

EXPERIMENTATION IN INNOVATION: FACTORS AFFECTING EXPERIMENTATION IN ORGANIZATIONS

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1. Introduction

"The notion that innovations can be studied or analyzed into existence flies in the face of history and fact" [Schrage 2000, p. 2]. Rather, they emerge from *serious play* with uncertainties [ibid]; through iterative prototyping, simulating and modeling activities, exploring different alternatives through trial-and-error. However, much of the formal innovation activities in current organizations are characterized not by exploring but by planning: sequences of pre-planned phases and inspection points involving activities that have to be undertaken in order to turn the invention into a commercial product or service [Smith 2006]. Phased approaches, such as the well-known Stage-Gate model [Cooper 1983], are intended for environments where there is enough information to make a plan at the outset of the project, i.e. the level of uncertainty is relatively low. These planning-driven approaches become inappropriate in explorative innovation settings where neither customer requirements nor technologies are known at the outset of the project [Lenfle 2008], and this information needs to be created through explorative experiments, aimed at learning and discovery. Hence, organizations that aim to stay at the forefront of innovation by introducing innovative new offerings, face a need to master experimentation-driven approaches to innovation – in addition to the planning-driven ones.

The idea of early, rough and iterative experimentation as a key driver for creating novel offerings and entirely new businesses has been surfacing in discussions within popular management and business literature during the last years (e.g. [McGrath and MacMillan 2009], [Ries 2011], [Tuulenmäki and Välikangas 2011]). Also the concept of design thinking has been promoting iterative prototyping as a key design practice that benefits managers facing the need to innovate in uncertain environments (e.g. [Kelley 2001], [Brown 2008], [Liedtka and Ogilvie 2011]). Design thinking is an example of an explorative approach to creating new solutions, and an example of the experimentation-driven approach to innovation. It sets out to discover and understand both the opportunity (e.g. unmet need, problem to be solved) and possible solutions through an iterative exploration process. All these above mentioned contributions build on the idea that in unpredictable, complex and unclear environments, it is more sensible to act into the future instead of planning into the future, i.e. to be experimentation-driven rather than specification-driven.

Experimentation is a fundamental innovation process activity [Thomke 1998] and nothing new as such to the management world. However, it has been noted that the barriers to making experimentation an established approach to innovation in organizations are deep-rooted and numerous, and establishing an experimentation-driven approach to innovation requires companies to overcome several internal obstacles [Cannon and Edmondson 2005], [Lenfle 2008], [Anderson and Simester 2011]. Previous research on creative work provide some insights into experimentation through the study of creativity at large, but little research has set out to directly examine experimentation and organizational conditions

that promote experimentation [Lee et al. 2004]. Furthermore, the recent discussion around design thinking as an innovation approach has raised the concept of prototyping to the lips of innovation managers (e.g. [Brown 2008]), but it has provided little or no knowledge on how to interpret the idea of “prototyping early and often” into non-design contexts, by non-designers. Neither has it built on the existing research in the fields of leading creativity or design research.

In this paper, we present the first step of a research project aimed to create deeper understanding of the organizational and individual factors affecting experimentation. This paper focuses on identifying factors affecting an individual’s experimentation behavior, either by encouraging or by discouraging experimentation. Furthermore, we aim to take steps towards building a linkage between the disconnected management and design discourse on design thinking, by exploring the interpretation of one design practice to a context beyond design, by non-designers. We propose experimentation-driven approach to innovation as a notion of iterative prototyping beyond the fields of design. With this research, we aim to move the conceptual discussion of prototyping in non-design domains towards a more practical one by proposing a set of guidelines for supporting experimentation in organizations. In the following chapters we first discuss the concept of design thinking and existing research on creative work. We then continue to introduce the research conducted for this paper. Drawing from the empirical research we present six categories of factors to take into consideration when adopting an experimentation-driven approach to innovation. These factors provide guidelines for managers who aim to create appropriate conditions to experimentation.

2. Experimentation in creative work

After the turn of the millennium, the concept of design thinking has been gaining increasing interest among the business and management literature, characterized by works such as Brown’s article on design thinking in Harvard Business Review in 2008 [Hassi and Laakso 2011]. In this popular, non-theoretical, managerial discussion, design thinking is presented as an innovation approach and a methodology deriving from the design disciplines, applied by non-designers to deal with complexity and ambiguity beyond the design context [Hassi and Laakso 2011], [Johansson et al. 2013]. This recent managerial interest in design thinking has been viewed critically in the academic world, mainly due to the lack of theoretical base and to the disconnect from the design discourse and the related academic research [Badke-Schaub et al. 2010], [Hassi and Laakso 2011], [Johansson et al. 2013]. This disconnect hinders both the cumulative knowledge construction [Johansson et al. 2013] and the development of the full potential of the approach in the realm of management. The interest for design thinking can be seen to reflect a need within management for a different, less analytical and planning-driven approach to innovation. To avoid design thinking becoming just a passing phenomenon in popular management discourse and to explore its full potential, what is needed is establishing an academic base for the managerial discourse on design thinking, linking it with the design discourse, and developing them both in parallel.

Design thinking starts with designer’s way of working and sense-making, and proposes that non-designers, for example managers, can benefit from this approach when facing complexity and uncertainty (e.g. [Brown 2008], [Cooper et al. 2009], [Lockwood 2010]). If we build on the idea of design thinking as applying design practices beyond the design context, by non-designers (e.g. [Dunne and Martin 2006], [Brown 2008, 2009], [Liedtka and Ogilvie 2011, 2012]) we need to understand what practices are we referring to, what are the possible application areas, and how can those practices be interpreted into these new environments. Iterative prototyping is one central design practice in any design discipline and it has been a focus of attention for research in the design discourse (e.g. [Yang 2005], [Gerber 2009], [Gerber and Carroll 2012]). Prototyping is also central in the concept of design thinking where an experimental and explorative mindset, readiness to “fail fast” and rapid, iterative development cycles are emphasized [Hassi and Laakso 2011]. Prototyping is essentially about experimentation; it is an iterative process, where solutions may be modified or new solutions may be developed until a ‘satisfying’ solution has been found [Simon 1969]. In this trial-and-error process, each trial generates new insights on a problem (e.g. [Thomke 1998]), and the consecutive cycles repeatedly generate and test new alternatives [Simon 1969].

Experimentation can be seen as one activity in creative work and as a mean to manage the uncertainty in the complex and unclear challenges often related with creative work. Creative work is often described to involve the solving of complex, ill-defined problems requiring the generation of novel, useful solutions [Ford 2000]. In addition to idea generation, creativity involves the evaluation and implementation of ideas [Mumford et al. 2002]. Important part of the idea evaluation is the progressive refinement of potentially useful ideas [Barlow 2000] e.g. through experimenting. There are previous studies on supporting creative work that raise aspects to be considered also when studying specifically experimentation. Earlier studies have noted work environment to have an important role in affecting people's willingness to engage in creative efforts and the likelihood to succeed in them [Amabile et al. 1996], [Amabile et al. 2004]. Above all, the role of immediate leaders in impacting employee's daily experience on the work environment has been regarded as significant [Amabile et al. 2004]. By directing and evaluating the work, providing the access or impeding it to resources and information, being involved in employees' engagement with tasks and other people [Amabile et al. 2004], and facilitating idea production, experimentation, and the implementation of these ideas into new products [Mumford et al. 2002], immediate leaders, play a significant part in how employees perceive their work environment [Mumford et al. 2002], [Amabile et al. 2004]. Considering the managerial level, several behaviors have been suggested to support the creative efforts of individuals. It has been noted, that successful leadership of creativity and innovation requires for example encouraging exploration [Hohn 2000], [Mumford et al. 2002], acting as a role model [Amabile 1997], [Farson and Keyes 2002], encouraging intellectual stimulation [Waldman and Bass 1991] and providing autonomy [Amabile et al. 2002] among others. Further, establishing a climate, which supports innovative pursuits, has been noted to be essential [Edmonson 1999], [Barckzak and Wilemon 2001], [Amabile and Khaire 2008].

Organizational encouragement of creative efforts on the other hand has been suggested to involve such things as encouragement of risk taking and idea generation, supportive evaluation of ideas, and reward and recognition of creative efforts [Amabile et al. 1996]. Further, Cannon and Edmonson [2005] suggest, crucial steps in tuning an organization towards more experimentation-driven are choosing the right indicator for success and effectiveness and having the reward systems and incentives for experimentation aligned with the organization's values of innovation. Further, the organizational infrastructure needs to be designed to support the running of experiments [ibid]. This includes at least necessary technology, e.g. software to structure and analyze the tests, a process for designing, running and analyzing experiments and means to capture learning – as well as a central organization that provides expert support for all that [Davenport 2009]. Furthermore, also specific technical skills are critical in implementing an experimentation-driven innovation. Employees need proper knowledge and skills for designing, executing and analyzing experiments [Cannon and Edmondson 2005]. Rigor is needed to design experiments that will effectively confirm or disconfirm initial assumptions and to generate useful learning. The need for technical skills for experimentation runs across the organization. If management is not well informed and trained to evaluate experiments good ideas may be rejected [Schrage 2006].

3. Methods

To investigate the organizational and individual factors affecting experimentation-driven approach in organizations the present study adopted a qualitative study approach based on three organizations.

3.1 Data collection

In order to research experimentation in the organizational context, the researchers launched an experimentation challenge in the volunteering departments of three different organizations (see Table 1). The aim of the experimentation challenge was to encourage the participants to develop ideas further through a series of experiments. The length of the challenges varied from 24 days to 35 days. The data was collected through semi-structured interviews during March-April 2013. All the interviews were held in Finnish, the mother tongue of the interviewees and therefore all the excerpts presented in the thesis have been translated into English. The resulting 10 interviews lasted between

20 and 58 minutes, averaging at 39 minutes. The interviews were carried out by two researchers and all the interviews were audio recorded and transcribed for analysis.

Table 1. Information of data collection

	Organization A	Organization B	Organization C
Industry	Retail chain, profit organization	Foundation-based non-profit organization, nationwide service provider and developer to a special needs group	Non-profit organization offering support services as well as training and communication services to an ideological organization
Number of people participating to the experimentation challenge	8 participants	10 participant	6 participants
Number of interviewees	4	2	4

3.2 Data analysis

The transcripts of the 10 interviews were screened for segments [Chi 1997] independently by three researchers, describing organizational or individual factors that had either encouraged or discouraged experimentation behavior. This resulted in 168 segments, which were categorized into mutually exclusive repeated themes on thematic similarity. The categorization resulted in six categories: climate, supporting structures and practices, leadership behavior, managing experiments, know-how, and attitude. These categories were then further grouped under three main classes describing the level in where the activity was appearing: organizational level, managerial level and individual level (see Table 2).

4. Results

From the data, we identified an initial set of organizational, managerial and individual factors that affect experimentation behavior. Next, we present and define six categories of factors to take into consideration when adopting an experimentation-driven approach: climate, supporting structures and practices, leadership behavior, managing experiments, know-how, and individual attitude. These categories received a rather equal number of mentions in the interviews, with the exceptions of two categories: Managing Experiments –category was mentioned considerably more times (58) and Attitude-category considerably fewer times (13) compared to others (21 - 30) (see Table 2).

Table 2. Organizational, managerial, and individual factors affecting experimentation

	Category	Description	Examples	No. of mentions in interviews
Organizational level	Supporting Structures and Practices	Structure, tools, methods, practices, processes for experimentation, provided by the organization	Weekly routines and organization of teamwork, documentation of experiments, ways to share information, tools gathering feedback from experiments, and protocol for running experiments.	30
	Climate	Attitudes, feelings, and behaviors that characterize the work environment for experimentation in the organization	Collaboration, trust, and openness between colleagues, delivering critique, sharing experiences from past projects, attitude towards new ideas and change, handling of failure, ambiguity and incompleteness.	21

Managerial level	Managing Experiments	The actions of the leader in managing experimentation efforts on individual, project and on organization level	Prioritization of experiments, timing of experiments, resource allocation, goal setting, managing incentives, communicating about experiments within the organization and giving visibility to the development activities	58
	Leadership Behavior	The way the superior acts and demonstrates commitment towards new ideas and experiments.	Attention given to employees' ideas and experiments, how leader demonstrates listening, caring support and encouragement, personal involvement of the leader in experiments, leading by example.	22
Individual level	Know-how	The practical skills and conceptual understanding of experimentation as and development approach.	Understanding the requirements and core concepts of experimentation, knowledge and technical skills on how to design, execute, and analyze experiments, awareness of different experimentation methods and their applicability to different situations	24
	Attitude	Factors influencing the willingness of an individual to engage in experimentation	Attitude towards change and newness, behavior when facing challenges, ability to take initiative, belief in one's abilities to complete tasks	13

4.1 Organizational level

This class involves those factors affecting experimentation that are managed on the level of the entire organization. It consists of two categories: climate, and supporting structures and practices. Mentions to climate-related issues were made 21 times in the interviews, and mentions to supporting structures and practices of the organization were made 30 times.

4.1.1 Supporting structures and practices

Supporting organizational structures and practices are the frames within which the management of experiments takes place and individual experimentation know-how is transformed into effective experiments. This category entails the structure, tools, methods, processes for experimentation provided by the organization, as well as the informal but established practices and ways of working. This is in contrast to the managing experimentation –category, which is concerned about doing - i.e. what specific actions are done by the management.

This category includes aspects such as time-allocation for experiments in the day-to-day schedule of an employee, enabling teamwork time-wise so that the right people are able to be in the right place on the right time, and building time-dependent routines such as weekly ideation meetings. Furthermore, the ways of working related to experimentation include the documentation of experiments, ways to share information, and tools that are used to e.g. gather feedback from experiments and manage the explorative development projects that the experiments are part of. Finally, the structure that an organization can provide related to experimentation includes specified processes and protocol, with the purpose that employees know what to do at each point of the experiments and how to proceed in different phases of experimentation. This includes having explicit checkpoints or intermediate goals, knowing when and if approvals are needed and from whom, and how to get support when needed.

4.1.2 Climate

The climate-category consists of the attitudes, behaviors and feelings that characterize the work environment where experimentation is to take place. This includes the level of collaboration, trust, and

openness between colleagues, handling and delivery of critique, and how experiences and examples from the development of new ideas are shared. Experimentation behavior is also affected by the organization's self-image, a more general attitude towards new ideas and changes, how those ideas and changes are supported and encouraged, and whether or not the organization is seen to appreciate or expect innovative behavior. As experimentation is part of exploration, the organization's willingness to tolerate ambiguity, incompleteness, and failure are also important for the overall climate.

4.2 Managerial level

This class involves factors affecting experimentation that are in the hands of managers. It consists of two categories: leadership behavior and managing experiments. Mentions to leadership behavior were made 22 times in the interviews, and mentions to issues related to managing experiments were made 58 times.

4.2.1 Managing experiments

Where leadership behaviour -category is more about the way managers act - the how -, managing experimentation -category is about specific management actions - the what - within the organization. These actions can be divided into three groups: managing multiple experimentation efforts, job expectation, and the visibility of the development activities. Managing multiple experimentation efforts means actions such as the prioritization of on-going experiments in terms of resource allocation and timing, assigning responsibilities and clarifying goals for experiments, as well as managing situations of unexpected successes and failures, and their effects on other experiments. Managing job expectations refers to the alignment of the expectations between the employee and the organization in regard to the innovation efforts of the employee. From the employee's perspective this means understanding the importance of innovation efforts in relation to other tasks and responsibilities. For an organization the alignment means setting non-contradictory goals, as well as providing incentives and resources that support the desired behaviours. Lastly, visibility is about having idea development included in the day-to-day conversations and communication of an organization, and the level of transparency of development activities throughout the organization. These actions include consistent reminders to try new ideas, discussions about them, and sharing of examples and celebrating successes from elsewhere in the organization, as well as from the outside.

4.2.2 Leadership behavior

Leadership behavior concerns the way the superior acts towards new ideas and experiments, and how this behavior demonstrates commitment to experimentation as a development approach. This consists of the manner in which experimentation as a development approach is appreciated by the leader, how much attention is given to employees' ideas as well as to past and present experiments. Acknowledgement from leaders to experimentation efforts was considered key for forming and maintaining a climate that supports experimentation as well as affecting directly the commitment of the individuals carrying out the experiments. How the leader demonstrates listening, caring, support, and encouragement in regard to experiments was considered a central factor. Furthermore, the personal involvement of the leader in experiments and other development activities, as well as other forms of "leading by example", are included in this category.

4.3 Individual level

This class involves individual level factors that affect experimentation. It consists of two categories: know-how and attitude. Mentions to know-how were made 24 times in the interviews, and mentions to issues related to an individual's attitude were made 13 times.

4.3.1 Know-how

Know-how is about individuals' conceptual understanding of experimentation (being able to tell how it differs from e.g. rapid implementation) and about their technical skills to use experimentation as

development approach. Categories know-how and supporting structures and practices are closely related, and the difference is in the perspective: supporting structures and practices are provided by the organization, whereas know-how relates to the individuals' ability to utilize the structure and practices provided. Understanding experimentation as a concept relates to knowing what counts as an experiment and what does not, what is the purpose behind doing experiments in the first place, being aware of the approach's benefits and drawbacks, and understanding when experimentation is a suitable development approach. The technical skills are about being able to think both in terms larger strategic goals and small steps for reaching them. This includes knowing how to move forward with the idea and how to evaluate progress; understanding the phases of the process, being aware of various means of creating and collecting information as well as evaluating and analyzing that information, knowing when to iterate, and how to take failures as learning experiences.

4.3.2 Attitude

Certain individual attitudes were found to influence the willingness to engage in experimentation. These factors can be divided in three distinct classes: individuals' resistance to change, learned helplessness, and self-efficacy. Individual's resistance to change can be observed in her ability to step out of the comfort zone, try new things, seek challenges, general attitude towards change, closed-mindedness, and fear or hostility towards new things. The above factors can be said to be more related to individuals' personality, but there is also indication of "learned helplessness" - the result of external forces having over time reduced the individual's gumption/initiative to respond to opportunities for improvement. Self-efficacy, that is the individual's perception of her own abilities to complete tasks and reach goals, can be observed as taking initiative, courage, positive self-esteem and assertiveness in the development of ideas.

5. Discussion and Conclusions

The results of the present study provide further support for previous research on creative work from different authors and disciplines. However, to our knowledge, the research presented in this paper is the first attempt to study directly and holistically experimentation behavior in organizations, whereas the existing knowledge on the topic is fragmented in different research streams and has mostly been studied as part of creativity or for example psychological factors related to prototyping [Gerber and Carroll 2011]. First of all, as the study showed, having a supportive climate for experimentation is a central organizational factor influencing experimentation behavior, which has been identified critical also in supporting creative pursuits by many authors (e.g. [Edmonson 1999], [Barckzak and Wilemon 2001]). Further, supporting structures and practices, such as time allocation for experiments, checkpoints and intermediate goals, are needed for experimentation to happen. Given the uncertain nature of creative work, actions reducing uncertainty and creating structure for the ill-defined challenges are essential as the earlier studies have noted (e.g. [Mumford et al. 2002], [Cannon and Edmondson 2005]).

Further, this study supports previous studies showing the critical role of immediate managers in demonstrating valued behavior, for example through role modelling, [Amabile 1997], [Edmonson 1999], [Cannon and Edmondson 2005] and providing encouragement and support [Mumford et al. 2002], [Amabile et al. 2004]. In addition, the managers have an important role in providing sufficient resources for pursuing the generation and implementation of different solutions in creative work, a fact recognized in the earlier studies as well (e.g. [Mumford et al. 2002]). Having time for exploring different perspectives and playing with ideas has been suggested to be one of the most important resource in creative work [Amabile et al. 2002], which was also demonstrated clearly in our study.

The study of Cannon and Edmondson [2005] noted that technical skills, i.e. proper knowledge and skills for designing, executing, and analyzing experiments, to be critical for the organization to learn from failure - which is a central part of experimentation. Similarly, our study also showed practical skills and conceptual understanding of experimentation (category: know-how) to be one of the factors influencing experimentation behavior on the individual level. Finally, the individual's attitude towards newness and challenges, alongside her belief in her own abilities, affected the experimentation

behavior. Related research in for example self-efficacy can be found in creativity research, but further research within the experimentation context is needed.

We have also proposed to build linkages between the currently disconnected design and management discourses on design thinking, in order to initiate cumulative knowledge building on the topic of experimentation. Here we have viewed specifically the prototyping activity of design and suggest viewing prototyping as a form of experimentation. For understanding and developing further the concept of experimentation behavior in organizations, the works of for example Schrage [2000, 2006] or Gerber and Carroll [2012] from the design discourse offer several valuable insights also for “non-designers in contexts beyond design”. Similarly, we hope the future research in experimentation behavior in organizations provides valuable insights also to the design discourse.

When aiming to establishing the right conditions for experimentation-driven innovation, all three levels need to be taken into account: organizational, managerial, and individual. However, the research provided some initial indicators that the factors within the categories differ in their strength of effect. One example was noted between the attitude-category and supporting structures and practices - category; an individual with strong drive to take initiative and belief in her abilities might well develop her ideas through experiments even in cases when the supporting structures and practices are not well provided, whereas in the opposite case it is unlikely the person would experiment new ideas even with supporting structures and practices in place. Also, leadership behavior seemed to have a strong affect on experimentation behavior, and non-supportive leadership behavior can hinder experimentation-behavior dramatically. In one example the employees were actively preparing for experiments, but the leader became the bottle-neck. The leader wanted to control all experiments, but due to his lack of time for this task most experiments never took place, and the employees never experienced the value of their efforts. Furthermore, the industry and the proximity to the client-interface seem to have some affect on experimenting, although it was not brought up in the interviews. In organizations where the research participants were daily in direct contact with the customers, more experiments were carried out and the participants reported less difficulty in experimenting new ideas.

With this research we hope to provide managers with practical insights for how to create the right conditions for experimentation and support experimentation in practice. The six categories indicate which areas to take into account. Moreover, with the examples we have raised from the research we hope to provide practical advice for managers aiming to support experimentation behavior. For example establishing weekly routines for experimentation (e.g. team meetings), sharing experiences from past experiments, and setting incentives that encourage experimentation are all examples of actions managers can take. The research presented in this paper is the first step in a research project aimed to create deeper understanding of the organizational and individual factors affecting experimentation. The results of this first research give direction for future research questions, such as for example the interrelatedness of different factors and the affect of distance to the client-interface. Future research will also critically view the initial framework presented in this paper, as well as aim to better define and deepen the understanding of the different categories and factors affecting experimentation. Furthermore, future research will aim to distinguish more clearly between supportive and hindering factors.

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