to face workshop involving the whole research team. Different modes of categorization were tested until the most important factors were identified. These were then grouped into six organizational factors relating to importance for development and evolution of innovation capability summarized in the list below, and elaborated in the following sections:

- User understanding and involvement
- Resources
- Risk taking permission and environment
- Learning and reuse of knowledge
- Balancing creativity and structure
- Leadership

4.1 User understanding and involvement

It is of utmost importance to include the user and/or the buyer in the process of innovating new solutions, and this factor was mentioned by all interviewees, especially in the mature organizations. It involves really understanding the users’ environment and the problem that the new solution is to address. This aspect also includes considerations concerning the business model used in the med-tech industry, where the regulatory system is tight and the buyer is most often someone other than the end user. Strategies to come closer to these demands include scenario techniques with members from different related bodies. An important issue is to create real opportunities to understand the holistic context for the product/service to be used in the context of the user. Approaching learning in relation to user understanding is therefore important, since people in the organization need to integrate the

knowledge they have about the user into the internal innovation process, as indicated in the quote from one of the established companies:
"Innovation is about new ways of meeting customers, marketing, sales channels and business models. The important thing for us is to be perceived as innovative by the customers, which means everything is important not only technology"

4.2 Resources

There are several types of resources known to be of importance for the innovation capability of an organization. In this study we focused on the resources related to competence, time and prototype possibilities and do not discuss e.g. the financial resources needed. The potential of teams composed of members representing differences in background, age, culture and gender was found to have a positive effect on the innovation capability in the organizations studied. To further extend this multi faceted setting, each organization had committed competencies from outside the organization to help develop new ideas, creative goal oriented workshops, and integration of the resultsin different parts of the innovation process. However, all organizations (except the consultancy firm) indicated that they could see ways to further develop this external involvement, using sources such as universities and special interest organizations. The start-ups preferred to reduce university contact in the initial phases, since they already had far too many ideas and needed to implement them in the innovation process. This was expressed in the following quote:
"*The university involvement will be reduced for the benefit of product development, quality control, implementation and clinical tests"*
In contrast, the established organizations indicated a need for more university and other external input in the entire innovation process.
Existing product development projects in the mature organizations were found not to have dedicated space and time for creativity. Here the respondents reflected on fully booked calendars, reporting requirements and the priorities being set to finalize existing projects before allowing time for new creative innovation and idea generation. This relates to the idea time and idea support factors in the CCQ.
The interviews revealed how important it is to the organizations to be able to use the support of modeling and prototyping in order to make ideas more concrete and to increase understanding, learning and communication between project members and external parties. All organizations underlined the importance of closeness to modeling and prototyping facilities for the creative process in order to be able to build early and simple models. The following quote exemplifies this:
" *You need to create a prototype that we can relate to. You can talk very much, but a prototype is showing reality, we have prototyping facilities nearby which are necessary for the development work"*

4.3 Risk taking permission and environment

Risk taking was elaborated upon by the respondents and revealed a difference between the organizations. In expressing their experiences of risk taking, the respondents revealed a difference between the organizations. The established organization B exists in a risk-cautious environment, and evaluating new ideas through business case models and relying on existing product portfolios are the predominant processes, which is exemplified in the following quote:
"At some occasions there are many men in black suits that need to be convinced"
The established organization A also has procedures for business cases, but had realized that risk-taking needs to be part of the research process of new innovations as expressed in the quote:
"Research budgeting requires keeping a cool head, since you don't know where it leads"
The start-ups clearly expressed the need to take risks in order to progress their innovation processes. The respondents in all organizations indicate a need for the organizations to take risks and to separate the process for completely new ideas from the process of incremental product development. To create temporary innovative environment for radical innovation (so called innovation hubs [16]) is certainly one way to go, and one of the established organizations has in fact created a permanent version, where the group is given space for experimental learning and idea generation for new innovations.

4.4 Learning and reuse of knowledge

It became clear from the interviews that none of the organizations had a structured way of bringing knowledge gained from failures or mistakes in previous projects back into the innovation process. Nor

did they structure learning from their successes. Likewise, in the work with idea generation many ideas were not used after the screening process. The "left over" ideas seemed to be forgotten due to lack of processes to take care of them in future work. As a result, new idea generation always started from scratch, not utilizing ideas that were born in previous projects. However, in the feedback sessions with the companies in this study, they all asked for procedures to enable common reflection on experiences from earlier projects at the start of new projects. Furthermore the interviews indicated a lack of established routines to take ideas and knowledge from daily work into the innovation process.

4.5 Balancing creativity and structure

All respondents agreed that there needs to be a balance between creativity and structure in order to achieve a balanced innovation capability in an organization. Despite this common answer that you need "*both creativity and structure*", some issues did arise to indicate that achieving this balance could be challenging. The main concern amongst respondents was how to maintain the balance between structured work procedures and the space and time allowance for handling innovation and idea generation. In particular, the established organizations highlighted the importance following time and space for creative ideas, and also that they needed to work on the development of structured processes for innovative solutions.

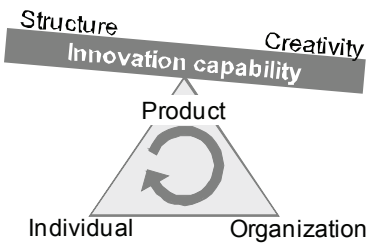

Figure 4. Innovation capability as the balance between structure and creativity is depending on the nature of product, individuals, and organization.

Two quotes highlight the importance and benefits of having the balance in an organization.
"*In the dialogue it requires one person who is visionary (the inventor) to be helped to become concrete and steered through a more structured way of working. With the combination of these capabilities and the help of structure, the inventor can become an innovator".* (established company)
" *Management need an ability to balance structure with the permission to break rules in order to make the development progress: working strictly "by the book" will never generate innovations*". (start-up company). This last quote also confirms the risk-taking aspect of the start-up that was elaborated under the factor of risk-permission.

4.6 Leadership

The leadership factor is crucial for the innovation capability of an organization. In this study we have asked specifically about leadership issues, not management ones. The interviews revealed that involving the employees in the discussion of the strategic goals of the business - and in the practical formulation of goals for the actual development task - was important in order to get commitment to the innovation work. The use of an incentive system was mentioned and reported to be used in order to value and compensate team performance over individual performance.
" *If we should measure and reward a patent, we should have at least 3-5 names on the patent application, ideas should not be kept by one person only"* (Established company)
In order to get such team efforts in place, an organization needs to create possibilities for co-operation between different parts of the organization, dedicate time and space, and give full leadership support to this entire way of working.
All of the organizations studied underlined the importance of a leadership that creates an environment that reflects trust and confidence in the individuals, has scope for debate, allows time and support for ideas and reflection, and that rewards and pays attention to employee contributions.

5 RESULTS FROM THE CCQ-SURVEY

The results from the survey are shown in Figure 5, where the curves for a typical innovative and a typical stagnated organization are also represented [14]. In the established firms A and B, six and two organizational units respectively took part in the survey, and these are represented by their mean in the diagram below.

The results show that each organization considered themselves as rather innovative. The separate groups showed some internal differences but in general all groups were found to be above the innovative curve on most factors, and in fact most results were better than the reference line of an innovative company. However, Ekvall [15] considers the key factors "risk taking" and "time for ideas" as particularly important to create an innovative organisation. As seen from the results, in our study these factors together with "conflicts" showed inferior performance in comparison to the other factors.

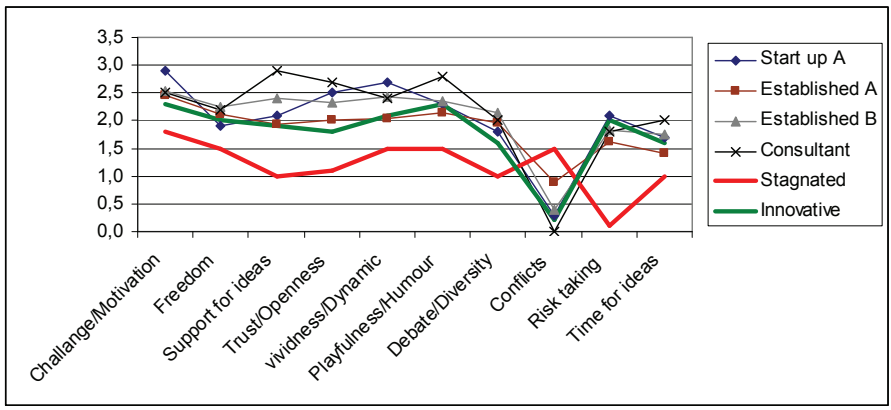

Figure 5. The summarized results of the survey in relation to a stagnated and an innovative organization.

6 CROSS CASE ANALYSIS

The qualitative input of this study elicits six organizational factors (user understanding and involvement, resources, risk-taking permission and environment, learning and reuse of knowledge, balancing creativity and structure, and leadership). The creative climate questionnaire has defined that permitting risk taking and allowing time for ideas are two of the most important factors in creating a creative climate. These factors are particularly important for the individual as well as for the organization in developing their innovation capability. The risk-taking factor directly corresponds to the risk-taking permission and environment factor elicited from the interviews in this study. Indirectly, it relates to the factors of leadership and balancing creativity and structure. The idea-time factor in the CCQ corresponds indirectly to the factors of user understanding and involvement, resources, leadership, learning and reuse of knowledge, and balancing creativity and structure, as elicited in the qualitative analysis.

The risk taking factor varied among the studied organizations. The start-ups clearly showed a higher level of risk-taking than the established organizations, in both the qualitative and quantitative results. The variance in risk-taking is however, obvious at the established organizations, both between them and also within them among different departments. Risk avoidance was expressed in the qualitative interviews in the established organizations, pre-dominantly in the discussion about the urge for fulfilling business case templates and getting management approval before new ideas are taken into projects. The survey confirms this by showing a lower value on this factor, particularly for the mature organizations where structured product planning processes prevail.

Related to the idea-time factor of CCQ, the interview responses regarding the balance between creativity and structure revealed an anxiousness to get time and space for working on new ideas and experiments, a factor that showed little variance in the survey, especially from the established organization A. The respondents in A also confirmed this anxiousness by asking for more non-allocated time for ideas. The start-up companies however, were looking for more structure and less time spent on idea generation since they felt that they already had too many ideas. The business idea

behind the consultancy firm was to help organizations with idea generation and methods for innovation, and they scored highly on this factor in the survey.

7 CONCLUSION & DISCUSSION

The qualitative study indentified six factors that are related to the innovation capability of an organization. All six factors are related to the dimensions of the CCQ instrument, and constitute part of these dimensions in different aspects. The results from the interviews and the surveys support each other and stress the importance of having time to freely debate ideas throughout the organization. The most important factors for an innovative company - time for ideas and risk taking - are the most urgent to be improved in order to develop innovation capability, according to the survey and the interviews. Another factor that needs attention in the development of the innovation capability, and which was specifically brought out in the interviews, is the need for increased user understanding and user involvement.

Today changes of organizations are much influenced by lean production thinking and a focus on standardization of working routines. Standardization is important in order to improve process quality, but if standardization decreases "risk taking" and reduces time and support for ideas, innovation capability can be inadvertently lowered. The balance between structure and creativity can also be described as a balance between divergent and convergent knowledge, according to Kolb (1984) as seen in Figure 3. An individual working with innovation in an organisation should have enough space and time to perform active experiments and to gain user insights and understanding by involving themselves in user contacts.

Innovation capability can be defined as the capability to handle future problems and challenges. It is important not only to think of the situation today, and this can be extended to the role of undergraduate education programmes. It is vital that the future needs of companies and organisations start to have a greater influence on the content and learning outcome of courses at universities.

This study can be seen as an action research study. The overall aim has been to develop new knowledge about the relationship between organizational factors and innovation capability, and in parallel to this our intention is to improve the innovation capability among the participating companies. Results from interviews and questionnaires have been discussed with the companies at feedback meetings, and based on these, some of the companies will participate in forthcoming projects, in order to continue to work on increasing their innovation capability via joint efforts between themselves and academia. The interview and questionnaire methods used in this initial study will be complemented by other methods e.g. learning network workshops and feedback seminars in the forthcoming study.

In addition to this, it is our intention to continue the research in the organizations that participated in the present study. This will be done through follow up investigations, new feed-back loops and joint learning network meetings, in accordance with the Kolb (1984) learning loop.

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We also give our gratitude to Professor Ekvall for his engagement and contribution to our understanding of the CCQ instrument and analysis.

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