

The Use of Design Thinking in a Global Information Technology Company

Gabriel Kryvoruchca¹, Lauriane Correa¹, Rafael Parizi¹, Sabrina Marczak¹

¹MunDDoS Research Group – School of Technology
Pontifícia Universidade Católica do Rio Grande do Sul - PUCRS
Porto Alegre, RS, Brazil

gabriel.kryvoruchca@acad.pucrs.br
{lauriane.pereira,rafael.parizi}@edu.pucrs.br
sabrina.marczak@pucrs.br

Abstract. *Software companies have been using Design Thinking to support software development, fostering the creation of innovative features and products. However, there is not so much knowledge of what matters for the application of Design Thinking being successful. Thus, this study aims to describe how does the adoption of Design Thinking with software development take place in a global information technology company through an interview-based case study with 16 professionals. Our analysis indicates that Design Thinking is used in software products, software improvements, processes, user experience identification and solution discovery. Also, there are perceived benefits and challenges during the Design Thinking activities. As a result, this paper describes the Design Thinking phenomenon in software development, serving as a guide for practitioners on how to set up and implement Design Thinking activities and publishing more academic research.*

1. Introduction

Information technology companies want to deliver software products in less time with higher-quality [Subih et al. 2019]. Putting the user at the center of the software development process has been pointed out for years as the key to success [Luedeke et al. 2018]. It has been argued that Design Thinking (DT) is relevant in this attempt to better establish user-centric activities to support the understanding of user needs and to develop a fit solution [Hehn et al. 2020].

The use of DT to aid software development activities fosters the development of human-centered solutions more effectively and, therefore, it is important to know in-depth about how organizations have used DT for their activities [Hehn and Uebernickel 2018].

This way, we focused on describing this phenomenon, answering the following research questions (RQ) “RQ1. How does the adoption of Design Thinking with software development take place?” and “RQ2. What are the perceived benefits and challenges of Design Thinking adoption?”. It aims to identify how the adoption of Design Thinking with software development takes place in a global information technology company (called ORG - confidential name), located in Brazil.

Thus, this study conducted an interview-based case study with 10 coaches and 6 participants, totaling 16 professionals to understand how DT is used, what techniques and

tools are used, how knowledge is shared to the team, which professionals (or team roles) get involved in Design Thinking activities and the perceived benefits and challenges of Design Thinking usage.

This paper reports a case study in a global information technology company. Our main contributions are: (i) a set of characteristics and techniques used in this context; (ii) perceived benefits by the teams; (iii) perceived challenges by the teams so far; and compared studies highlighting similarities and differences.

The paper is organized as follows: Section 2 presents the Design Thinking background. Section 3 provides the research method used. Section 4 describes the preliminary results. Section 5 discusses our findings. Section 6 covers related work. Section 7 concludes with a summary of this article and future studies.

2. Design Thinking in Software Development

Design thinking has gained recognition as an approach to problem-solving that relies on interdisciplinary teamwork, exploration of human needs, rapid prototyping and interactive learning cycles in the earlier stages of product, service and system development processes [Brown 2008]. Design thinking proposes to assist software development by supporting the understanding of the users needs [Vetterli et al. 2013].

Focusing on user needs, the purpose of DT is to collaboratively and innovatively identify opportunities to solve problems. It can be defined in three perspectives: as a process, as a mindset or as a toolbox [Brenner et al. 2016]. As a mindset, DT is focused on a strong orientation to discover the obvious and hidden customers' and users' needs and prototype the possible solutions. As a process, DT is seen as a combination of a micro-process as an innovation process and a macro-process as the milestones manifested in prototypes that must fulfill defined requirements. Finally, as a toolbox, DT refers to the application of numerous methods and techniques from design, software engineering and psychology [Brenner et al. 2016], for instance, personas, brainstorming, others.

DT and requirements engineering are distinct when it comes to the underlying philosophies, but many artifacts are complementary or even overlapping, the Design Thinking follows a philosophy of domain understanding and the learning curve leading to it – regardless of the surrounding processes [Hehn et al. 2020]. When looking through the lens of process, DT can be defined as a set of distinct working spaces, which can be adapted and executed non-sequentially according to the context [Thoring et al. 2011].

There is a wide variety of Design Thinking models, emerging and being updated to support the distinct contexts and problems that Design Thinking can support [Hasso-Plattner Institute 2020]. There are models such as double diamond design model [Council 2020] and d-school model of the Hasso-Plattner-Institute [Hasso-Plattner Institute 2020]. Although exists the guides and manuals on Design Thinking, there are professionals who do not know how to conduct and decide techniques [Mateusz Dolata 2017].

3. Research Method

This study conducted an interview-based case study. We did design our study considering its qualitative nature [Dybå et al. 2011] based on the procedure by [Runeson and Höst 2009], which is: to establish the study goal and scope, to define the case and criteria to

Table 1. Professionals' Profiles

ID	Role	Description	Yrs at ORG	Yrs in DT
C1	Developer	Development team member	10	5
C2	Developer	Development team member	9	2
C3	Developer	Development team member	8	3
C4	Developer	Development team member	6	1
C5	Product Support Manager	Manages the entire product support organization	10	7
C6	Partner Service Delivery	Responsible to provide support, training and assistance to certified partners	10	6
C7	Customer Relations	Responsible for representing the customer within ORG. Will coordinate and speed up trainings, assistance, etc	9	5
C8	Customer Center	Responsible for offering ORG applications and enabling co-innovation with partners and customers	7	4
C9	Product Support	Support engineer working with ORG applications	5	2
C10	Product Support	Support team member	5	4
P1	Product Support	Support team member	10	4
P2	Product Support	Support team member	7	2
P3	Product Support	Support team member	7	3
P4	Product Support	Support team member	5	2
P5	Product Support	Support team member	4	3
P6	Product Support	Support team member	3	3

select it, to select the data collection method, to decide on the data analysis method, and to get ethics approval to conduct the study within our institution and from the company management. Our research within this study was guided by the following research questions (RQ) “*RQ1. How does the adoption of Design Thinking with software development take place?*” and “*RQ2. What are the perceived benefits and challenges of Design Thinking adoption?*”.

3.1. Case Study Setup

We set up a descriptive case study in a global information technology company, called ORG. ORG develops and sells software systems solutions. This European-based company counts with over 10,000 information technology professionals around the world. Also, ORG follows D-school model in DT.

First, we observed a DT session for 2 hours to understand how it was applied. After that, we invited 20 employees from different teams, which 16 accepted to participate in this study. These professionals have different roles, such as Developer, Product Support, Manager and others, they are identified in Table 1.

We conducted an interview-based case study with 10 coaches and 6 participants, totaling 16 information technology professionals located in Brazil site. ORG classifies the professionals in two profiles: Design Thinking coach who receives a formal training and conducts sessions and, Design Thinking participant, who attends a session. A Design Thinking session can be organized in a few hours or a set of days, depending on demand.

Table 2. Interview Script

RQ	ID	Question
RQ1	Q1	When, how and for what purpose is used Design Thinking?
	Q2	Who are the stakeholders involved during the Design Thinking?
	Q3	Which resources and tools do you use to support the Design Thinking?
	Q4	How the gathered knowledge during Design Thinking is shared to the development team?
RQ2	Q5	What are the perceived benefits of Design Thinking usage?
	Q6	What are the perceived challenges of Design Thinking usage?
	Q7	What the perceived quality aspects are identified when Design Thinking is used?

3.2. Data Collection and Analysis Methods

The interviews were semi-structured, organized in 7 open-ended questions, see Table 2. To define this interview script we followed the guidelines suggested by [Kitchenham and Pfleeger 2002]. We performed the activities: (1) interview script creation, (2) script evaluation with a senior researcher who has industry experience in software development (12 years) and Design Thinking (3 years), (3) professionals selection, (4) interviews conduction, (5) interview transcription, and (6) data analysis and consolidation.

All professionals accepted the consent form. Each interview took on average of one-hour long. Notes were taken by the interviewer and used to aid data analysis. The study used content analysis technique to gain insights into the different variations of the Design Thinking phenomenon in a specific scenario through the subjects' feelings and thoughts. This way, all interviews were transcribed and analyzed using the this technique based on Krippendorff [Krippendorff 2018].

It aims to reveal perspective and patterns of behaviors among the professionals. All answers were analyzed to classify the results. The results were organized following the interview script. The authors discussed the results classification and categorization, achieving a consensus of all perspectives, as reported in Section 4.

4. Results

In this section, we present the questions from our interview script and its consolidation based on professionals' perspectives. They are identified in Table 1, where 'C' represents a DT coach and 'P' a DT participant. Table 3 and Table 4 show an extract of the results for the interviews questions, grouped for RQ1 and RQ2, respectively.

The Design Thinking model used at ORG is D-school [Hasso-Plattner Institute 2020]: **understand** working space aims to discover the user needs, the professionals highlighted the following techniques: (i) *briefing* to start the conversation among all stakeholders; (ii) *statement/challenge* to explore the needs; (iii) *customer journey map* to understand the process as a whole; (iv) *charting* to define possible solutions, and; (v) *creative reframe* to rewrite the challenge, focused on discovering new aspects.

In the **observe** working space, they mentioned the ways: (i) *interviews* with users; (ii) *shadowing* to observe the users in their activities; (iii) *desk research* to explore about the topic, and; (iv) *competitors' research* to explore how the competitor are doing it. In **point of view** working space, the professionals mentioned the following techniques: (i) *storytelling* to describe users' perspectives; (ii) *personas* to identify the people who will

Table 3. Interview's questions and professionals' answers for RQ1.

RQ1. How does the adoption of Design Thinking with software development take place?	
Question	Result (Professionals – ['C': Coach - 'P': Participant])
Q1. When, how and for what purpose is used Design Thinking?	(i) discover new requirements (C1, C2, C5, C6, P2) (ii) promote technological development (C8, C9, P1, P4, P5) (iii) improve projects and processes (P3, P4, P5, P6, C8), and (iv) build a mindset (C4, C5, C8, P2)
Q2. Who were the stakeholders involved during the Design Thinking?	(i) interdisciplinary team (e.g. C9, C10, P1, P2, P3) (ii) consultants (C1) (iii) business specialists (C3, C6) (iv) product owner (C5, C10) (v) designers (C2, C3, C7) (vi) managers (C1, C7, C9, P6) (vii) end-users (C4, C5, P2, P3) (viii) developers (C1, C5, C8, C9, C10), and (ix) Design Thinking coaches(P5, P6)
Q3. Which resources and tools did you use to support the Design Thinking?	(i) google drive (C5) (ii) github (P4) (iii) boards (C3, C8, P1, P3, P4) (iv) prototyping tool (C2, C10), and (v) flip-charts and pens (C1, C5, C10 e P1)
Q4. How the gathered knowledge during Design Thinking was shared to the development team?	(i) storyboard (C6) (ii) storytelling (C5, C6, C8) (iii) pictures (e.g. C9, C10, P4, P5, P6) (iv) sheets (C2, C8, P6) (iv) documents (C2, C8, C9), and (v) emails (C7, C9, C10)

interact with the solution, and; (iii) *point of view*¹ to represent the users' visions.

During the **ideate** working space, the professionals described the following techniques: (i) *brainstorming* to generate the participants' insights (ii) *2x2 matrix* to organize insights; (iii) *reverse brainstorming* to find a viable solution. In **prototype** working space, the professionals mentioned the following techniques: (i) *storyboard* to align the ideas in a graphical visualization way; (ii) *low-fidelity prototypes* to evaluate the solutions; (iii) *canvas* to visualize the business aspects (iv) *flowchart* to draw the flows; (iv) *mock-ups* to give an idea of how it would be and then start a prototype, and; (v) *physical prototypes*.

In **test** working space, the professionals reported the (i) *test matrix* to map the positive and negative points, and questions about the solution; (ii) *user validation* using paper prototype; (iii) *usability tests*, and; (iv) *user feedback* to understand the users' perceptions.

5. Discussion

This study identifies how the adoption of Design Thinking with software development takes place in a global information technology company. Our discussion is organized to answer our two research questions.

¹Apache MADlib: <https://madlib.apache.org/>

Table 4. Interview's questions and professionals' answers for RQ2.

RQ2. What are the perceived benefits and challenges of Design Thinking adoption?	
Question	Result (Professionals)– ['C': Coach - 'P': Participant]
Q5. What were the perceived benefits of DT usage?	(i) creativity (P1, P4) (ii) discovery of innovative solutions (C4, C10, P3) (iii) cost reduction and time optimization (C3, C6, C8) (iv) users' collaboration (C2, C3, C6, C8, P6) (v) focus on end users (C3, C5, C9, P2, P5) and (vi) problem identification (C1, C2, C4, C5, P1, P2)
Q6. What were the perceived challenges of DT usage?	(i) availability of rooms (P1, P2, C7) (ii) lack of valorization (C1, C10, P1, P5) (iii) lack of enough time to solve the problem (C2, C3, P5, P6), and (iv) lack of goals' definitions (P5, C10)
Q7. What the perceived quality aspects are identified when DT is used?	(i) effort maintenance reduction (C5) (ii) quality increase (C4, P6, P2, C10, P4) (iii) focus on final users (C1, C6, C9, C10, P5)

RQ1. How does the adoption of DT with software development take place?

Through our case study, we observed that period of time to use Design Thinking depends on the goal, e.g. a Design Thinking can take months or hours. The participants use it to focus on solving problems, improving solutions or building a mindset among participants. The interpretation of Design Thinking as a mindset and as a process were dominant in coaches' and participants' perceptions. This is in line with research that claims that practicing Design Thinking can lead to the development of a Design Thinking mindset [Brenner et al. 2016].

The professionals reported that Design Thinking was essential to achieve specific project goals, through working spaces with tools and techniques to achieve and explore these goals. We found that Design Thinking, using d-school model, is applied in different ways with software development, showing that there is indeed a need for different levels of Design Thinking application within the software development process. Existing studies suggest that the level of Design Thinking application depends on the project's goal, e.g. [Dobrigkeit et al. 2019].

Additionally, we identified that Design Thinking has a strong focus on understanding the users. Thus, the participants need to work in interdisciplinary teams and explore problems and solutions, matching with the Design Thinking principles mentioned within the literature [Brenner et al. 2016, Brown 2009, Díaz et al. 2014].

Luedeke et al. [Luedeke et al. 2018] argue that deploying the appropriate methods during Design Thinking is a key success factor. All participants of this study use the D-school model, however, each coach uses techniques to achieve the specific goal.

Overall, the participant roles and their understanding of Design Thinking suggests that different roles can conduct Design Thinking, but it is important to consider the experience or good knowledge of the Design Thinking coach. Because of it, the company gives the training to empower the professional to conduct Design Thinking sessions,

called Design Thinking coach. Also, our findings highlight the importance of transfer the knowledge gathered during the Design Thinking among all involved.

RQ2. What are the perceived benefits and challenges of Design Thinking adoption?

Our findings suggest that Design Thinking is a good way to identify the users' and clients' needs, exploring it in depth and developing products focusing on their needs. It can be observed the relationship between participants who have a Design Thinking mindset and implementation of it. We identified that the coaches not only use Design Thinking to improve their software products but also to improve their processes or working spaces.

The perceived benefits were the cost reduction and time optimization because the participants are engaged to build a solution together, so it increases the quality during solution definition. Also, the users' collaboration to discover and gather software requirements, reducing conflicts between people. It confirms that Design Thinking adds value to deliverable solving practical problems, as mentioned in literature [Brown 2008].

Our findings indicate that DT reflects the needs in designed solutions, promoting satisfaction between stakeholders. However, our findings suggest some challenges such as unavailability of rooms to conduct Design Thinking for an extended period of time, coaches unavailability to conduct sessions and enough time to solve the problem.

6. Related Work

Studies are discussing how to use Design Thinking in software development, they focus on understanding an issue or phenomenon, illustrated in Table 5. In our study, we conducted a case study to explore the Design Thinking adoption and the perceived benefits and challenges in a global software company.

Carlgren, Elmquist and Rauth [Carlgren et al. 2014] (column A) argued that Design Thinking can be understood as a user-centered innovation approach, a process to develop new ideas, a mindset, or a combination of mindset and methods. In line with these findings, we identified this understanding among our professionals.

Hehn and Uebernickel [Hehn and Uebernickel 2018] (column B) highlighted the integration among stakeholders, better usability requirements elicitation and different viewpoints shared for an in-depth requirements elicitation during Design Thinking [Hehn and Uebernickel 2018]. Also, Lucena et al. [Lucena et al. 2016] (column C) identified that time spent contributes to improve software development goals and deliver better results and Jensen, Lozano and Steinert [Jensen et al. 2016] (column D) observed that Design Thinking involves the customer on the products' context understanding [Jensen et al. 2016]. De Paula, Amancio and Flores [de Paula et al. 2020] (column E) identified that Design Thinking adds value to the product, project, people and whole organization.

In our study (column F), we identified the same characteristics mentioned above and cost reduction because the stakeholders are engaged during the Design Thinking. De Paula, Amancio and Flores highlighted the known solutions emerged and many ideas generated were executed as challenges [de Paula et al. 2020]. Our findings suggest that innovative solutions can emerge during the DT, however, some ideas are not executed too.

Table 5. Related work

	A) Carlgren, Elmquist and Rauth	B) Hehn and Uebersnickel	C) Lucena et al.	D) Jensen, Lozano and Steinert	E) de Paula, Amancio and Flores	F) Our Study
Objective	Explored how DT is used in large organizations	Identified the potential between DT and Requirements Engineering	Identified how IBM uses DT	Described the research fields behind the DT methods	Evaluated a DT light version usage at IBM	Describes the adoption of DT in a global IT company
Method	Interviews with participants from 16 companies	Case study	Survey	Case study with professionals from SAP	Survey with two groups from IBM	Case study with 16 professionals from a global IT company
RQ1. Adoption	DT as a user-centered approach, a process to develop new ideas, a mindset, or a combination of mindset and methods	n/a	DT is used for product development	71% use Scrum with DT and 14% Kanban	n/a	DT is used in software products, software improvements, processes, user experience identification and solution discovery
RQ2. Perceived benefits	n/a	Integration among stakeholders, better usability requirements elicitation and different viewpoints shared for an in-depth requirements elicitation	The time spent contributes to improve agile software development goals and deliver better results	Provide an interactive development with stakeholders, gain a holistic problem overview and involve the customer on the products' context understanding	DT adds value to the product, project, people and whole organization.	Cost reduction, time optimization, users' collaboration to discover and gather the software requirements, conflicts reduction and increased quality
RQ2. Perceived challenges	n/a	n/a	n/a	n/a	Participants used already known solutions and many of the ideas generated were not executed	Unavailability of rooms to use during DT, coaches unavailable to conduct DT and enough time to solve the problem

7. Final Considerations

This study aims to describe how the adoption of DT with software development takes place in global information technology. This way, we identified how DT, through working spaces, is used, what techniques and tools are used, which artifacts are produced and which professionals (or team roles) get involved in DT activities. Also, we identified the perceived benefits and challenges of DT usage. With these parameters in mind, we conducted semi-structured interviews with 10 coaches and 6 participants, totaling 16

professionals who have experience with DT in software development.

Our findings can serve as a guide for practitioners on how to set up and implement DT activities. Thus, we focus on answering the research questions (RQ) “*RQ1. How does the adoption of DT with software development take place?*” and “*RQ2. What are the perceived benefits and challenges of DT adoption?*”.

As a result, we identified that DT is used in software products, software improvements, processes, user experience identification and solution discovery. Also, there are perceived benefits like cost reduction, time optimization, users’ collaboration to discover and gather the software requirements, conflict reductions and increased quality. However, there are challenges such as unavailability of rooms to use during DT, coaches unavailable to conduct DT and enough time to solve the problem.

The study has limitations inherent to any empirical study. For instance, we interviewed only 16 employees, which might not represent the company view on the topic. To mitigate that we did select employees with different levels of expertise, time working in the company, and from different company areas.

For future studies, we intend to explore in-depth knowledge about DT and its tools, and techniques used in software development, as well as conduct case studies with other software companies to create a wider vision of DT integrated to software process, its benefits, challenges and ways of the application.

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