What is Beyond the Box? A Survey on the Human Perspective in Design Thinking Activities in Software Development

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Abstract. *Design Thinking (DT) is an approach that promotes user engagement and stimulates stakeholders' creativity in Software Engineering activities. The literature has shown that applying DT supports software teams in developing solutions that meet users' real needs. However, there is still a lack of studies exploring the human perspective associated with the use of DT, to understand not only how companies have been using DT but also the experiences of participants in its application and how teams are actually formed. Therefore, this study presents an exploratory research that investigates the human dimension in the use of DT in software development. The results indicate that DT is adapted according to team composition, which is generally multidisciplinary and diverse, with varying levels of DT knowledge ranging from intermediate to advanced. As contributions, the study emphasizes the need for continuous training in DT to optimize its use in software development, highlighting the importance of collaborative and user-centered approaches.*

Resumo. *Design Thinking (DT) é uma abordagem que promove o envolvimento do usuário e estimula a criatividade dos stakeholders nas atividades de Engenharia de Software. A literatura tem mostrado que a aplicação do DT apoia as equipes de software no desenvolvimento de soluções que atendem às reais necessidades dos usuários. No entanto, ainda há carência de estudos que explorem a perspectiva humana associada ao uso do DT, para compreender não apenas as formas como as empresas têm usado o DT, mas também as experiências dos participantes em sua aplicação e como as equipes são realmente formadas. Portanto, este estudo apresenta uma pesquisa exploratória que investiga a dimensão humana no uso do DT no desenvolvimento de software. Os resultados apontam que o DT é adaptado de acordo com a formação da equipe, que estas são geralmente multidisciplinares e diversas, e o nível de conhecimento em DT variando de intermediário a avançado. Como contribuições, o estudo enfatiza a necessidade de treinamento contínuo em DT para otimizar seu uso no desenvolvimento de software, destacando a importância de abordagens colaborativas e centradas no usuário.*

1. Introduction

Software development teams have recognized Design Thinking as an mechanism that enhances user engagement in activities related to system design [Canedo and Parente da Costa 2018]. DT is a User-centered Design Approach (UCD) that drives the creativity of stakeholders [Docherty 2017] and centers development on the user [Lindberg et al. 2011]. Integrated into agile methods, DT contributes to supporting constant deliveries, rapid feedback, and self-organized teams, and also encourages teams to develop solutions that truly meet user needs [Sohaib et al. 2019, Parizi et al. 2022b].

The literature in the Software Engineering (SE) field has explored different ways to support development teams regarding the set of processes, techniques, and tools associated with DT [Parizi et al. 2022b]. Moreover, some studies have investigated the selection of which techniques to use, such as static recommendations [Souza et al. 2020], collaborative recommendations [Parizi et al. 2022a], Technique Repositories [Meireles et al. 2021], and selection of techniques based on the team experience [Hehn and Uebernickel 2018].

However, despite various advances in understanding the use of DT in software development, there is a lack of studies that explore the human perspective related to the use of DT, as well as there is a lack of studies seeking to understand not only how companies have used DT but also what the participants' experience is regarding its use, whether they receive any training prior to participation, and how the teams are actually formed.

In this scenario, this paper poses the following main research question (RQ): *"How do software development companies consider the human perspective when using Design Thinking?"*. To answer the RQ, we conducted an exploratory survey following the guidelines presented in [Pfleeger and Kitchenham 2001, Kitchenham and Pfleeger 2008]. We carried out the survey between June and August 2022, answered by 51 professionals from 10 Brazilian software development companies. In our research, we intentionally kept the concept of "human perspective" open, aiming to capture diverse experiences and human-related aspects that could emerge naturally during data collection. This flexible approach allowed us to gather a broader range of insights, enabling a more comprehensive understanding of how Design Thinking not only incorporates processes but also integrates essential human factors that significantly influence software development.

This study brings the following contributions: (i) it offers insights on how companies are using DT, highlighting practices that promote diverse points of view, diversity, and customer involvement in development teams; (ii) it compiles strategies adopted by software companies to foster an innovative and collaborative environment based on the use of DT. Thus, this study can assist software companies in effectively incorporating the human aspect into their DT processes, which is a human-centered approach, thereby enriching the understanding and implementation of DT in their operations.

The remainder of this paper is structured as follows: Section 2 introduces Design Thinking in software development. Section 3 describes the Exploratory Survey conducted in this study. Section 4 presents the obtained results, while Section 5 discusses these results and contrasts them with related work in the literature. Finally, Section 6 provides a summary of the work, presents risks to validity, points out implications for both Academia

and Industry, and suggests future research directions.

2. Design Thinking in Software Development

Design Thinking is a human-centered and creative approach to problem-solving and developing innovative solutions. It relies on empathy for the user, collaboration, and iterative thinking [Brown 2018]. The process includes a non-linear set of working spaces such as empathy to understand users' needs, problem definition, ideation to generate solutions, prototyping for testing, and continuous refinement through iterations [Prestes et al. 2020].

[Hehn and Uebernickel 2018] argue that DT is easily integrated into Requirements Engineering (RE). DT supports requirements elicitation and becomes an option for developers in understanding the real user needs. [Dorst 2010] mention that DT is a promising approach to support RE, facing the challenge of discovering and satisfying the confusing needs and volatile requirements of the various stakeholders involved in the process.

[Prestes et al. 2020] highlight that DT is not merely a methodology but an approach that demands attention in terms of human factors, which are crucial in its application. The authors also point out that the difficulty in communicating to all stakeholders that DT is more than a collection of techniques and tools and the importance of ensuring a comprehensive understanding of DT among all participants are two significant challenges to be aware of when using DT.

Therefore, despite recent advances in the SE field, there remains a gap related to the integration of DT in software development, especially regarding the human factors involved [Parizi et al. 2022b, Hehn and Uebernickel 2018]. In light of this, this study collected data from professionals to understand how companies apply DT in software development, exploring the participants' experience, their training in DT, and the composition and organization of the teams involved.

3. Research Methodology

This paper presents an exploratory survey to investigate the human perspective involved in the use of DT in software development. Following the guidelines suggested in [Pfleeger and Kitchenham 2001, Kitchenham and Pfleeger 2008], we conducted the study by performing 5 activities: (i) Definition of Goals, (ii) Planning and Design, (iii) Prior Validation, (iv) Execution, and (v) Analysis of the collected data.

3.1. Definition of Goals

Inspired on the different perspectives of DT, which include Mindset, Process, or Toolbox and recognizing that the human factor is involved in all of these aspects, in the activity of defining the goals of the study we established the goal of collecting various perspectives that involve the human dimension in the use of DT in the context of software development. Specifically, we aimed to understand how software development companies form teams or groups for the application of DT techniques.

3.2. Planning and Design

In the Planning and Design activity of the study, we defined research questions aimed at achieving the specified goals (Section 3.1). Accordingly, we formulated the main research question (RQ): *"How do software development companies consider the human perspective when using Design Thinking?"*.

To support the Main RQ, we defined 4 Complementary Questions (CQs): CQ1. How have companies been using DT for software development?; CQ2. What is the participants' experience regarding the use of DT?; CQ3. Do companies train participants for the use of DT in software development?; CQ4. How are the teams involved with DT composed, in terms of (i) Multidisciplinarity, (ii) Diversity, (iii) Training, (iv) Number of participants, (v) Client participation, (vi) Organization, and (vii) Validation?

Next, we defined the target audience for the study as professionals working in companies that utilize DT for software development activities. Subsequently, we created a questionnaire using Google Forms, consisting of 14 questions to support data collection. We structured the questionnaire into 11 distinct sections, comprising 4 different blocks: 1) Demographic questions; 2) Questions about the human aspects on use of DT; 3) Questions about the non-use of DT; and 4) Questions on the impact of DT on customer activities. We also compiled a Informed Consent Form and included it in the data collection form. In this study, we focus on blocks 1 and 2.

3.3. Prior Validation

Once we finished building the questionnaire, we conducted a pilot data collection as a preliminary validation activity to verify the consistency of the form. As part of this process, we shared the questionnaire with a senior researcher in software development, who reviewed it thoroughly and provided detailed feedback regarding clarity, question structure, and alignment with the research objectives. Based on these insights, we made the necessary adjustments and generated an updated version of the questionnaire.

3.4. Execution

During the execution of the survey, we distributed the questionnaire to 150 software development professionals via e-mail and WhatsApp groups in June 2022. The Informed Consent Form was included as the first section of the questionnaire, where participants were asked to voluntarily indicate their consent or refusal to participate in the study, with the assurance that all data would be anonymized. As a result of the study, 51 professionals from 10 different software development companies responded to the Survey, representing a response rate of 34%.

3.5. Data Analysis

In the data analysis phase, we tabulated the obtained results and performed statistical analysis. Section 4 presents the demographic data of the study participants, along with an analysis focused on addressing the research questions established for the study.

4. Results

This section presents the results collected from the Survey for each of the Research Questions that we defined in Section 3. We consider the 51 professionals who accepted to participate in our survey as participants[1].

[1]The raw data of the *Survey* can be found at `https://zenodo.org/records/13946141`

4.1. Participants' Demographic Data

Regarding the role of the participants, the highest response percentages indicate that 43.1% are from the development team, 15.7% are project managers, and 13.7% identify as IT managers. In terms of age, 56.9% of the participants are between 20 and 40 years old, 41.2% are between 41 and 60 years old, and 2% are up to 19 years old. Regarding gender, 82.4% reported being male, while 17.6% reported being female.

In terms of experience in IT, 62.7% of the participants indicated having more than 10 years of experience. This is followed by 19.6% who have between 5 and 10 years, 7.8% with less than 1 year, and 9.8% with between 1 and 5 years of experience in IT. Regarding formal training in DT, 80% reported not having such training, while 20% indicated having completed specific DT courses. In terms of years of experience in DT, 54.6% have more than 2 years, 36.4% have between 1 and 2 years, and 9.1% have less than 1 year of experience.

The participants are based in different Brazilian states, with notable representations from Amapá (21.6%), Distrito Federal (21.6%), and São Paulo (19.6%). Concerning the size of the companies where the participants work, 35.3% are in large companies with more than 500 employees, 17.6% in companies with 100 to 499 employees, 19.6% in companies with 50 to 99 employees, 7.8% with 10 to 49 employees, and 19.6% in companies with 1 to 9 employees.

4.2. Answers to Research Questions CQ1 to CQ4

CQ1. How have companies been using DT for software development?

To answer CQ1, we initially inquired about how long which participants' companies have been incorporating DT in software development. Figure 1–A shows that 47.1% of companies have been using DT for over 3 years, 23.5% for between 2 and 3 years or less than 1 year, and 5.9% for between 1 and 2 years.

We also asked whether DT is utilized in all software projects. Figure 1–B illustrates that 52.9% of participants indicated their companies do not use DT in all projects, while 47.1% affirmed its use in every project. Among those who reported selective usage of DT, the primary reason, as shown in Figure 1–C, is a lack of qualified personnel (66.7%), followed by deadline constraints (22.2%).

Additionally, we queried the participants about the number of projects where DT has been applied. Figure 1–D illustrates that 62.5% of participants have used DT in more than 10 projects, while the other 37.5% have applied it in up to 5 projects.

CQ2. What is the participants' experience regarding the use of DT?

To answer QA2, we asked participants about the experience of those involved with the use of DT for software development. We gathered data on how many team members typically have knowledge of DT. Figure 2–A indicates that 35.3% of participants reported that only 1 or 2 team members were familiar with DT. In contrast, 17.5% indicated that 2 to 5 team members knew DT, 29.4% had 5 to 10 knowledgeable individuals, and 17.6% worked in teams where more than 10 members were versed in DT.

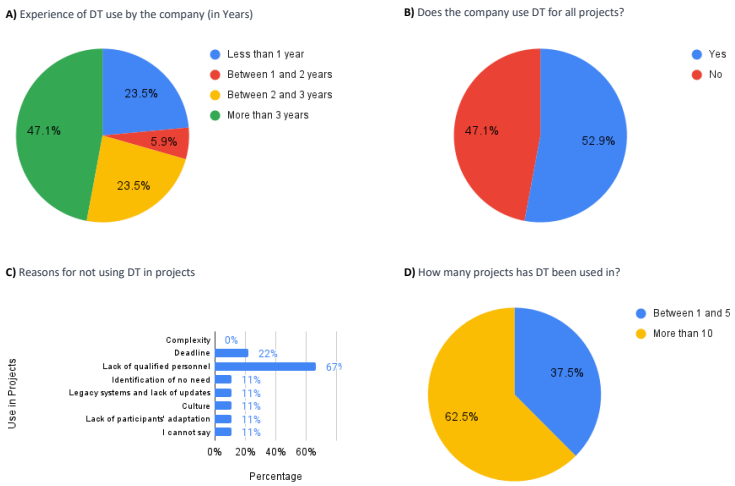

Figure 1. Use of DT by software companies

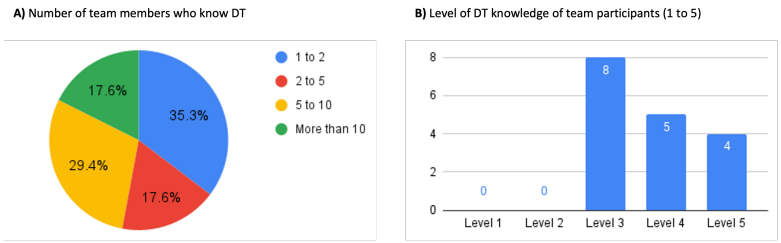

Figure 2. Participants' knowledge in DT

Next, we inquired the participants about the depth of DT knowledge among those involved with DT. Figure 2–B reveals that on a knowledge scale of 1 to 5, where 1 indicates minimal and 5 indicates extensive knowledge, all participants ranked between 3 and 5. Specifically, 47.1% rated their knowledge level at 3, 29.4% at 4, and 23.5% at the highest level of 5.

CQ3. Do companies train participants for the use of DT in software development?

To address CQ3, we asked participants whether their companies provide DT training for those involved in its use within software development projects. Figure 3–A reveals that 58.8% of the responses indicated that companies do not offer such training, whereas 41.2% confirmed that training is provided.

Among the participants who reported the availability of DT training, we further inquired about the participants in these training sessions. Figure 3–B points out that in 76.5% of the cases, only company members are involved in the training, while in 23.5% of the instances, client members also participate in the DT training activities.

CQ4. How are DT-involved teams composed?

To answer CQ4, we considered the following aspects regarding the formation of teams involved in the use of DT: (i) Multidisciplinarity, (ii) Diversity, (iii) Formation, (iv) Number of participants, (v) Client participation, (vi) Organization, and (vii) Validation

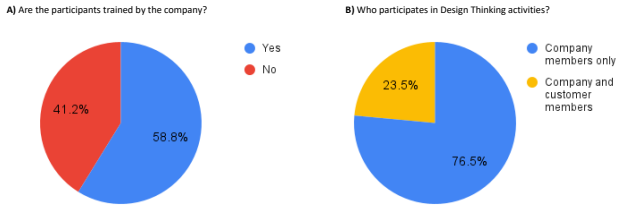

Figure 3. Participants' training and participation in DT activities

Regarding (i) Multidisciplinarity, 52.9% of participants indicated that companies form DT teams with diverse functions. On the other hand, 47.1% did not recognize multidisciplinarity in their teams (Figure 4–A). As for (ii) Diversity, Figure 4–B reveals that teams are composed of participants with diverse experiences, geographic backgrounds, genders, and behavioral profiles. In terms of (iii) team formation, participants identified the following team roles: Project Managers (76.5%), Developers (58.8%), Software Architects (52.9%), Clients (41.2%), and UX/UI Designers (5.9%).

Regarding the (iv) Number of participants, Figure 4–C shows that 62.5% of teams consist of 1 to 5 members, 25% have 5 to 6 members, and 12.5% comprise more than 6 members. When asked about (v) client participation in DT activities, 47.1% of participants reported occasional client involvement, 29.4% indicated consistent participation, and 23.5% noted the absence of clients (Figure 4–D).

We also asked participants about the organization of (vi) DT teams within their companies, specifically whether teams were formed per project or were permanent. Figure 4–E shows that 70.6% of participants reported that teams are organized on a project basis, while 29.4% indicated the presence of permanent teams.

In the final part of the questionnaire, we inquired about the participants involved in the validation of DT artifacts, such as prototypes, diagrams, and user journeys. The results showed that the client is most frequently involved in validation (93.3% of cases), followed by the design team (73.3%), users specified by the client (60%), users selected by the DT team (53.3%), and developers (46.7%).

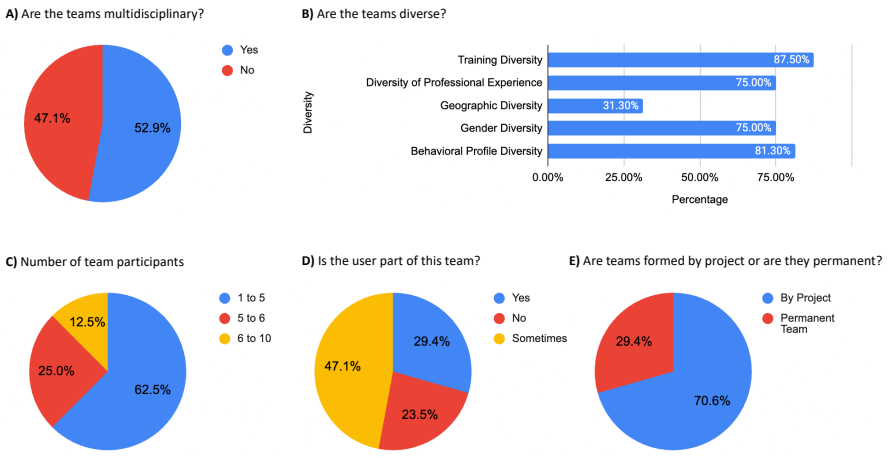

Figure 4. DT teams composition

5. Discussions

This section discusses the results obtained from the survey we conducted for investigating the human perspective when using DT in software companies. The experience with DT reveals that a significant portion of companies have employed DT for more than 3 years, indicating a continuous value perceived in this approach such as better understanding of user needs and innovation in the development process [Parizi et al. 2022a]. However, more than half of the companies do not adopt DT in all their projects. This can be interpreted as a selective application of DT, suitable for specific projects requiring user-centered innovation and creativity, or as a reflection of practical challenges, such as time and resource limitations [Pereira et al. 2021].

Regarding the challenges in implementing DT, the lack of qualified personnel is a hurdle, underscoring the importance of forming teams with relevant skills in DT [Pereira et al. 2021]. Additionally, the pressure for rapid deliveries and the conflict with DT's iterative approach emerge as limiting factors, although complexity is not seen as an impediment, indicating a growing adaptation of companies to the iterative and user-centered nature of DT [Parizi et al. 2022b].

Considering participants' experience with DT, the study highlights varied levels of DT knowledge within teams. Some teams reportedly have only 1 or 2 members familiar with DT, indicating a potential limitation in effective application due to concentrated knowledge. In contrast, other teams have 5 to 10, or even more than 10 members knowledgeable in DT, suggesting broader dissemination and possibly more effective use of DT in software projects. [Dobrigkeit and de Paula 2019] showed that as experience varies within the team, the perception of DT differs. This impacts the use of DT in requirements engineering activities.

Furthermore, regarding the degree of DT knowledge, most participants have intermediate knowledge in DT. This indicates that while there is a substantial understanding of DT among team members, there is potential for further deepening and expanding this expertise. This scenario underscores the need for continuous investment in training and development of DT skills to fully leverage its benefits in software development [Souza et al. 2020].

The survey results indicate a diverse situation regarding DT training for software development in companies. There are companies which do not offer DT training, pointing to a potential gap in equipping teams with essential skills for effectively applying this methodology. In contrast, other companies do provide DT training, mainly to internal team members. Additionally, some companies extend this training to include client members, suggesting a more collaborative and user-focused approach that could enhance the alignment of software solutions with client requirements.

The survey found that many teams using DT are multidisciplinary and diverse, with roles like project managers, developers, and software architects, often involving clients. Most teams are small (one to five members) and organized per project, though some are permanent. Clients, design teams, and users frequently participate in validation, highlighting the importance of collaboration and continuous feedback for effective DT application.

In summary, software development companies consider the human perspective in

Design Thinking through the formation of multidisciplinary and diverse teams, the inclusion of clients in both training and validation processes, and the adaptation of DT practices based on project demands. However, the varying levels of DT knowledge and the selective application of DT reveal that the human dimension is integrated to different extents, reflecting both the opportunities and challenges in aligning human-centered methodologies with practical constraints. This suggests that companies acknowledge the value of human factors but still face obstacles in fully embedding this perspective into all stages of software development.

6. Final Considerations

This exploratory study investigated the human perspective of DT usage in software development. It revealed that despite the widespread adoption of DT by companies over several years, indicating its effectiveness and value, challenges remain. These include a lack of comprehensive DT training and a tendency for DT knowledge to be concentrated among a few team members. This scenario suggests a possible shortfall in critical DT skills, potentially hindering the full effectiveness of DT in software development. DT teams are multidisciplinary and diverse, yet team organization often aligns with project demands, featuring varied levels of client involvement.

The survey highlights key industry implications. Companies using DT for over three years demonstrate its lasting value in meeting user needs and driving innovation. However, its selective use suggests DT is best suited for projects requiring user-centered creativity or faces practical constraints like time and resources. A shortage of skilled professionals points to the need for targeted DT training, and aligning DT's iterative nature with fast delivery demands remains a challenge.

From a research standpoint, the survey reveals varying levels of DT knowledge within teams. Concentrated expertise can hinder effective use, emphasizing the need for broader training. Conversely, teams with widespread DT knowledge show greater potential for successful application, particularly in requirements engineering.

The study faces validity risks concerning the representativeness of the sample and data interpretation. The sample do not fully capture the universe of companies employing DT, and the perceptions of participants could differ based on their individual experiences. As future work, we intend to explore specific strategies that companies can implement to address challenges like inadequate DT training and knowledge concentration. A deeper exploration of DT's implementation across different types of companies and its specific impacts on various software development stages would be of help. Furthermore, examining client perspectives within DT teams could shed light on optimizing client-developer collaboration through this methodology.

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