ABSTRACT
This paper discusses the findings of an empirical study and an action research on factors that influence and drive multidisciplinary collaboration. The research was carried out during projects using a fast-paced collaborative innovation approach in one of the largest electronics firms in the world. In such context, collaboration poses multiple challenges to the successful project outcome. Therefore, the main research problem was: what factors aid collaboration in this context. As a result, a framework of factors that influences and drives it was devised. Based on the framework, an application that helps facilitators to deal with its challenges was designed. While initially the focus was on the entire course of a project, during the action research the emphasis shifted to factors that influence the initial stages of team development: ‘clarity’, ‘trust’, ‘conflict’ and ‘personal values’. These factors can build a solid base for optimal multidisciplinary collaboration. Together with the rest of the framework they can provide the facilitator with a structure and awareness of how to optimize the collaboration in the context of the approach.

INTRODUCTION
Nowadays innovation is often about the embodiment of ideas, values and beliefs created with a multidisciplinary approach (Zelenko & Felton, 2013). The collaborative practice usually poses challenges to individuals who must work together but have different goals and values (Holland et al., 2007). In this paper we have studied one of the largest electronics companies in the world. Focused in the areas of healthcare, consumer lifestyle and lighting, this firm uses multidisciplinary collaboration in its daily practice. Specifically difficult are the projects using fast-paced collaborative innovation approach. Developed and facilitated by the design department of the firm, these projects are carried out in multiple iterative loops of a day to a week. Prototypes and value propositions are created early in the New Product Development (NPD) process. The major challenge is the collaboration between people with diverse cultural and professional backgrounds coming from within and outside the firm. Usually participants have never worked together and come with pre-fixed ideas of how the project is supposed to go. The main research problem was: what factors aid collaboration in this context.

An empirical and an action research were carried out. The aim of the empirical research was to uncover the
critical factors that influence and drive multidisciplinary collaboration in projects using this approach. Based on the research results, an action research was carried out and different solutions that can help facilitators of such projects to increase the chances of a successful project outcome were designed.

LITERATURE AND THEORY

The question guiding the literature review was: ‘what are the factors that influence and drive multidisciplinary collaboration?’. Many examples and success formulas can be found in the literature. Some studies point at external factors for the team like professionally stimulating and challenging work environments (Wallgren, 2011; Thamhain, 2012); opportunity for accomplishments and recognition (Parker, 2003; Webber, 2002; Pierce, Kostova, & Dirks, 2001); clearly defined authority relations (Thamhain, 2012; Hackman, 2002; McDonough III, 2000); maturity of the project team (Hackman, 2002); and project visibility and popularity (Thamhain, 2012).

Others focus on internal team factors. Establishing clear team goals, tasks, purpose, mission, plans, core norms of behavior and communication are frequently mentioned factors (Campany, Dubinsky, & Druskat, 2007; Thamhain, 2012; Beckhard, 1972; Kets De Vries, 1997; Duygulu & Çiraklar, 2009; Hackman, 2002). Job skills and expertise of the team members appropriate for the project work are also important (Webber, 2002; Levine & Moreland, 1990). Team members who have worked successfully together in the past should also be considered (Webber, 2002) as well as the overall directions and team leadership (Hackman, 2002; Lencioni, 2002; Harvard Business School, 2007). Last but not least, several studies have demonstrated the role of the interpersonal trust, respect, and credibility among team members and their leaders as a moderator of effective teams and successful projects (Burke et al, 2007; Dirks, 1999; Dayan & Di Benedetto, 2010; Kets De Vries, 1997).

In addition, the collaboration is influenced by team members’ personal networks and integrity (Ancona, Bresman, & Caldwell, 2009; Steinfeld & Walker, 2007), sufficient time to map the expertise of others (Ancona, Bresman, & Caldwell, 2009) and personal values (Brannen & Salk, 2000; Leung, Bhagat, Buchan, Erez, & Gibson, 2005). Barriers that hinder team collaboration such as unresolved conflict (Kets De Vries, 1997; Buur & Larsen, 2010; Clarke 1991; Jehn & Marnix, 2001), groupthink (Janis, 1972), self-censorship, (Kets De Vries, 1997) and differences in language and jargon (O'Daniel & Rosenstein, 2008) have to be taken into consideration, too.

The literature review helped in defining a solid base of factors to look for during the empirical study. It also provided better understanding of the different influences on team dynamics in similar to the researched contexts.

DATA AND METHODS

The results collected during the literature review contributed to making the research question more specific: ‘what are the critical success factors for creating optimal conditions for multidisciplinary collaboration during fast-paced collaborative projects in the researched firm?’ A participatory action research and 12 retrospective interviews were conducted, carried out mainly with participants and facilitators of the observed projects. The participatory action research was applied with the means of fly on the wall and participant observations (Blessing & Chakrabarti, 2009) within 4 collaborative projects. All of them used the collaborative approach, had different duration, stage of development and facilitators.

The results were collected in daily journal entries and detailed transcriptions of each interview. The initially gained insights were clarified and confirmed by the subsequent interviews and observations as well as by further in-depth literature study.

This was followed by an action research that narrowed down the scope to the critical factors that influence the initial stages of team development. It was carried out while developing different design concepts that solve the uncovered during the empirical study problems.

EVALUATION OF DATA

Standard qualitative data analysis methods such as content analysis, color coding and affinity diagraming (Martin & Hanington, 2012) were employed. In order to evaluate and summarize the collected data, they were complemented by both inductive and deductive clustering.

A general structure and direction for the field investigation were provided by the literature review. After that the data from the carried out observations and interviews were collected and analyzed. This helped in uncovering common patterns. Then clusters for each method were defined, consisting of quotes in order to provide a sufficient level of context and
depth. Each quote was later on simplified and summarized in a short phrase. The data were further analyzed with the use of multiple mind maps in order to achieve mutual dependency and consistency.

RESULTS

All of the uncovered factors from the literature review and the empirical study were placed together in a framework. Categorized in five different clusters – ‘Before’, ‘During’, ‘After’, ‘Barriers’ and ‘Context’, it served as a starting point in the design of a solution. The framework can be found in the Appendix.

<table>
<thead>
<tr>
<th>Before</th>
<th>During</th>
<th>After</th>
<th>Barriers</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear hypothesis</td>
<td>Clear rules, scope and methodology</td>
<td>Clear results</td>
<td>Limited availability</td>
<td>Clear context</td>
</tr>
<tr>
<td>Pre-selected teams</td>
<td>Externalization of ideas (prototypes, drawings)</td>
<td>Consolidation of new learning</td>
<td>Non-structured process</td>
<td>Enthusiastic business owner</td>
</tr>
<tr>
<td>Initially briefed team</td>
<td>On-going dialogue</td>
<td>Pre-fixed ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personality fit</td>
<td>Fun</td>
<td>Tight time frame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept level of thinking</td>
<td></td>
<td>Distraction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: Part of the factors from the empirical study

Based on the framework and a brainstorm session with several stakeholders, two design concepts were developed. Both of them are aimed at helping current and future facilitators of the approach to deal with the challenges multidisciplinary collaboration imposes. They also outline and explain the framework. The first one is a corner dedicated to the approach. There the values and beliefs behind it are showcased. The concept also provides a physical space where facilitators can sit together and discuss the approach. The second one is a sketchbook that explains the approach and the uncovered factors. An interactive element was added as well by using augmented reality. Both of the concepts are paired with an app giving an access to a database of methods. The methods are aimed at guiding facilitators handling the challenges of collaboration. To do that, they deal with the ‘Before’, ‘During’ and ‘After’ stages of a project. They also help the facilitators to cope with the projects’ ‘Barriers’ and ‘Context’.

The sketchbook was selected as a final concept. The choice was based on the input of different stakeholders from the design department of the firm and several evaluation matrices. The book is divided in three main sections. ‘Why’ explains the values and beliefs behind the approach. ‘What’ discusses case studies and ‘How’ provides guidelines on how optimal conditions for collaboration can be created. The book also serves as a branding guideline of the approach. In the accompanying app, facilitators can search for methods while preparing the project. The app helps them to envision and solve problems and nudges them to add the successful methods afterwards. The main idea, however, is to encourage facilitators to share their experience and learn from each other. Ultimately, it leads to building a community around the approach.

Now our question was, would this concept help in dealing with the challenges multidisciplinary collaboration poses on the successful outcome of a project. Would facilitators use it, was another important question. To answer that, the concept was tested with facilitators who have different levels of experience with the approach. They were given the prototype and were walked through its features. They
were also asked to perform certain tasks such as adding a method and searching for one. Afterwards interviews were carried out.

The initial feedback was positive and various suggestions were made. However, all facilitators said that they will probably not use the book more than once and the augmented reality is not a crucial feature. They also pointed out that they are mostly interested in giving a good start of a project. They consider this to be the most difficult part.

As a result, the concept was simplified and only the app was further developed. Some of the screens can be found in the Appendix. The app still provides facilitators with a medium where they can share their experience, add and review methods and learn from each other. It also gives them an option to create a personal profile. There they can publish case studies and discuss them with other facilitators. The app informs the facilitators about all of the uncovered factors, but pays attention to the ones that help with the initial stages of team development. To do that it gives each facilitator daily tips. The daily tips are also used to communicate the values and beliefs behind the approach.

In order to uncover factors that can help in creating a solid base for a successful collaboration, an in-depth literature study on factors that influence the initial stages of a multidisciplinary collaboration was carried out. The uncovered factors were cross-referenced with the collected observation notes and the transcribed interviews. As a result, four factors emerged. The first one is ‘clarity’ of expectations, communication and team goals. ‘Clarity’ can stimulate better cooperation and ensure team members’ confidence in the direction of the project (Dewald, 2002). The second factor is ‘trust’, seen as a moderator of effective teams and successful projects (Burke et al, 2007; Dirks, 1999; Dayan & Di Benedetto, 2010). ‘Conflict’ should also be considered as it is better to have “conflict openness norms” than no conflicts (Jehn, 1995). Conflict is also likely to have a role in decision making points where problems or concerns need to be communicated by team members (Lovelace et al., 2001). Last but not least, attention has to be paid to the ‘personal values’, the bridge between the other three factors, as they define attitudes and norms that guide team members’ behavior (Kets De Vries, 1997). Furthermore, teams with shared values benefit from less conflict (Gibson & Earley, 2002; McGrath et al., 1995) and improved team performance (Kirkman & Shapiro, 2005; Klein et al., 2011).

**CLARITY**

“…It’s like building a house and everyone brings piece so you have to have a clear idea of how you contribute”

“Never enter a project without knowing what is in scope and what is out of it: are we going to think about potatoes and bananas or only bananas”

“It will be nice to point out: you should do that, you should do that rather than: “think about it yourself and tell me what you have done so far”

During the empirical study ‘clarity’ was the most frequently discussed and observed reason for both the success of a workshop and its failure.

For instance, in one of the observed workshops the level of initial obscurity was so high that it eventually led to the workshop’s failure. Four designers with different areas of expertise and on different levels of the hierarchy were invited as an addition to an already existing technical development team. They had never worked together before and no one knew what the others are good at. None of the designers was aware of what the goal of their participation was. Nobody knew what exactly they were supposed to deliver, either. The facilitator repeatedly tried to come up with a clear task, but this only led to more confusion. In the end their work was not used further in the project.

“…it was confusing and also I think that it would be nice to, you know, specify what my role exactly is…. so there could be a clear way to work together with the other people.”

**TRUST**

“If I should rate the factors that determine good collaboration, trust would be the most important one”

“…but actually the group should trust each other – the only thing I can do as a facilitator is help them trust each other.”

“I can say that building trust starts with “are you trustworthy or not” or at least, can you give somebody the feeling that you are.”

“…and maybe you can be careful with inviting people that you know beforehand are unpredictable. And unpredictable behavior is associated with no trust.”

The importance of trust was mentioned by almost all of the interviewees and its presence or lack was observed in every workshop. One of them was quite unusual as people ended up volunteering to contribute their free time to work on
The project was later in its development process and the team dynamics were in a more matured phase. The majority of the members were Dutch and although they work for different departments, most of them hold a degree in a design discipline. There was mutual trust between the members. They have known each other for a long time and therefore, there were no obstacles for clear communication. When one of the designers unexpectedly brought numerous materials and proposed to turn the sketches into tangible models, the facilitator and the team went along without hesitation.

**CONFLICT**

“So the morning session was full of discussions whether we have to do this or not and after we couldn’t find a solution, the facilitator, I think, and some key business owners decided that this is not the right way we wanted to do it, so they stopped it.”

“I once had to work with a person that was truly horrible – he always knew better than everybody else and we always had to do what he wanted – he used his higher status every time... I personally know about colleagues that moved to the other hemisphere in order not to work with him”

During the participatory research two forms of conflict were observed: process and task conflict (Jehn, 2001). Strong process conflict was observed in only one of the workshops. The conflict arose after a team of 20 people was divided in three professionally homogenous groups. Each of the teams, except the design one, has been given a clear explanation of what was expected from them. During the second day of the workshop, the facilitator tried to clarify the designers’ tasks. While doing this, new requirements for the other two teams came up. As a result, a conflict between one of the teams and the facilitator arose. This was followed by a conflict between the facilitator and one of the designers. The facilitator tried to resolve the conflicts as quickly as possible by giving the design team a new task. In the end, there was frustration among the designers as they delivered something that was not used during the final user testing.

Task conflict was observed in a two-day workshop. On the second day, a new person joined the team as a substitute of one of the members. He was not completely aware of the scope of the project and kept proposing things that were different than the already defined direction. This led to a mild conflict between him and the business owner. The facilitator and the project lead immediately reacted trying to explain the scope of the project but also to hear out the new-comer’s ideas. This led to new ideas, proving to be beneficial to the team performance.

**PERSONAL VALUES**

“... you know, we have different cultures so sometimes their attitude might be quite rude for me. But I won’t say anything directly, I’ll just keep it in my mind and for example, I will listen carefully what they have to say and agree, not really object”

“...so if he is very good at doing that thing, we have to ask him to do that thing rather than something he is not really interested in.”

“... For the designer, the asset is fun, always fun – that’s a good starting point …”

“The business person looks at different things than the engineer, frames it differently, tells it differently, and it helps if the facilitator does something to make people aware of that.”

“...because in design, empathy, building empathy is key design competence that we always use, we are well-equipped to be… to take the role of the bridge between all the different teams.”

The previously discussed workshop where task conflict occurred was interesting in another way. The differences in the communication styles and values of some members were easily noticeable there. During the first day the team dynamics were smooth as the team members were carefully selected before the workshop. They were involved in the topic directly or indirectly for a long time. Therefore they all wanted to look at it from a positive point of view. Furthermore, they all had experiences with similar workshops and most of them were Dutch. In addition, the workshop’s goal was communicated regularly before and during the workshop.

When the new team member from the research department of the firm joined, the difference between his and the business owner’s communication style was obvious. While the business owner looked at the big picture, the new-comer was talking about the details. This led to a minor task conflict. However, the facilitator and the project lead, together with the entire team, immediately addressed the problem and tried to find a solution.

“...we carefully selected the participants rather than bring everyone, which means that they have clear goals and clear purpose to participate in the workshop and that’s very helpful to lead them and facilitate them because they all have very clear vision”
DISCUSSION

The obstacles and challenges connected with multidisciplinary collaboration are well studied and documented in the literature. During such collaborative projects, however, these issues become more specific and the facilitators need guidance to deal with them. Although, the initially derived framework can provide such guidance, attention has to be paid to the above mentioned factors. They are tightly connected to the first two stages of team development (Tuckman, 1965) and can provide a solid base for successful project outcome.

During the stage of forming, groups initially concern themselves with identifying the boundaries of the task and the approach to be used in dealing with it. The importance of clarity here is crucial as its lack can prevent the team from accomplishing the task at hand (Eckert et al., 2003).

The second phase, storming, is characterized by conflict and polarization around interpersonal issues. Only by dealing with the conflict the team can continue to work successfully together. Furthermore, the existence of interpersonal trust provides the foundation for unfiltered debates (Lencioni, 2002) and therefore the easier and faster resolution of each conflict.

In addition, the team performance is directly influenced by the personal values of each team member (Bergema et al., 2011, Kets de Vries, 1997). They are the ones to provide the foundation for building trust, a common goal and organized processes in relatively early stages of team interaction (Adair et al., 2013).

Although the participatory research lacks diversity due to its short time span, constant reflection and cross-reference between the different methods was used. Furthermore, all of the observed projects were at different stages of development. This allowed a broader overview of the possible influences. It also created better understanding of the processes that might occur during such projects. In addition, some of the facilitators were interviewed twice in order to clarify the raised concerns and reach deeper level of understanding.

CONCLUSION

The initially derived framework can provide guidance how to deal with the challenges multidisciplinary collaboration imposes, but it is rather complex. Focusing on the four main factors ‘clarity’, ‘trust’, ‘conflict’ and ‘personal values’ will be more pragmatic. They have influence on the initial stages of team development and therefore, they offer the facilitators a clear and apprehensible way of creating a solid base for optimal multidisciplinary collaboration.

However, further in-depth investigation of the significance of each of the four factors in this and other similar contexts is necessary. Conditions for developing interpersonal trust, dealing with conflicts and utilization of personal values should be researched as well. Furthermore, other factors that can aid the creation of a solid base of a project should be explored.

In conclusion, these results have direct implication on the way fast-paced collaborative projects in the researched firm are facilitated. They show a positive effect. Therefore they might be valuable to other fast-paced innovation approaches with similar context.

REFERENCES


Holland, R., & Kim, B. Y. (2007). Design Education For Successful Cross-Functional Cooperation In NPD. NEWCASTLE UPON TYNE.


Thamhain, H. J. (2012). Leadership Effectiveness in Global Project Teams. *Bentley University, Waltham, MA - USA.*


**APPENDIX**

**FACTORS THAT INFLUENCE DRIVE**

**MULTIDISCIPLINARY COLLABORATION**

**GLOBAL PROJECT SUCCESS RATE**
- Projects that either missed all goals or were stopped
- Projects that fully met their objectives within planned time, budget and quality constraints
- Projects that did not meet either time, budget or quality goals

**SET-UP**
clear hypothesis 
contact upfront 
initial briefing 
preslected teams 
understand the initial idea

**TEAM GELLLING**
challenge each other 
close proximity 
informal relationships 
different location 
fun 
good food 
low inter personal conflict 
membership stability 
no self-censorship 
psychological safety 
"shared enemy" 
trust 
warmp-up exercises

**TEAM SELECTION**
no hierarchy 
work well together before 
wide personal network 
personal ity fit 
reason to participate 
relevant competence

**ORGANISATION**
aligned vision 
authority relations 
clarify of methodology 
clear and common agenda 
clear and shared goal 
clear boundaries 
clear expectations 
clear role and task 
clear rules 
clear scope 
filling and organisng 
superordinate goals

**FACILITATION**
address conflict and issues 
bring new perspective 
celebrate success 
constant updates 
continuous support 
different role 
flexibility 
make use of everybody's resources 
no assumptions 
self-expectation 
shared responsibility 
map the expertise of others 
 triggers 
back-up

**COLLABORATION**
externalising of ideas 
space and materials 
commitment 
complete focus 
cooperative decision-making 
enthusiasm 
frequent communication 
hold one another accountable 
no blockers 
no hard lines b/w disciplines 
on-going dialogue 
people feel appreciated 
respect 
small teams 
structured freedom

**LEARNING**
conscious about learning 
equal level of learnings 
learn each other's discipline

**RESULTS**
clear results 
consolidation of new learning 
handing over of the project

**BARRIERS**

**BEFORE**
different schedules 
different way of working 
limited availability 
personal culture and ethnicity 
personal values 
Intellectual Property 
non-structured process 
pre-fixed idea 
stereotyping 
different funds and systems of knowledge 
tight time frame

**DURING**
unresolved conflict 
unwillingness to collaborate 
unwillingness to iterate 
unwillingness to prototype 
inefficient communication 
power hoarding 
rivalries 
silent team members 
distraction 
groupthink

**CONTEXT**

- clear context 
enthusiastic business owner 
personal interest 
pride and satisfaction 
professional opportunities 
reward system 
sixth degree principle 
stimulating environment
Start screen

‘Search for a method’ screen

‘Add a method’ screen

Method reviews