Universidade do Minho
Escola de Engenharia

Catarina Alexandra Silva Gonçalves

**The Application of Design Thinking:
A Literature Review**

The Application of Design Thinking:
A Literature Review

Catarina Alexandra Silva Gonçalves

julho de 2021
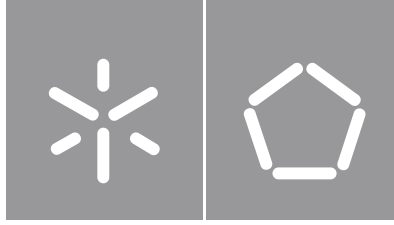
Universidade do Minho
Escola de Engenharia

Catarina Alexandra da Silva Gonçalves

**The Application of Design Thinking:
A Literature Review**

Dissertação de Mestrado
Mestrado Integrado em Engenharia e Gestão Industrial

Trabalho efetuado sob a orientação do
**Professor Doutor Paulo Alexandre da Costa Araújo
Sampaio**

julho de 2021

DIREITOS DE AUTOR E CONDIÇÕES DE UTILIZAÇÃO DO TRABALHO POR TERCEIROS

Este é um trabalho académico que pode ser utilizado por terceiros desde que respeitadas as regras e boas práticas internacionalmente aceites, no que concerne aos direitos de autor e direitos conexos.

Assim, o presente trabalho pode ser utilizado nos termos previstos na licença abaixo indicada.

Caso o utilizador necessite de permissão para poder fazer um uso do trabalho em condições não previstas no licenciamento indicado, deverá contactar o autor, através do RepositóriUM da Universidade do Minho.

Acknowledgments

Throughout this dissertation I have received a great deal of support and assistance.

I would first acknowledge Professor Paulo Sampaio for his availability, patience, expertise, and contributions. I'm very thankful for having the opportunity to finish my academic path with the support of such an exceptional professor.

I am deeply grateful to my parents Fátima e Ricardo, for their love, caring, and sacrifices for educating and preparing me for my future. You are always there for me, and this achievement is also yours. I am also grateful to my young sister Letícia, whom I love and wish a tremendous future.

I would also like to thank all my family, who are an inspiration for me.

Special thanks go to my boyfriend Nuno for all these six years together, his support and love. There are not enough words to explain how remarkable you are and how much you impact my personal and professional life.

I would acknowledge all my friends from the Industrial Engineering and Management course, from AAUMinho - Associação Académica da Universidade do Minho, NEEGIUM - Núcleo de Estudantes de Engenharia e Gestão Industrial with whom I shared the best years of my life and provided me amazing experiences. I would acknowledge my friend Pedro for his friendship during these years, support, and valuable inputs on my dissertation.

Finally, I would like to acknowledge Nikita Savitskiy for his friendship, for being an incredible career mentor, and inspiring my interest in product management and design thinking. Your insightful feedback pushed me to sharpen my thinking and brought my work to a higher level.

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

A Aplicação de Design Thinking: Uma Revisão de Literatura

Resumo

Tem-se tornado evidente que as organizações com estruturas empresariais tradicionais frequentemente enfrentam dificuldades no que diz respeito a manter a "bandeira" da inovação. A maioria das organizações reconhece que a inovação é a chave para o sucesso e, em alguns casos, a chave para sobreviver. Mas a inovação é um desafio e requer que as organizações encontrem novas formas de trabalho, novas competências e uma nova mentalidade.

Com o significativo aumento da digitalização no mundo atual é notório o impacto que a tecnologia pode criar nas organizações sobretudo no que diz respeito à inovação. Contudo, inovação é sinónimo de incerteza e é por isso fundamental capacitar as organizações de ferramentas capazes de as auxiliar a lidar com a incerteza associada ao processo de inovação.

O *design thinking* revelou ser uma abordagem poderosa para lidar com a incerteza e para ajudar as organizações a prosperar e a desenvolver ideias inovadoras. É um processo iterativo, que se foca em encontrar o problema certo e em resolver o problema correctamente, e é também uma abordagem centrada no utilizador, uma vez que tem em consideração as necessidades dos utilizadores, com o objetivo de desenvolver produtos e serviços que são desejáveis do ponto de vista do utilizador, viáveis do ponto de vista tecnológico e valiosos do ponto de vista do negócio.

A aplicação desta abordagem tem vindo a crescer massivamente e tem sido adotada em diferentes contextos organizacionais para resolver problemas complexos. Quando as organizações consideram implementar *design thinking*, é importante que estas compreendam como é que esta abordagem tem vindo a ser implementada e que impacto tem gerado nas organizações.

Contudo, apesar da inovação ser fundamental para o sucesso das organizações e o *design thinking* uma abordagem que suporta a inovação, existe uma escassa quantidade de investigação sobre a implementação de *design thinking*, os métodos de design utilizados e os resultados da sua aplicação.

De modo a contribuir para o preenchimento desta lacuna, foi realizada a revisão sistemática da literatura de 58 artigos publicados desde 2010, com o objectivo de analisar como o *design thinking* tem sido aplicado em diferentes contextos e também identificar futuras oportunidades de investigação.

Palavras-Chave: *Design Thinking*, Desenvolvimento de Produto, Desenvolvimento de Serviços, Inovação, Revisão de Literatura.

The Application of Design Thinking: A Literature Review

Abstract

It has become evident that organizations with traditional business structures often struggle to keep the flag of innovation. Most of the organizations understand that innovation is the key to grow and in some cases to survive. However, embracing innovation is challenging and requires new ways of working, skills and mindset.

With the significant increase of digital technologies in today's world it's clear that technology can create a major impact on organizations and boost innovation, but it also creates the need for organizations to be able to deal with the uncertainty. So it becomes crucial to create the abilities inside the organizations to deal with that in the most efficient way.

Design thinking has revealed to be a powerful approach to deal with uncertainty and to help thrive and develop innovative ideas. It is an iterative process, that focuses on finding the right problem and solving the problem right, and it is also a user-centered approach since it considers the users needs, in order to deliver products and services that are desirable, feasible, and valuable.

The application of this approach has been growing extensively and it has been adopted in a wide variety of organizational contexts to solve complex, or also called, wicked problems. When organizations consider to embrace design thinking, it's important to understand how it has been applied and also what impact it has been creating.

But although innovation is key in the success of organizations and design thinking is an approach that supports innovation, there is a scarce amount of research regarding the way organizations implemented design thinking, the design methods used and the results of its application.

In order to contribute to fill this gap a systematic literature review of 58 papers published since 2010 was conducted with the aim to analyse how design thinking has been applied in different contexts and identify further research opportunities in the design thinking field.

Keywords: Design Thinking, Product Development, Service Development, Innovation, Literature Review.

Contents

List of Figures

List of Tables

Acronyms

DT Design Thinking.

IT Information Technology.

VPD Value Proposition Design.

Chapter 1

Introduction

The first chapter provides a brief context of the dissertation topic, followed by a short description of the problem, the motivation, the objectives and the research methodology adopted is detailed. At the end, the structure of the dissertation is detailed.

1.1   Context

"Most companies today have innovation envy" (Martin, 2009). They dream of creating similar game-changing innovation like Apple's iPod, but when it comes to triggering that kind of innovation and growth too often companies steadily believe they are not able to raise the bar so high, and play the game so well as such successful companies, so they rely on fragile market research reports to search for the next panacea that will accelerate their growth instead of embracing a designer mindset that will support companies uncovering true market needs (Liedtka and Ogilvie, 2011).

Some companies make authentic efforts to bring innovation inside their doors, they spend on solutions such as R&D, hire creative designers, innovation consultants, among others but many times they obtain disappointing outcomes (Martin, 2009).

On *The Design of Business* book Roger L. Martin suggests that the disappointing outcomes occur mainly because executives rely exclusively on analytical thinking which only contributes to reinforce the current knowledge and produces small improvements to the status quo. Whereas, on other hand, design thinking can foster innovation in companies and generate competitive advantage (Martin, 2009).

Design thinking has raised special interest around the business press and has been hailed as a convenient problem-solving approach to the challenges companies face in fostering innovation and growth (Liedtka, 2015).

Although there are different definitions of Design Thinking (DT) the most common include principles such as user-centeredness, iterative process, prototyping, testing and learning from failure. Tim Brown, an advocate of design thinking describes DT as "a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown, 2008).

Not only big companies like Apple and Google can apply this kind of approach, any company can commit to successful design thinking, but this initiative needs to be led and implemented from the very top by a management. There needs to be a strong figure to properly define what shape design thinking will take otherwise there will not be a strong direction, no relevant follow-through and no participation from the different sectors of a business (Martin, 2009).

According to Carlgren et al. there's not enough studies on how companies use DT, and there's a limited comprehension of the potential benefits of implementing DT as well as the impact it generates on organizations. This limited understanding can guide companies to adopt DT for the wrong reasons, or with faulty expectations and led to a unsuccessful implementation (Carlgren et al., 2016).

1.2 Motivation

Innovation is seen by organizations as a fundamental source of differentiation, growth and competitive advantage, and they are faced on a daily basis with the challenge and pressure of innovation and associated questions such as how can their organization become more innovative, how can they implement design thinking, how can they equip their employees with the necessary skills to deal with the uncertainty inherent in every innovation among other questions.

Since DT creates a natural flow from research to implementation which is able to produce innovation success, it is important to have an overview of how organizations have implemented design thinking, which methods they use in order to enable other organizations to adopt similar approaches and allow them to thrive in the field of innovation.

Thus, due to the lack of research surrounding the application of design thinking, the present dissertation aims to contribute for the fulfilment of that research gap as well as identify other future research opportunities.

1.3 Objectives

The current dissertation proposes to conduct a research, through a systematic literature review, with the aim to understand the practical application of design thinking in products and services, identify gaps in the literature and possible future research directions.

In order to accomplish this dissertation, the following five research questions were defined:

1. Which sectors have been applying design thinking?
2. What industries have been been applying design thinking?

3. Design thinking has been mostly applied in the development of products or services?

4. What design thinking processes have been applied?

5. Which design methods have been used on the design thinking process?

In summary, the development of this dissertation, aims to answer the following question: How has design thinking been applied in practice?

To provide an answer to this question, a systematic review of the literature and a content analysis of the respective content was conducted.

1.4   Dissertation structure

The present dissertation is structured in five chapters. The first chapter presents the research theme, the respective context, motivations and goals. The second chapter presents a literature review of the dissertation topic. The third chapter explains the purpose of the research, describes the adopted research method, explains in detail each stage of the research process and describes the material collection strategy. The fourth chapter analyses and summarizes the collected literature. To conclude the fifth chapter presents the conclusions, and a summary of identified gaps in the literature as well as recommendations for future research.

```
Introduction
    │
    ▼
Literature Review
    │
    ▼
Research
Methodology
    │
    ▼
Result Analysis
and Discussion
    │
    ▼
Conclusion
```

Figure 1.1: Dissertation Structure

Chapter 2

Backgroud

In this chapter a literature review for the present dissertation is presented. The first section is dedicated to an overview of fundamental concepts followed by a description of some of the design thinking processes found and design methods.

2.1 Design Thinking

Design thinking has been around in the sciences field since 1950 and in some engineering disciplines the term can be traced at least back to the early 1970s but it's only been adopted by business in the last three decades (Gobble, 2014).

Design thinking goes beyond design as most of us imagine it, is not concerned solely, or even primarily, with the look of a product. Rather, it encompasses a whole range of principles, tools and frameworks, many drawn from other disciplines, that reflect its driving concern with human experience (Gobble, 2014). It also allows people who aren't trained as designers to use creative tools to address a vast range of challenges.

In *Change by Design* book Tim Brown, executive chair of the design firm IDEO that is responsible for a long list of stunning innovations, from the Apple mouse to a self-sealing water bottle intended for dirt bikers, sums up design thinking as a human-centered approach to problem solving (Gobble, 2014). This approach, matches what is desirable from a human point of view, and prioritizes a deep empathy for the desires, needs, and challenges of the end user to fully understand a problem, with what is technologically feasible and economically viable, with the aim to build innovative and more effective solutions that create customer value and market opportunity (Gobble, 2014), (Roberts et al., 2016). Figure 2.1 illustrates the intersection of the three key elements for innovation.

In developing a product or service, design thinking focuses first on the needs and experiences of real people as a source of inspiration and insight rather than hypothetical "market segments" (Gobble, 2014). An early major advocate of design thinking, Bruce Nussbaum, made a push back in a 2011 Fast Company article and declared design thinking as "a failed experiment". For Nussman the widespread adoption of design thinking has overemphasized its processes, "turning it into a linear, gated, by-the-book methodology that delivered, at best, incremental change and innovation." In other words the author explains that design
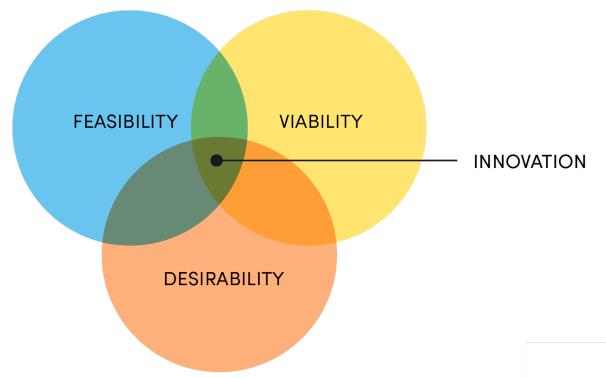
Figure 2.1: Feasibility, Viability, Desirability Model; Source: IDEO

thinking was integrated into the system becoming a "process trick" that would produce change rather than a truly innovative approach but Nussbaum doesn't discount the value of design thinking (Gobble, 2014).

One of the key factors to make that transformation is the way that the change is communicated across the organization. Kim Erwin argues in *Communicating the New* that radical innovation requires a different set of communication tools than incremental innovation or business as usual and it demands an organizational change. Multidisciplinary teams and complex problems, demand a framing on communication strategies in a way that creates engagement, alignment among the participants and recognizes the various perspectives involved, with the aim to be inclusive rather than exclusive. Erwin defends that when this communication works, communicating and creating the new become inseparable (Erwin, 2013).

Roger Martin of the Rotman School of Management, David Kelley, and Tim Brown of IDEO have popularized Design Thinking, they provide several examples of organizations that have implemented design thinking successfully, which includes successful organizations such as Procter & Gamble. Under the leadership of A. G. Lafley, Procter & Gamble, was perhaps the most successful company to make the transition to design thinking. During his tenure as CEO of the consumer goods giant, Lafley has made innovation P&G's primary mission, integrating innovation into everything P&G does and moving the company focus towards consumers creating new customers and new markets. He chronicled P&G transformation in *The Game-Changer* book that also shows how companies such as LEGO, Nokia, General Electric, Hewlett-Packard among others have made similar transformations (Gobble, 2014).

According to Gobble, John Miziolek argues in a Fast Company article that "any business can commit to successful design thinking," but that initiative "has to be led and implemented from the very top by a management committed to the process." At the end design thinking is heavily connected with the company culture and building such a culture does not only requires a transformation in the way organization approaches innovation but how the organization conceives innovation on itself (Gobble, 2014).

2.2 Design Thinking Key Principles

On an empirical interview study with employees from different functions, such as R&D and innovation managers and DT specialists, of six organizations Carlgren et al. identifies user focus, problem framing, diversity, visualization, experimentation and iteration as the five design thinking key principles. In the same study Carlgren et al. (2016) proposes a framework with the aim to create more specific discussion that encompasses different understandings of how DT affects, and potentially creates, value in large organizations.

The principles are highly interconnected between them and may be applied in different order throughout the design thinking processes ((Brown, 2009); (Brown, 2008)). The five design thinking key principles are also mentioned by other authors (Carlgren et al. (2016); Glen et al. (2015); Liedtka (2014); Shapira et al. (2017)), although there are some inconsistencies regarding the use of the terminology. The five design thinking key principles are described below.

User Focus

The first principle refers to create empathy and gain deep understanding around user context, functional, social and emotional needs, and behaviors. The big difference between technology based approaches, from human-centered based approaches, as design thinking, is that they tend to not focus on the users first, while human-centered approaches, as DT, does. To gain those user insights there is a variety of research methods such as interviews, focus groups, usability tests, observations, diary/camera studies, among others that can be used (Carlgren et al., 2016).

Problem Framing

The second principle refers to the ability to discover more about the problem and create a broaden understanding by reformulating and challenging it allows to enlarge the scope creating larger problem space as well as larger solution space, instead of try to solve it immediately, jumping to fast into the solution (Carlgren et al., 2016).

Visualization

The third principle refers to make solutions and ideas tangible with low fidelity visual representations or mock-ups. There is different ways to create these representations it could include sketching in two or three dimensions, improvisation through acting and storytelling or making simple mock-ups with paper and other convenient materials. This techniques allows companies to prototype and test solutions and

ideas without committing with significant investment of human and financial resources (Carlgren et al., 2016).

Experimentation and iteration

The fourth principle refers to do iterative experiments of solutions with the aim to increase the learning rate per unit of time and decrease the failure rate. As earlier in the development process ideas are tested, the sooner users will provide feedback and the collected feedback will and used to improve the solution. Experimentation is about fail soon to succeed later, and mindset characteristics as curiosity and optimism are viewed as supportive on experimentation process (Carlgren et al., 2016).

Diversity

The fifth principle refers to the importance of collaborating and combining teams with diverse backgrounds, perspectives and abilities, and bring them through the overall process. Having inspiration from different fields by networking with organizations, as universities and companies, research competitors, as well as analyse past, current and future trends allows to expand the horizons and create more meaningful solutions (Carlgren et al., 2016).

2.3   Design Thinking Process

Design thinking is an iterative, non-linear process that teams use to understand users, challenge assumptions, redefine complex, or also called wicked problems that are ill-defined or unknown, and create innovative solutions to prototype and test. (Scuttari et al., 2021) Despite of a significant theoretical literature base reveal accordance around the fundamental meaning of design thinking the same doesn't happen on the practise of design thinking, divergence has often been found between theory and practice (Liedtka, 2015).

On this article Liedtka examines the state-of-the-art practice in design thinking field and shows the different views of DT process and tools used from leading consultants in the design space like IDEO and Continuum, and educators like Stanford Design School, the Rotman School at the University of Toronto, and the Darden School at the University of Virginia.

Table 2.1 shows that despite each one of them use different terminology, there is three common stages. The first one focuses on gathering data about user needs and define the problem, followed by

7

the second stage that focuses on idea generation for user problems, followed by a final stage focused on prototyping and testing solutions (Liedtka, 2015).

Stage	IDEO	Continuum	Stanford	Rotman	Darden
Stage I data gathering about user needs	Discovery and interpretation	Discover deep insights	Empathize and define	Empathy	What is?
Stage II idea generation	Ideation	Create	Ideation	Ideation	What if?
Stage III testing	Experimentation and evolution	Make it real: prototype, test, and deploy	Prototype and test	Prototyping and experimentation	What wows? What works?

Table 2.1: Models of Design Thinking Process in Practice. Source: Adapted from Liedtka (2014).

Although the proposed models are favored by different approaches, they are all based on the same design principles. Darden's model, is probably more like a toolbox, as each stage is named with an actionable question and each stage brings together the applicable design methods. While the other four models presented here are similar to the Stanford model, with slightly different stage names. For that reason, in the following sections both models from Stanford and Darden University are explained in more detail.

2.3.1 Design Thinking Process proposed by the Hasso-Plattner Institute of Design at Stanford (d.school)

The Hasso Plattner Institute of Design at Stanford (d.school) describes design thinking as a five-stage process (see Figure 2.2). It's important to note that these five stages are iterative, teams should not understand them as a static and hierarchical process instead they should run them in parallel, out of order and repeat them in a non sequential way that contribute to innovation.

Empathize

As a human-centered approach empathy is the centerpiece of the design process. Through user research the empathize stage focus on understand and get to know people, why and how they do things, what physical and emotional needs they have, how they think about the world, what is important to them and also understand the context of the design challenge. Empathy allows design thinkers to disregard their
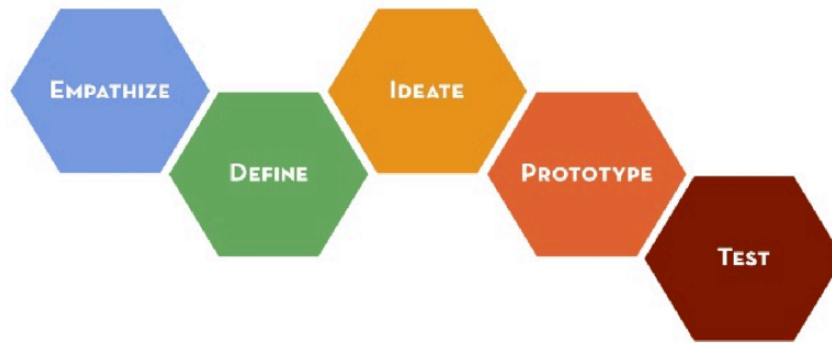
Figure 2.2: Stanford d.school Design Thinking Process

own assumptions about the world and gain insights about users and their needs in order to support the design process and come with meaningful innovations that address people's needs.

Define

The define stage of the design process is all about analysing and synthesizing the collected information about the user and the context to discover connections and patterns and bring clarity and focus to the design space. The goal is to then create actionable problem statements, frequently called point-of-view, that focuses on the insights and needs learned about a user. The define stage allows to progress to the third stage, Ideate, by asking questions that can help look for ideas for solutions.

Ideate

The ideate stage focuses on generating ideas to solve user's needs with a solid background provided from the previous two stages. Ideate stage is about generating as many ideas as possible to create a broader range of possibilities for each identified problem instead of generating the right or perfect idea. This stage is the source for building prototypes that then can be tested by the users.

Prototype

The prototype stage focuses on the iterative creation of artifacts with the aim identify the best possible solution for each problem found. In this stage the team builds a number of quick and cheap prototypes that users can interact so the team can test and investigate the ideas previously generated one-by-one.

Test

The test stage focuses on test the best solutions identified on prototyping stage. Although test is the final stage, the feedback collected from the users on the tests can be used to redefine the problem

statements and derive deeper understand of the users, the product, the context of use, how people think, behave, and feel (empathise). The collected feedback can then be implemented in order to get the closest final solution possible.

2.3.2 Design Thinking Process proposed by the University of Virginia's Darden Business School and the Design Management Institute

Years ago Liedtka, a professor at the University of Virginia's Darden School of Business and Ogilvie, CEO of innovation strategy consultancy Peer Insight published *Designing for Growth: A Design Thinking Tool Kit for Managers*, a book where the authors distilled what they have learned from the designers that they thought will be equally important for managers (Liedtka, 2014).

In it, the authors presented design thinking as a systematic approach to problem solving built on four questions. Each one of the four questions - What is? What if? What wows? and What works? - explored a different stage of the design thinking process (Liedtka, 2014).

1. What is? Examines the current reality.
2. What if? Uses the learning derived from the first stage to envision alternatives to create a new future.
3. What wows? Helps managers making choices about where to focus by collecting users insights.
4. What works? Makes it work in real world, and as a business to interact with users through small experiments.

According to Liedtka, a view of the design thinking process incorporating the four questions is represented on Figure 2.3.
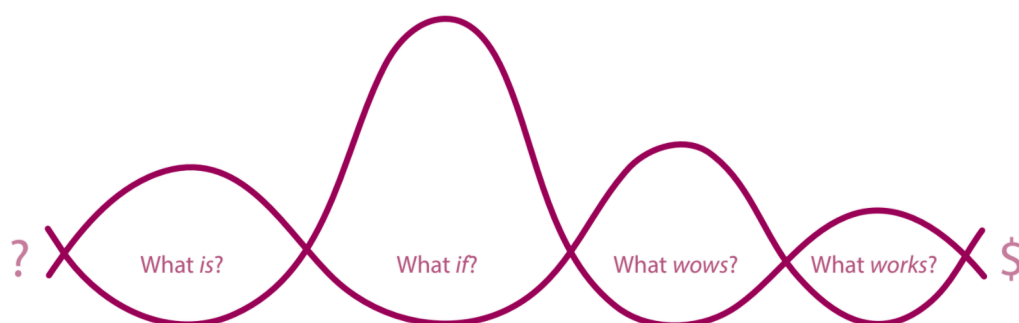
Figure 2.3: The four questions. Source: (Liedtka, 2014)

Most organisations try very hard to eliminate uncertainty because it is inefficient and unpredictable, but uncertainty is where innovation grows and design thinking process and the respective methods can

help organizations navigate through the uncertainty to innovation. Created by Damien Newman, a former IDEO worker, the figure 2.4 represents The Newman Design Squiggle a simple visual illustration of the design process and it captures the process of going from chaos and uncertainty to clarity an focus and intends to convey the feeling of the journey, starting on the left with mess and uncertainty and ending on the right eventually concluding in one single designed solution.

Noise / Uncertainty / Patterns / Insights   Clarity / Focus

Research & Synthesis   Concept / Prototype   Design
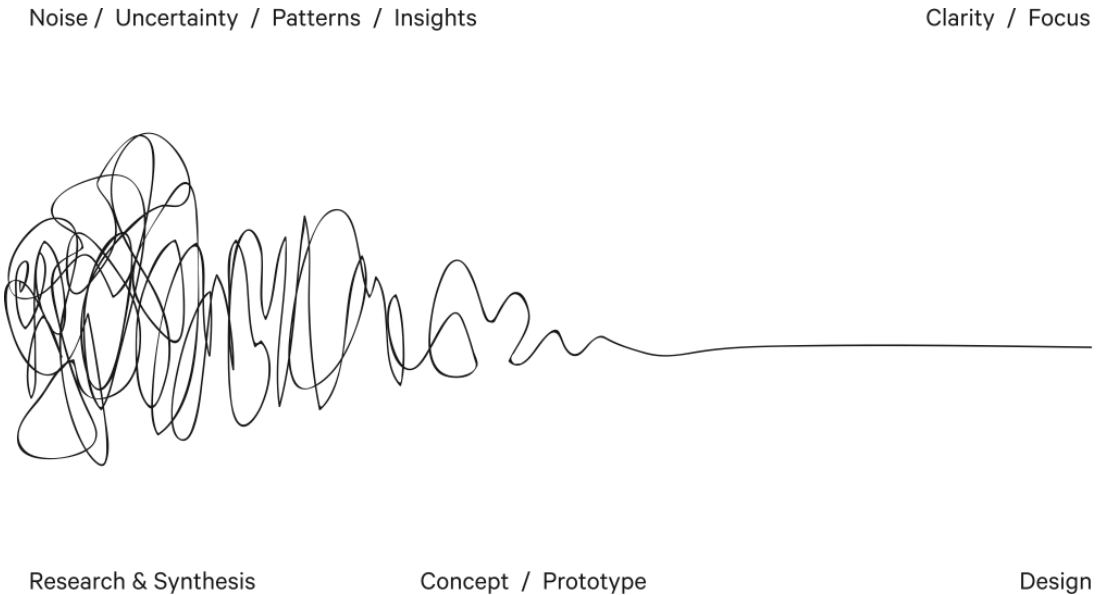
Figure 2.4: The Newman Design Squiggle

2.4   Design Methods

There is a wide variety of design methods to support design thinking process but the used methods can differ among authors and practitioners (Seidel and Fixson, 2013). Liedtka summarizes the more prominently but different stage. The first stage of emphasize includes a variety of ethnographic research techniques, such as interviews, participant observation, job to be done analysis, and journey mapping.

On the second stage of define includes sense-making tools such as mind mapping and other forms of cluster analysis. The third stage of ideation includes tools such as brainstorming and concept development.

The fourth stage of prototype includes tools such as storytelling, storyboarding, user scenarios, metaphor, experience journeys, and business concept illustrations. As for the fifth stage of test includes tools such as user testing, usability testing, A/B testing. Other tools, such as visualization and cocreation, are used throughout the process (Liedtka, 2015).

To guide managers through these four questions Liedtka suggests an accompanying set of ten design tools:

1. Visualization
2. Journey Mapping
3. Value Chain Analysis
4. Mind Mapping
5. Brainstorming
6. Concept Development
7. Assumption Testing
8. Rapid Prototyping
9. Customer Co-Creation
10. Learning Launch

On Figure 2.5 the design thinking process is presented by combining the four questions with the essential ten tools to be used on each stage of the process (Liedtka, 2014).
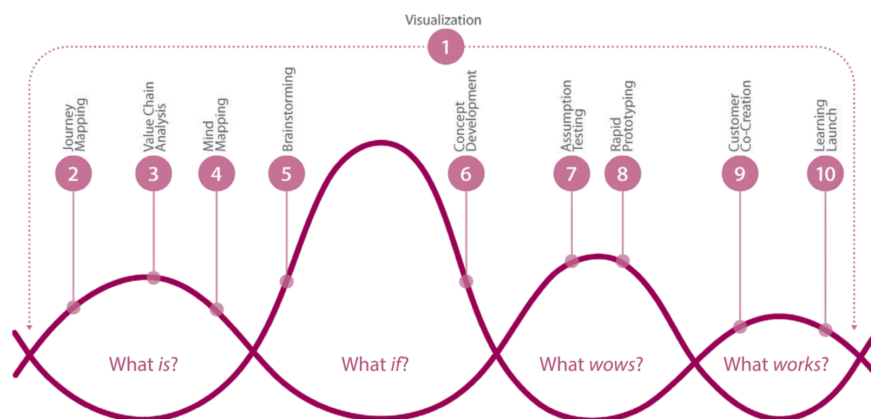
Figure 2.5: Design Tools. Source: (Liedtka, 2014)

2.4.1   Design Methods Description

Along the conducted literature review it was possible to find descriptions for some of the used design methods. This section presents a wide variety of design methods and the respective description.

Value Proposition Design

The Value Proposition Design (VPD) canvas is a business design tool devised by Osterwalder et al. (2014) that intends to propose a creative, simple and fast way to design minimal viable product proposals that customers want, supporting them through further research (Armellini et al., 2017). According to

Armellini et al. (2017), the VPD canvas is actually a breakdown of two of the core blocks of the business model canvas (Osterwalder and Pigneur, 2011), namely: "value proposition" and "customer segments".

Interviews

Interviews consist in structured questions designed to gain insights regarding attitudes, motivations, opinions and behaviours of a research group (Berg (2008); Straker et al. (2020)).

Journey Map

Journey map is a visual interpretation used in design to explore the overall interactions between people and products, services or businesses over time and across different channels (Straker et al., 2020).

Personas

Personas are fictional characters usually used to illustrate a target group of customers and it should communicate their motivations, frustrations, attitudes, goals, behaviors and demographic information, that then can be used to communicate the user needs within the design team and anticipate design problems before reaching usability testing stage ((Garrett and Wrigley, 2019); (Straker et al., 2020)).

Market research

Market research and analysis is the process of exploring data and reports with the aim to gain meaningful insights, that can be used to better comprehend and enhance business performance. Market research plays a key role in influencing and driving the actions that result in generate more value in organizations (Straker et al., 2020).

Stakeholders analysis

Stakeholders analysis consists in uncover the different needs, motivations, obstacles they might face and gather the interests of the different stakeholders involved in the design process (Selloni and Corubolo, 2017).

Co-design

Co-design principle is to "design with" instead of "design for" people. In co-design users and relevant stakeholders play an active role, by participating and contributing in the design, rather than passively responding to design decisions, to ensure that their needs are in the center of the design process in order to improve the value of the outcome. ((Straker et al., 2020); (Steen, 2013)).

Prototype

Prototypes are a low-fidelity representation of the envisioned product or service which can be tested with customers and on franchisee personas in order to understand how customers react and collect their feedback before an eventual implementation. The prototype development is an iterative cycle build upon user testing findings and respective incorporation of those findings in order to improve the prototype (Straker et al., 2020).

Usability Test

Usability testing is usually conducted with a prototype and allows to determine whether people understand whether the conceptual model of the product or the service matches the user's understanding and expectations (Straker et al., 2020).

Storytelling

Storytelling consists in asking users to tell a story about their experience to uncover contradictions and failures (Beckman and Barry, 2009).

Scenarios

Scenarios consist in the use of images to contextualise the story, along with brief written descriptions (Chamorro-Koc et al., 2012).

Customer Narratives

Customer narratives consists in the creation of a touch point timeline that explores the major touch points of customer's engagement with a business, product or service ((Bucolo et al., 2012); (Liedtka, 2011); (Zurlo and Cautela, 2014)).

Focus Group

Focus group consist in the interactions of an interviewer with a group participants to gain facts, opinions and attitudes (Kidd and Parshall, 2000).

Survey

Surveys consist in a number of questions to either select pre-determined answers or provide short answer responses given to participants (Groves et al., 2011).

Mind Map

Mind-mapping is an ideation method that is analogous to human memory. Ideas are organized in a hierarchical structure with individual ideas under categories which in turn map to a topic (White et al., 2010).

Shadowing

Shadowing is a design method that consists in observe customers and their behavior as they proceed through a products, service or business interaction (Colin, 2002).

Service Safari

Service safaris are experiential field trips in which designers experience services from the customers' perspective to explore offerings in other industries that and customer interaction procedures with similar products, services or businesses they are designing (Stickdorn and Schneider, 2010).

2.5 Design Thinking in Products and Services

Thinking like a designer can transform the way organizations develop products, services, processes, and strategy. Design thinking is a human-centered approach that encourages creativity and innovation to create a product or service that solves a complex problem of customers or target users.

2.5.1 Product Innovation

Design thinking is often utilised and focused on the development of new products (Gobble, 2014). The focus of DT within product innovation from companies such as Apple, Nintendo and Alessi have led to rapid growth within industry of customer centric designed products (Brown, 2009).

According to Gobble, Kelley acknowledge that IDEO's "blend of methodologies, work practices, culture, and infrastructure" can be applied anywhere and he also shares IDEO's five-step development process, but Kumar offers a more structured approach to the frameworks of design thinking (Gobble, 2014).

In *101 Design Methods* book, Kumar, approaches the practice of creating new products, services, and customer experiences as a science, rather than an art, providing examples that illustrate the application of the various practical set of collaborative tools and methods of service design thinking for planning and defining successful new offerings (Kumar, 2012).

2.5.2   Service Innovation

The focus of design thinking on human experience makes it a natural tool not only for product innovation but also for service innovation. The relatively new discipline of service design is inspired on some of the tenets of design thinking (Gobble, 2014).

According to Gobble there are two recent works that explore the value of design thinking in the context of service design. The first one is the book *This is Service Design Thinking*, that brings together nearly two dozen contributors to lay out the basic principles of service design, drawing from their roots in ethnography, strategic management, and various design disciplines; having thoroughly mapped the basics, the book provides a series of case studies to illustrate how those principles might be applied.

The second is the book *Service Design: From Insight to Implementation* written by Polaine et al., where the author approaches service design as a whole system and claims that no matter how good it was the work of product or interaction designers "if another link in the chain was broken, the entire thing was broken from the customer's perspective."

2.6   Research Gaps

Based on the extensive literature review carried out during this dissertation, the main gap that was found concerns with the lack of overview regarding design thinking application. Several studies have been published regarding the application of design thinking but a very low number of them includes a detailed analysis of them based upon the design thinking process adopted, the design methods used, and if it was applied in a product or a service.

This research encompasses a systematic literature overview throughout the research methodology explained in chapter 3 that aims to contribute to fill this gap.

Chapter 3

Research Method

The third chapter explains the purpose of the research, describes the adopted research method, explains in detail each stage of the research process and describes the material collection strategy.

3.1 Problem and Research Opportunity

Following the motivation of the current dissertation, described previously, a set of research questions was defined to assess the state of the art on the topic of design thinking. These are key to provide a better understanding of the topic and to guide the research to be done. Four research questions where specified:

1. Which sectors have been applying design thinking?
2. What industries have been been applying design thinking?
3. Design thinking has been mostly applied in the development of products or services?
4. What design thinking processes have been applied?
5. Which design methods have been used on the design thinking process?

3.2 Methodology

The development of this dissertation is supported by the systematic literature review research method and the respective content analysis.

According to Williams research can be originated around at least one question regarding one "phenomenon of interest" and the most common methods to conduct research are quantitative, qualitative, and mixed methods. Each method has different techniques to collect the research material, the quantitative method gives an objective measure of reality, while the qualitative method allows the researcher to explore and more fully understand a phenomenon (Williams, 2007).

Systematic literature reviews are deemed the most reliable tool for synthesizing the available literature evidence (Linde and Willich, 2003).

The central source of the literature review should be from papers in academic and research journals. They will include a literature review, a discussion of the research method, an analysis of the results, and the respective conclusions and recommendations (Rowley and Slack, 2004).

A literature review consists in the analysis of the existing literature and the state of the art summary in a subject field. Through the review of previous and recent work, it is therefore possible to identify areas in which additional research would be valuable (Rowley and Slack, 2004).

3.3   Research Process

The research process of this dissertation consists in two main stages, the first stage consists in a systematic literature review and the second stage consists in the respective content analysis.

To produce valid work through the literature review, the research process relies on the following steps:

- Step 1 - Theme definition;
- Step 2 - Research process definition;
- Step 3 - Systematic literature review;
- Step 4 - Content analysis;
- Step 5 - Discussion and results;

Figure 3.1 illustrates the research process adopted.

Figure 3.1: Research Process

The first stage of the research process, consists in the explanation of concepts related with the present dissertation. This stage defined concepts such as design thinking, different design thinking processes and respective design methods.

On the second stage the research process to conduct this dissertation is defined.

The third stage consisted on a systematic literature review, that allowed to summarize the existent information related with the theme.

The fourth stage consisted on the analysis of the content of the previous stage.

And the last stage consisted on the discussion of the analysed content, and the presentation of the research results.

3.4   Material collection

The publications here presented and analysed were collected as the result of a set of searches on the Scopus database where the following terms were explored: "design thinking" AND innovation.

Table 3.1 shows the keyword assembly structure where the first level defines the search context and the second level contains the modeling keywords. The modeling keywords are kept at a general level to cover a broader range of studies.

Table 3.1: The proposed keyword assembly structure.

Research query	(KEY ("design thinking") AND KEY (innovation))
Time span	All papers published up to March 2021
Article type	Peer-reviewed scientific journals
Language	English
Hits in Scopus	211

This resulted in an initial set of 211 publications. To better define the papers that should be the focus of further analysis, papers with the following conditions were considered:

- Papers in English language and published in peer-reviewed journals since 2010 until March 2021 are included.
- Papers that focus on the application of design thinking in products or services are included.
- Papers that focus on the creation of frameworks based on design thinking to apply in marketing or other company sectors are excluded.
- Papers that focus on explaining the importance of teaching design thinking are excluded.

- Papers that do not provide an overview of how companies applied design thinking or papers that did not implemented design thinking are excluded.

A content analysis of each paper, through the reading of respective abstracts, made possible the intersection with the established conditions and, consequently, made possible to identify their relevance for the purpose of this dissertation. This resulted in a more restricted set of publications, 58 papers in total, the papers are presented in table 3.2 and ordered by the highest number of citations.

Table 3.2: Literature review.

Begin of Table	
Reference	**Number of citations**
(Roach et al., 2016)	49
(Hobday et al., 2012)	35
(Sorice and Donlan, 2015)	26
(Ana et al., 2013)	24
(Seeber et al., 2015)	22
(Baldassarre et al., 2020)	14
(Sklar and Madsen, 2010)	10
(Redante et al., 2019)	8
(Beltagui, 2017)	8
(Valentine et al., 2017)	8
(Price and Wrigley, 2015)	8
(Rau et al., 2017)	7
(Steen et al., 2014)	7
(Davis et al., 2016)	5
(Rodriguez et al., 2016)	5
(Eines and Vatne, 2017)	4
(Pericu, 2017)	4
(Kurikka et al., 2016)	4
(Thies, 2015)	4
(Bermejo and Rodríguez-Monroy, 2020)	3

Continuation of Table 3.2	
Reference	**Number of citations**
(Tushar et al., 2020)	3
(Fleischmann, 2019)	3
(Selloni and Corubolo, 2017)	3
(Lub et al., 2015)	3
(Pandey, 2015)	3
(De Carvalho et al., 2020)	2
(Park et al., 2020)	2
(Shen, 2018)	2
(Fleischmann, 2018)	2
(Ghajargar et al., 2017)	2
(Cheung, 2012)	2
(Scuttari et al., 2021)	1
(Criado et al., 2020)	1
(van der Westhuizen et al., 2020)	1
(Kim, 2020)	1
(Appleyard et al., 2020)	1
(Mahmoud-Jouini et al., 2019)	1
(Jayakumar et al., 2019)	1
(Garrett and Wrigley, 2019)	1
(Shen, 2019)	1
(Armellini et al., 2017)	1
(Ortiz and He, 2021)	0
(Emma and Orbulov, 2020)	0
(Alexandrakis, 2021)	0
(Chonde et al., 2021)	0
(Pham et al., 2021)	0
(Giusti Gestri, 2021)	0
(Kodrat et al., 2020)	0
(Da Silva et al., 2020)	0

Continuation of Table 3.2	
Reference	**Number of citations**
(Kim et al., 2020)	0
(Silva and Marques, 2020)	0
(El-Farargy, 2020)	0
(Przybilla et al., 2020)	0
(Straker et al., 2020)	0
(Folmer et al., 2018)	0
(Henkel et al., 2017)	0
(Masajtis et al., 2016)	0
(Macdonald and Elahee, 2016)	0
End of Table	

In order to validate the adopted filtering process and papers selection criteria, a keyword bibliometric analysis based on co-occurrence data was performed in both initial (211 papers) and final (58 papers) sets of papers, by using the software VOSviewer.
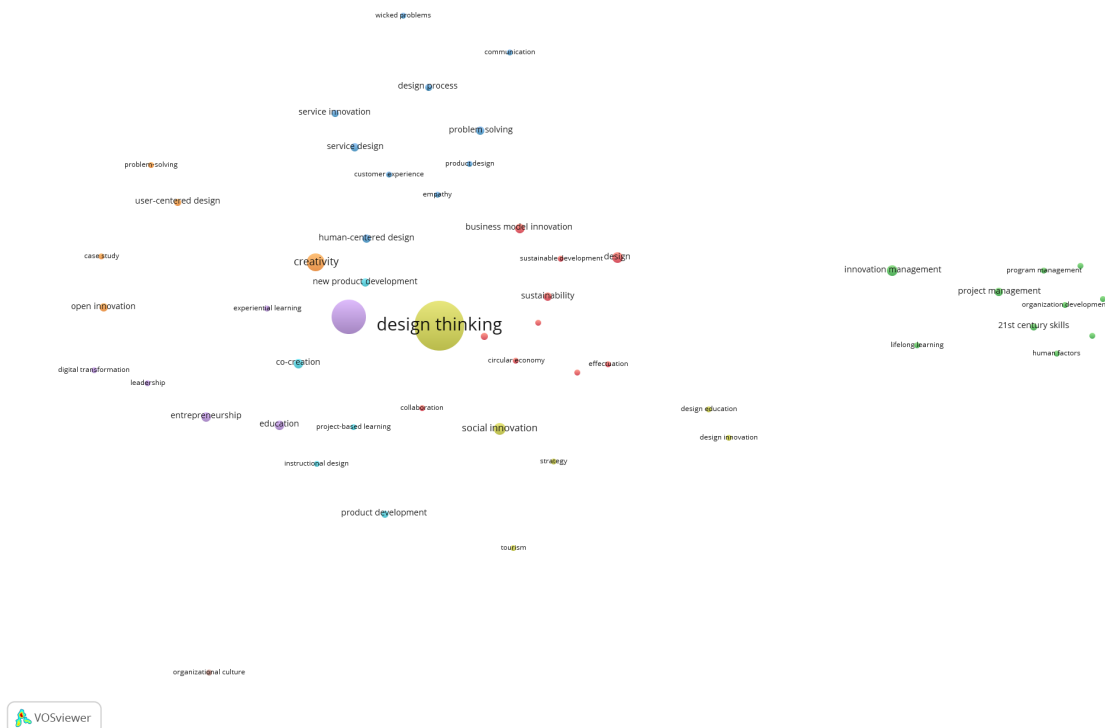
Figure 3.2: Co-occurrence maps for indexed keywords in initial sample
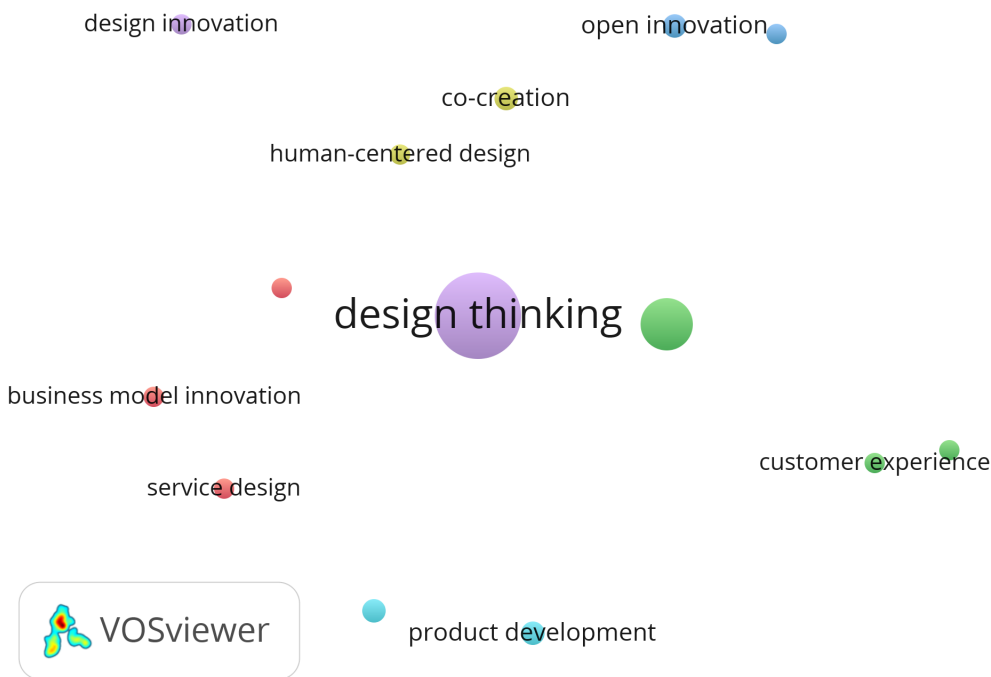
Figure 3.3: Co-occurrence maps for indexed keywords in final sample

The Figure 3.2 and the Figure 3.3 show co-occurrence maps of keywords present in the papers of the initial and final samples, respectively. In both maps, the bigger the circle of a keyword, the more frequently that keyword occurs in the respective sample.

Furthermore, the smaller the distance between two or more keywords, the larger the number of co-occurrences of such keywords in the same paper. A comparison between both maps reveals that the papers included in the final sample comply with the objective of this systematic review.

At this point, note that fundamental keywords, such as "design thinking", "product development" and "service design" are not excluded during the content analysis of each paper and application of the mentioned inclusion and exclusion conditions. In particular, this validates the filtering process from the initial to the final sample of papers included in the subsequent analyses.

Chapter 4

Results Analysis and Discussion

The fourth chapter analyses and summarizes the collected literature, and uncovers potential research gaps and opportunities for future research on these topic. The information from the analyzed publications was grouped in order to be possible to retrieve valuable knowledge from a wide set of sources and thus respond accurately to the research questions raised in chapter 1.

4.1 Category selection and material evaluation

The selected papers were characterized according to four distinct categories: type of sector, industry sector; and product or service. Table 4.1 summarizes the findings regarding the application of design thinking in different scenarios.

Table 4.1: A literature overview of design thinking application for different sectors, industry and product or service.

Begin of Table			
Reference	**Sector**	**Industry**	**Product/Service**
(Roach et al., 2016)	Private	Manufacturing	Product
(Hobday et al., 2012)	Public	Governmental	Service
(Sorice and Donlan, 2015)	Public	Governmental	Service
(Ana et al., 2013)	Private	Orthopedic	Product
(Seeber et al., 2015)	Public	Healthcare	Service
(Baldassarre et al., 2020)	Private	Sustainability	Product
(Sklar and Madsen, 2010)	Public	Non Governmental	Service
(Redante et al., 2019)	Private	Manufacturing	Product
(Beltagui, 2017)	Private	Manufacturing	Service
(Valentine et al., 2017)	Public	Healthcare	Service
(Price and Wrigley, 2015)	Private	Aviation	Service
(Rau et al., 2017)	Private	Utilities	Service
(Steen et al., 2014)	Private	IT	Product

Continuation of Table 4.1			
Reference	**Sector**	**Industry**	**Product/Service**
(Davis et al., 2016)	Public	Governmental	Service
(Rodriguez et al., 2016)	Private	Retail	Product
(Eines and Vatne, 2017)	Public	Healthcare	Service
(Pericu, 2017)	Private	Social	Product
(Kurikka et al., 2016)	Private	Healthcare	Product
(Thies, 2015)	Public	Healthcare	Service
(Bermejo and Rodríguez-Monroy, 2020)	Private	Utilities	Service
(Tushar et al., 2020)	Private	Utilities	Service
(Fleischmann, 2019)	Private	Sustainability	Service
(Selloni and Corubolo, 2017)	Public	Social	Service
(Lub et al., 2015)	Private	Hospitality	Service
(Pandey, 2015)	Public	Education	Service
(De Carvalho et al., 2020)	Private	Electronic	Product
(Park et al., 2020)	Private	IT	Product
(Shen, 2018)	Public	Education	Service
(Fleischmann, 2018)	Private	Sustainability	Service
(Ghajargar et al., 2017)	Private	IT	Service
(Cheung, 2012)	Private	Healthcare	Product
(Scuttari et al., 2021)	Private	Transport	Service
(Criado et al., 2020)	Public	Governmental	Service
(van der Westhuizen et al., 2020)	Public	Healthcare	Service
(Kim, 2020)	Private	IT	Product
(Appleyard et al., 2020)	Private	Electronic	Product
(Mahmoud-Jouini et al., 2019)	Private	IT	Product
(Jayakumar et al., 2019)	Public	Non Governmental	Service
(Garrett and Wrigley, 2019)	Private	Insurance	Service
(Shen, 2019)	Public	Education	Service
(Armellini et al., 2017)	Private	Construction	Service

Continuation of Table 4.1			
Reference	**Sector**	**Industry**	**Product/Service**
(Ortiz and He, 2021)	Public	Agricultural	Service
(Emma and Orbulov, 2020)	Private	Manufacturing	Product
(Alexandrakis, 2021)	Public	Sustainability	Service
(Chonde et al., 2021)	Public	Healthcare	Product
(Pham et al., 2021)	Private	IT	Service
(Giusti Gestri, 2021)	Private	Manufacturing	Product
(Kodrat et al., 2020)	Private	Manufacturing	Product
(Da Silva et al., 2020)	Private	Manufacturing	Product
(Kim et al., 2020)	Private	Sustainability	Service
(Silva and Marques, 2020)	Private	Manufacturing	Product
(El-Farargy, 2020)	Public	Healthcare	Service
(Przybilla et al., 2020)	Private	Manufacturing	Product
(Straker et al., 2020)	Private	IT	Product
(Folmer et al., 2018)	Public	Healthcare	Service
(Henkel et al., 2017)	Public	Education	Service
(Masajtis et al., 2016)	Private	Manufacturing	Product
(Macdonald and Elahee, 2016)	Private	IT	Service
End of Table			

4.2   Descriptive analysis

The selected papers were descriptively characterized according to the following criteria: the number of publications over time and per international peer-reviewed journal; the sector, if it was applied in a product or a service, the design process followed and the design methods used.

Regarding the number of published papers evolution, by following the selection criteria outlined above, it is possible to infer that the publications start from 2010. And there is an increasing trend in the number of publications throughout the time window considered, between 2010 and March 2021. (see Figure 4.1).

It is noticeable from Figure 4.1 that there is a significant increase in the number of published papers from the year 2019 onwards, being 2020 the year with most identified papers. The years of 2016, 2017, and 2019 also reveal a significant number of published papers.
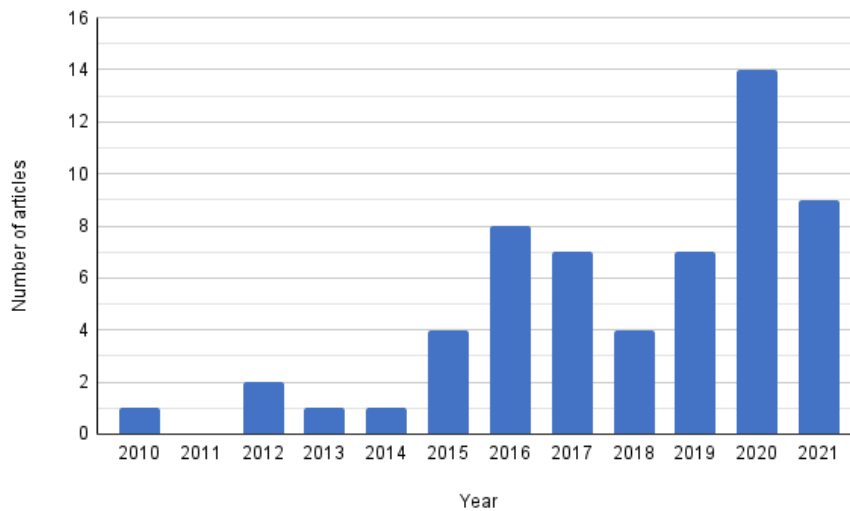
Figure 4.1: Papers distribution across 2010 and March 2021

The collected sample is distributed among 47 different journals, where a higher number of publications do not mean a higher relevance within the set. The Design Journal lists the maximum number of published papers over the time window considered with 6 papers (see Figure 4.2).
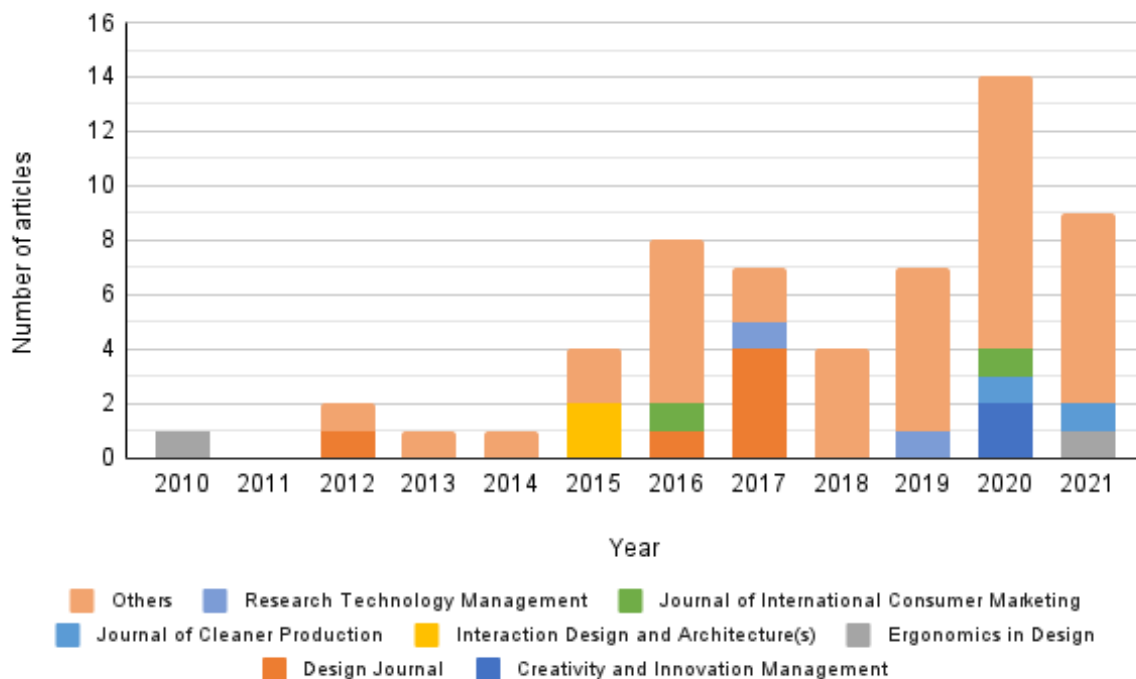
Figure 4.2: Papers distribution by peer-reviewed journal from 2010 to March 2021

Other journals such as Creativity and Innovation Management , Ergonomics in Design, Interaction Design and Architecture(s), Journal of Cleaner Production, Journal of International Consumer Marketing

and Research Technology and Management also contain a considerable number of publications (2 papers per journal) on the topic of the application of Design Thinking in products or services development as seen from Figure 4.2).

In what concerns to the application of design thinking, the private sector represents the great majority of the papers (64%), while application of design thinking in public sector are employed by the remaining 36%, from Figure 4.3.


Figure 4.3: Papers distribution by private and public sector
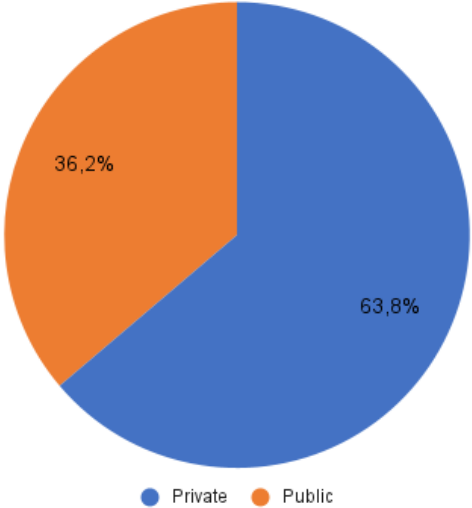
On regards the application of DT in products or services, this research made possible to infer that 35 of the 58 papers analyzed (60%) refers to the application of design thinking in services, while 23 papers refers to the application in products, corresponding to 40% of the total sample (see figure 4.4).
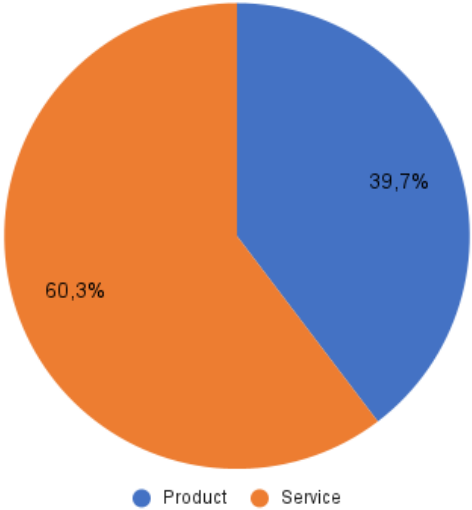
Figure 4.4: Papers distribution by product and service type

In what concerns to the distribution of the papers according to the industry type this research made possible to infer that Healthcare, Manufacturing, Information Technology (IT) and Sustainability industries are the most representative ones when it comes to apply design thinking, from Figure 4.5.
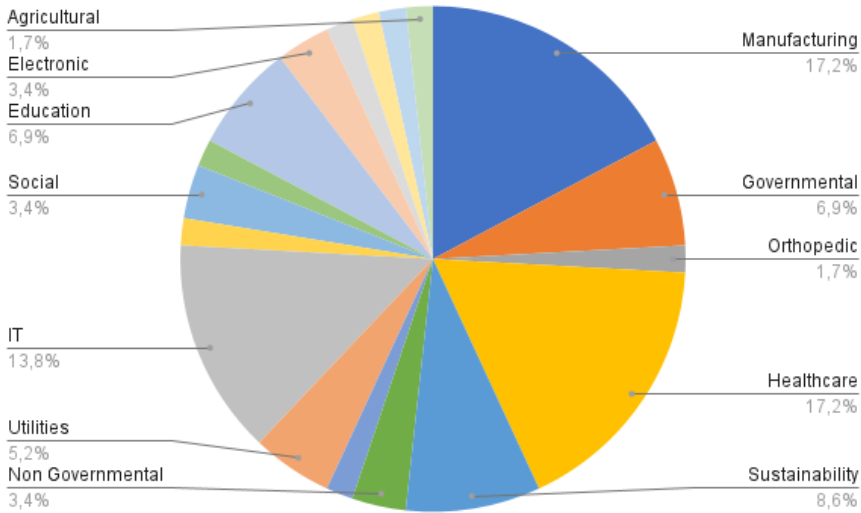
Figure 4.5: Papers distribution by industry type

The 58 papers were then submitted to a comprehensive analysis on the design process and design methods used. Table 4.2 synthesizes the findings of what design process was adopted in each article. It was possible to identify the adopted design process of 60% of the 58 papers, which is the equivalent to 35 papers.

Table 4.2: A literature overview of the design processes adopted.

Begin of Table	
Reference	**Design Process**
(Ana et al., 2013)	Discovery; Envision and Create; Refine
(Seeber et al., 2015)	Understand; Observe; Point of View; Ideate; Prototype; Test
(Valentine et al., 2017)	Understanding; Diverging; Converging; Refining and Testing; Communicate and Disseminate
(Price and Wrigley, 2015)	Problem; Market Research; Deep customer Insights; Idea generation; Business Development; Solution
(Rau et al., 2017)	Exploration; Creation; Reflection; Implementation
(Steen et al., 2014)	Initial analysis and requirements; Concept development; Integration; Evaluation"

Continuation of Table 4.2	
Reference	**Design Process**
(Davis et al., 2016)	Identification of research themes; Multidisciplinary stakeholder engagement; Development; Delivery
(Rodriguez et al., 2016)	Deepen; Recognize; Explore; Inspire; Transform; Development
(Pericu, 2017)	Empathise; Define; Ideate; Prototype; Test
(Bermejo and Rodríguez-Monroy, 2020)	Observation; Inspiration; Synthesis; Ideation; Prototyping; Testing; Communication
(Tushar et al., 2020)	Discover; Define; Develop; Deliver
(Selloni and Corubolo, 2017)	Problem Setting; Warm Up; Ideas Generation; Service Development; Collective Assessment
(Lub et al., 2015)	Trend analysis; From people in context to future consumers; Trends and future strategic objectives; Integration and consolidation of future concepts
(Pandey, 2015)	Problem identification; Problem and context discovery; Synthesis; Prototyping
(De Carvalho et al., 2020)	Identification; Product prospecting; Conception; Initial Requirements; Exploration; Ideation; Prototyping
(Park et al., 2020)	First prototype and evaluation; Second prototype and evaluation; Technical features of StoryWeb; Design features of StoryWeb
(Ghajargar et al., 2017)	Empathise; Define; Ideate; Iterate; Conclude
(Cheung, 2012)	Identifying opportunities; Understanding the opportunity; Conceptualizing the opportunity
(Criado et al., 2020)	Empathy; Redefinition; Ideation; Prototyping; Implementation
(van der Westhuizen et al., 2020)	Inspiration; Ideation; Implementation
(Mahmoud-Jouini et al., 2019)	Inspiration; Ideation; Implementation
(Jayakumar et al., 2019)	Insighting; Ideation; Impact
(Garrett and Wrigley, 2019)	Contextualise; Propose; Reframe; Strategise

Continuation of Table 4.2	
Reference	**Design Process**
(Ortiz and He, 2021)	Exploration; Prototype; Evaluation
(Emma and Orbulov, 2020)	Definition; Observation; Ideation; Prototyping; Testing
(Alexandrakis, 2021)	Understand ; Emphatize; Define; Ideate; Prototype; Test
(Chonde et al., 2021)	Empathise; Define; Ideate; Prototype; Test; Implement
(Pham et al., 2021)	Concept; Develop; Launch
(Giusti Gestri, 2021)	Explore; Define; Design; Product
(Da Silva et al., 2020)	Understand ; Observe; Define; Ideate; Prototype; Test
(Kim et al., 2020)	Empathise; Define; Ideate; Prototype; Test
(Silva and Marques, 2020)	(Re)define the problem; Find needs and benchmark; Brainstorm; Prototype; Test
(El-Farargy, 2020)	Identification; Research; Development; Implementation; Maturity
(Przybilla et al., 2020)	Problem definition and redefinition; Needfinding and Synthesis; Ideation; Prototyping; Testing
(Straker et al., 2020)	Contextualise; Propose; Re-frame; Strategise
End of Table	

Although some papers used design processes proposed by design thinking pioneers such as the design firm IDEO, or by Stanford University, as is the case of Mahmoud-Jouini et al. (2019) and Pericu (2017) respectively, other papers adjusted those design processes according to their needs, as is the case of Przybilla et al. (2020).

Despite the fact that the papers use different terminology to refer to the different stages of the design process, the principles of design thinking, explained in chapter 2, are applied during the design process. The final analysis presented was conducted in order to identify what design methods were used in the 58 papers. The findings are presented in Table 4.3, that is structured in 2 columns, the first column presents the design method and the second column presents the papers, ordered by the highest number of citations, that used the respective design method.

It was possible to identify 26 different design methods among 46 papers.

According to table 4.3 it is possible to infer that the three most used design methods are the interviews, used across 37 papers, followed by the prototype used across 30 papers and lastly the journey map used across 18 papers.

It is important to note that the result of this analysis doesn't intend to privilege these three design methods neither conclude that these are more relevant when compared to other methods, as well as disfavour the less used methods.

Table 4.3: A literature overview of the design methods used.

Begin of Table	
Design Method	**Reference**
Observation	(Ana et al., 2013); (Davis et al., 2016); (Thies, 2015); (Pandey, 2015); (Shen, 2018); (Ghajargar et al., 2017); (Scuttari et al., 2021); (Mahmoud-Jouini et al., 2019); (Jayakumar et al., 2019); (Armellini et al., 2017); (Giusti Gestri, 2021); (Da Silva et al., 2020); (Silva and Marques, 2020); (Przybilla et al., 2020); (Straker et al., 2020)
Survey	(Ana et al., 2013); (Price and Wrigley, 2015); (Pericu, 2017); (Kurikka et al., 2016); (Bermejo and Rodríguez-Monroy, 2020); (Tushar et al., 2020); (Ghajargar et al., 2017); (Armellini et al., 2017); (Emma and Orbulov, 2020); (Alexandrakis, 2021); (Chonde et al., 2021); (Straker et al., 2020)

Design Method	Reference
Interviews	(Ana et al., 2013); (Seeber et al., 2015); (Beltagui, 2017); (Price and Wrigley, 2015); (Rau et al., 2017); (Steen et al., 2014); (Davis et al., 2016); (Rodriguez et al., 2016); (Pericu, 2017); (Kurikka et al., 2016); (Thies, 2015); (Bermejo and Rodríguez-Monroy, 2020); (Fleischmann, 2019); (Selloni and Corubolo, 2017); (Lub et al., 2015); (Pandey, 2015); (Shen, 2018); (Fleischmann, 2018); (Ghajargar et al., 2017); (Cheung, 2012); (van der Westhuizen et al., 2020); (Kim, 2020); (Mahmoud-Jouini et al., 2019); (Jayakumar et al., 2019); (Shen, 2019); (Emma and Orbulov, 2020); (Alexandrakis, 2021); (Chonde et al., 2021); (Pham et al., 2021); (Giusti Gestri, 2021); (Da Silva et al., 2020); (Kim et al., 2020); (Silva and Marques, 2020); (El-Farargy, 2020); (Przybilla et al., 2020); (Straker et al., 2020); (Folmer et al., 2018)
Focus Group	(Valentine et al., 2017); (Price and Wrigley, 2015); (Rau et al., 2017); (Steen et al., 2014); (Davis et al., 2016); (Bermejo and Rodríguez-Monroy, 2020); (Tushar et al., 2020); (Pandey, 2015); (Pham et al., 2021); (Giusti Gestri, 2021); (Kodrat et al., 2020); (El-Farargy, 2020)
Shadowing	(Ana et al., 2013); (Price and Wrigley, 2015); (Pericu, 2017); (Bermejo and Rodríguez-Monroy, 2020); (Fleischmann, 2018)
Market Research	(Ana et al., 2013); (Rau et al., 2017); (Ghajargar et al., 2017); (Kim, 2020); (Garrett and Wrigley, 2019); (Armellini et al., 2017); (Emma and Orbulov, 2020); (Straker et al., 2020)
Persona	(Beltagui, 2017); (Price and Wrigley, 2015); (Rau et al., 2017); (Tushar et al., 2020); (Lub et al., 2015); (Criado et al., 2020); (Garrett and Wrigley, 2019); (Straker et al., 2020)
Field trips	(Valentine et al., 2017); (Rau et al., 2017); (Ghajargar et al., 2017); (Mahmoud-Jouini et al., 2019); (Armellini et al., 2017); (Emma and Orbulov, 2020)
Empathy Map	(Beltagui, 2017); (Fleischmann, 2019); (Armellini et al., 2017)

Continuation of Table 4.3	
Design Method	**Reference**
Jobs To Be Done	(Armellini et al., 2017)
Value Proposition Canvas	(Armellini et al., 2017)
Stakeholder Analysis	(Fleischmann, 2019); (Selloni and Corubolo, 2017); (Cheung, 2012); (Scuttari et al., 2021); (van der Westhuizen et al., 2020); (Mahmoud-Jouini et al., 2019)
5Whys	(Criado et al., 2020)
Affinity Map	(Tushar et al., 2020); (Pandey, 2015); (Emma and Orbulov, 2020)
Journey Map	(Ana et al., 2013); (Valentine et al., 2017); (Rodriguez et al., 2016); (Pericu, 2017); (Bermejo and Rodríguez-Monroy, 2020); (Tushar et al., 2020); (Fleischmann, 2019); (Selloni and Corubolo, 2017); (Lub et al., 2015); (Pandey, 2015); (Fleischmann, 2018); (van der Westhuizen et al., 2020); (Mahmoud-Jouini et al., 2019); (Giusti Gestri, 2021); (Kim et al., 2020); (El-Farargy, 2020); (Przybilla et al., 2020); (Straker et al., 2020)
Touchpoint timeline	(Price and Wrigley, 2015); (Rodriguez et al., 2016); (Bermejo and Rodríguez-Monroy, 2020)
Mind Map	(Tushar et al., 2020); (Pandey, 2015); (Kim et al., 2020)
Brainstorm	(Ana et al., 2013); (Valentine et al., 2017); (Rau et al., 2017); (Davis et al., 2016); (Bermejo and Rodríguez-Monroy, 2020); (Selloni and Corubolo, 2017); (Pandey, 2015); (Mahmoud-Jouini et al., 2019); (Armellini et al., 2017); (Emma and Orbulov, 2020); (Kim et al., 2020); (Przybilla et al., 2020)
How might we	(Seeber et al., 2015); (van der Westhuizen et al., 2020); (Mahmoud-Jouini et al., 2019)

Continuation of Table 4.3	
Design Method	**Reference**
Prototype	(Ana et al., 2013); (Seeber et al., 2015); (Steen et al., 2014); (Rodriguez et al., 2016); (Pericu, 2017); (Kurikka et al., 2016); (Bermejo and Rodríguez-Monroy, 2020); (Tushar et al., 2020); (Selloni and Corubolo, 2017); (Lub et al., 2015); (Pandey, 2015); (Park et al., 2020); (Ghajargar et al., 2017); (Cheung, 2012); (Scuttari et al., 2021); (van der Westhuizen et al., 2020); (Kim, 2020); (Mahmoud-Jouini et al., 2019); (Jayakumar et al., 2019); (Shen, 2019); (Ortiz and He, 2021); (Emma and Orbulov, 2020); (Alexandrakis, 2021); (Pham et al., 2021); (Giusti Gestri, 2021); (Kodrat et al., 2020); (Da Silva et al., 2020); (Silva and Marques, 2020); (Przybilla et al., 2020); (Folmer et al., 2018)
Usability Test	(Ana et al., 2013); (Seeber et al., 2015); (Valentine et al., 2017); (Bermejo and Rodríguez-Monroy, 2020); (Tushar et al., 2020); (Pandey, 2015); (Park et al., 2020); (Ghajargar et al., 2017); (Kim, 2020); (Jayakumar et al., 2019); (Emma and Orbulov, 2020); (Silva and Marques, 2020); (El-Farargy, 2020); (Przybilla et al., 2020); (Straker et al., 2020); (Folmer et al., 2018)
Co design / Co creation	(Price and Wrigley, 2015); (Davis et al., 2016); (Tushar et al., 2020); (Fleischmann, 2019); (Lub et al., 2015); (Fleischmann, 2018); (Ghajargar et al., 2017)
Storytelling / Story Board	(Price and Wrigley, 2015); (Rau et al., 2017); (Steen et al., 2014); (Bermejo and Rodríguez-Monroy, 2020); (Tushar et al., 2020); (Lub et al., 2015); (Pandey, 2015); (Mahmoud-Jouini et al., 2019); (Emma and Orbulov, 2020); (Folmer et al., 2018)
Design Sprint	(Emma and Orbulov, 2020)
Visualization	(Seeber et al., 2015); (Valentine et al., 2017); (Steen et al., 2014); (Davis et al., 2016); (Pericu, 2017); (Pandey, 2015); (Ghajargar et al., 2017)
End of Table	

4.3 Literature summary and discussion

Throughout this chapter a systematic literature review was carried out aiming to analyse how design thinking has been applied, by answering the research questions presented in the beginning of this chapter.

A detailed content analysis of the collected papers was conducted, and each paper was characterized according to the following five categories. The first one was the type of sector, private or public, the second one was if design thinking was applied in a product or a service, the third one was the type of industry, the fourth one was the design thinking process as the last one was the design methods used.

As stated before, this systematic literature review aimed to answer the following research questions:

1. Which sectors have been applying design thinking?

2. What industries have been been applying design thinking?

3. Design thinking has been mostly applied in the development of products or services?

4. What design thinking processes have been applied?

5. Which design methods have been used on the design thinking process?

In what concerns to the research question "Which sectors have been applying design thinking?" within the analyzed literature, it was possible to find that the private sector is the most representative in terms of design thinking application.

In regards to the research question "What industries have been been applying design thinking?" it was possible to infer that the healthcare, manufacturing, IT and sustainability industries own the majority when it comes to applying DT.

In what concerns to the research question "Design thinking has been applied mostly in products or services?" it was possible to conclude that most of the analyzed papers consist in the application of design thinking in products.

With regard to the research question "Which design thinking processes have been applied?" it was possible to conclude that some papers used design processes proposed by design thinking pioneers while other papers adjusted those design processes according to their needs.

In what concerns to the research question "Which design methods have been used on the design thinking process?" it is possible to infer that the three most used design methods are the interviews, followed by the prototype and lastly the journey map.

Overall, within the analyzed literature, it was possible to retrieve relevant insights for the design thinking application and, consequently, drawn conclusions regarding the environment in which the design thinking is applied.

Nevertheless, it is also possible to identify a few research gaps and opportunities for future work on the present topic. In what follows, some shortcomings are outlined and future directions in this domain are discussed in the chapter 5.

In summary, this review allows concluding that design thinking is a growing topic that continues challenging both academics and practitioners. This dissertation intends to contribute to the existing literature on this subject.

Chapter 5

Conclusion

This last chapter analyzes the obtained results and discusses their theoretical and managerial implications, uncovering opportunities for future research.

5.1   Final considerations

In this dissertation, a systematic literature review was performed, aiming to understand the application of design thinking.

This is a topic of growing interest for academics and practitioners, however, from our research, only two publications were identified as reviews on the design thinking application.

We start by presenting design thinking definition, followed by design processes and design methods definition, identifying the different authors' approaches and conceptualizations proposed.

Additionally, a content analysis was performed on design thinking application in a set of 58 publications with relevance on product and service development.

The use of qualitative research methods to support further innovative product and service development was shown to be prominent and a set of challenges was presented to further develop and implement different qualitative research methods.

As seen in the literature review, there is a variety of different research methods used on the overall design thinking process. The ability to understand how are qualitative and quantitative research methods best triangulated to gain that understanding and what research methods best matched to the context is crucial to increase design thinking adoption.

Within the application of design thinking process, performance metrics assume a key role. However, these are only appropriate if they accurately measure the transient results along several iterations of the design thinking process. This is still an area in need of further research due to its relevance when design thinking is applied, as it ultimately allows an increased knowledge on the complete design thinking functioning, what respective outcomes.

A clear need for the improvement of how companies can adopt design thinking so as to measure the impact of its application was identified, which might be achieved by developing more understanding among the field and quantitative models that companies can use to monitor and measure the product or/and service performances.

Furthermore, more research is needed to understand under what circumstances design thinking should or should not be a company-wide undertaking. As well as understanding what approaches to framing and problem-solving can be used and provide knowledge to practitioners about alternative approaches that they can apply.

According to the literature there is an increase of published papers around the application of design thinking in product and service development. The lack of recommendations on how companies can cultivate design principles and capabilities to become more design driven, and who in the organization should be tasked with performing this research, and how might the learning about customers that is done at various points throughout an organization be collected to create shared understanding. However, this area is not yet fully explored, thus investment on answering those questions should be done in order to measure comprehensively design thinking.

Within the analysed literature, there is little examination of how design thinking practices fit with other approaches from which firms might choose to frame and solve problems such as agile, lean startup, scientific method, Six Sigma, critical thinking, and systems thinking. And how well do current research approaches do in gaining deep understanding of not only functional, but also the social and emotional "jobs to be done" of customers and users.

Finally, the treatment of real cases should be further explored as, although some papers claim to have dealt with case studies, the current state of the art does not provide nor a vast and broad spectrum nor a particular investment of an individual industry in design thinking approach. Therefore, address such gap is imperative.

From the work developed, it can be stated that the implementation of design thinking can be one efficient and important strategy for companies to create competitive advantage.

Design thinking is a field of study that can have a positive impact on companies, needing more thorough studies so as to meet the identified challenges and explore the potential of such interesting field.

5.2   Suggestions for future research

As with any relatively new research area, the analysis of the papers presented on this dissertation are a small sample of how companies have been implementing design thinking. As such, it is an obvious limitation. This research contributes to the existing body of knowledge by summarizing the implementation of several different design thinking processes on products and services as well as the design methods adopted. In addition it also identifies gaps in the literature.

The implementation of design thinking in products and services which is underrepresented in the existing literature was directly addressed. The idea of establishing a meaningful linkage between the application of design thinking, the process and design methods adopted was a central concept for this dissertation.

The opportunities for further research are abundant. Since the papers examined in this dissertation are sourced from the scientific database *Scopus*, thus a possible research opportunity is the analysis of papers sourced from other trusted and / or scientific databases.

Further research on suitability and efficacy of design thinking in different industry sectors would be highly recommended. For instance, in industries such as, but not limited to the public sector, sustainability, agriculture and education.

The implementation of design thinking, its principles, process, and methods requires that current and new employees are endowed with the knowledge to implement it. Due to the scarcity of case studies and scientific research on this topic, when compared with others, like Lean, Total Quality Management, it is required to increase the adoption of design thinking in organizations.

Therefore, more fieldwork in regards to the implementation of design thinking is needed, as well as more encouragement to publish scientific papers to understand the implemented process, the adopted design methods, the mistakes, and the achieved results.

This approach has been demonstrated to be useful for creating value and supporting management decision making under uncertainty inside organisations. Finally, measuring the impact of design thinking represents a potential future research stream that will provide important insight into the outcomes of this phenomenon. This measurement will help organisations optimize products and services development processes.

Bibliography

J. Alexandrakis. Cycling towards sustainability: The transformative potential of urban design thinking in a sustainable living lab. *Transportation Research Interdisciplinary Perspectives*, 9, 03 2021. doi: 10.1016/j.trip.2020.100269.

F. Ana, K. Umstead, G. Phillips, and C. Conner. Value driven innovation in medical device design: A process for balancing stakeholder voices. *Annals of biomedical engineering*, 03 2013. doi: 10.1007/s10439-013-0779-5.

M. Appleyard, A. Enders, and H. Velazquez. Regaining r&d leadership: The role of design thinking and creative forbearance. *California Management Review*, 62:000812561989739, 01 2020. doi: 10.1177/0008125619897395.

F. Armellini, R. Pelicioni, P. Kaminski, and S. Bassetto. Including the voice of the client in the creative process: A case study of the integration of quality function deployment (qfd) to the value proposition design (vpd) in the service sector. *Journal of Modern Project Management*, 5(2):6–21, 2017. doi: 10.19255/JMPM01401.

B. Baldassarre, J. Konietzko, P. Brown, G. Calabretta, N. Bocken, I. Karpen, and E. Hultink. Addressing the design-implementation gap of sustainable business models by prototyping: A tool for planning and executing small-scale pilots. *Journal of Cleaner Production*, 255:120295, 05 2020. doi: 10.1016/j.jclepro.2020.120295.

S. Beckman and M. Barry. Design and innovation through storytelling. *International Journal of Innovation Science - Int J Innovat Sci*, 1:151–160, 12 2009. doi: 10.1260/1757-2223.1.4.151.

A. Beltagui. A design-thinking perspective on capability development: The case of new product development for a service business model. *International Journal of Operations & Production Management*, 38:1041–1060, 12 2017. doi: 10.1108/IJOPM-11-2016-0661.

B. Berg. Qualitative research methods for the social sciences. Pearson, 2008.

G. Bermejo and C. Rodríguez-Monroy. Design thinking methodology to achieve household engagement in urban water sustainability in the city of huelva (andalusia). *Water*, 12:1943, 07 2020. doi: 10.3390/w12071943.

T. Brown. Design thinking. *Harvard business review*, 86:84–92, 141, 07 2008.

T. Brown. *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. HarperBusiness, New York, Enfield, 2009.

S. Bucolo, C. Wrigley, and J. Matthews. Gaps in organizational leadership: linking strategic and operational activities through design-led propositions. *Design Management Journal*, 7(1):18–28, 2012.

L. Carlgren, I. Rauth, and M. Elmquist. Framing design thinking: The concept in idea and enactment. *Creativity and Innovation Management*, 25:38–57, 03 2016. doi: 10.1111/caim.12153.

M. Chamorro-Koc, B. Adkins, and S. Bucolo. Using scenarios to explore the social aspects of design led innovations. In C. Hinrichsen, editor, *Projecting Design 2012: Global Design Bridge - Cumulus Conference*, pages 186–191. Duoc UC, Chile, 2012. URL `https://eprints.qut.edu.au/56046/`.

M. Cheung. Design thinking in healthcare: Innovative product development through the inpd process. *The Design Journal*, 15(3):299–324, 2012. doi: 10.2752/175630612X13330186684114.

D. Chonde, A. Pourvaziri, J. Williams, J. McGowan, M. Moskos, C. Alvarez, A. Narayan, D. Daye, E. Flores, and M. Succi. Radtranslate™: An ai-powered intervention for urgent imaging to enhance care equity for patients with limited english proficiency during the covid-19 pandemic. *Journal of the American College of Radiology*, 01 2021. doi: 10.1016/j.jacr.2021.01.013.

R. Colin. *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*. Wiley-Blackwell, 2002.

J. I. Criado, T. Dias, H. Sano, F. Rojas-Martín, A. Silvan, and A. Isidro-Filho. Public innovation and living labs in action: A comparative analysis in post-new public management contexts. *International Journal of Public Administration*, 44:1–14, 02 2020. doi: 10.1080/01900692.2020.1729181.

R. Da Silva, P. Kaminski, and F. Armellini. Improving new product development innovation effectiveness by using problem solving tools during the conceptual development phase: Integrating design thinking and triz. *Creativity and Innovation Management*, 29, 08 2020. doi: 10.1111/caim.12399.

J. Davis, C. Docherty, and K. Dowling. Design thinking and innovation: Synthesising concepts of knowledge co-creation in spaces of professional development. *The Design Journal*, 19:117–139, 01 2016. doi: 10.1080/14606925.2016.1109205.

R. De Carvalho, H. da Hora, and R. Fernandes. A process for designing innovative mechatronic products. *International Journal of Production Economics*, 231:107887, 07 2020. doi: 10.1016/j.ijpe.2020.107887.

T. Eines and S. Vatne. Nurses and nurse assistants' experiences with using a design thinking approach to innovation in a nursing home. *Journal of Nursing Management*, 26, 10 2017. doi: 10.1111/jonm.12559.

N. El-Farargy. Circumnavigating the world of quality and patient safety: a compendium of highlights and perspectives. *Scottish Medical Journal*, 65:3–11, 02 2020. doi: 10.1177/0036933019898816.

L. Emma and V. Orbulov. Case study for product development innovation based on design thinking approach, demonstrated by smart furniture project. *Periodica Polytechnica Civil Engineering*, 12 2020. doi: 10.3311/PPci.17321.

K. Erwin. *Communicating The New:Methods to Shape and Accelerate Innovation*. Wiley, New York, 2013.

K. Fleischmann. Design evolution and innovation for tropical liveable cities: Towards a circular economy. *eTropic: electronic journal of studies in the tropics*, 17, 04 2018. doi: 10.25120/etropic.17.1.2018.3642.

K. Fleischmann. Design-led innovation and circular economy practices in regional queensland. *Local Economy: The Journal of the Local Economy Policy Unit*, 34:382–402, 06 2019. doi: 10.1177/0269094219854679.

M. Folmer, K. Jangaard, and H. Buhl. Design of genuine birth environment: Midwives intuitively think in terms of evidence-based design thinking. *HERD: Health Environments Research & Design Journal*, 12:193758671879665, 09 2018. doi: 10.1177/1937586718796654.

A. Garrett and C. Wrigley. Navigating market opportunity: traditional market research and deep customer insight methods. *Qualitative Market Research: An International Journal*, 22:00–00, 06 2019. doi: 10.1108/QMR-05-2017-0091.

M. Ghajargar, G. Mangano, A. De Marco, and R. Giannantonio. Design thinking applied to data storage innovation: A case study. *Design Journal, The*, 20:3776, 09 2017. doi: 10.1080/14606925.2017. 1352881.

L. Giusti Gestri. Is it still worth challenging the status quo? a design process article with an example application to australian jockey's safety vests. *Ergonomics in Design: The Quarterly of Human Factors Applications*, page 106480462098664, 01 2021. doi: 10.1177/1064804620986642.

R. Glen, C. Suciu, C. Baughn, and R. Anson. Teaching design thinking in business schools. *The International Journal of Management Education*, 13, 07 2015. doi: 10.1016/j.ijme.2015.05.001.

M. M. Gobble. Design thinking. *Research-Technology Management*, 57(3):59–62, 2014. doi: 10.5437/ 08956308X5703005.

R. M. Groves, F. J. Fowler, M. P. Couper, J. M. Lepkowski, E. Singer, and R. Tourangeau. *Survey Methodology*. Wiley and Sons, New York, NY, 2011.

M. Henkel, A. Ilhan, A. Mainka, and W. Stock. Case studies on open innovation in libraries. 10 2017.

M. Hobday, A. Boddington, and A. Grantham. Policies for design and policies for innovation: Contrasting perspectives and remaining challenges. *Technovation*, 32:272–281, 05 2012. doi: 10.1016/j. technovation.2011.12.002.

T. Jayakumar, K. Das, and N. Srivastava. Design thinking: a working strategy for the third sector. *Journal of Business Strategy*, 40, 02 2019. doi: 10.1108/JBS-11-2018-0195.

P. Kidd and M. Parshall. Getting the focus and the group: Enhancing analytical rigor in focus group research. *Qualitative health research*, 10:293–308, 06 2000. doi: 10.1177/104973200129118453.

Y. Kim, J. Jeong, Y. Hong, and S. J. Hong. A schema for systematic service imagining: Context-based activity modeling. *Sustainability*, 12, 11 2020. doi: 10.3390/su12229558.

Y.-J. Kim. Tracking dynamics between digital design agencies and clients of hybrid outsourcing in the double diamond website development process. *Archives of Design Research*, 33(1):17–35, 2020. doi: 10.15187/adr.2020.02.33.1.17.

D. Kodrat, T. Melinda, and D. Krisprimandoyo. Developing innovative footwear designs: Empirical evidence from indonesia [développer des conceptions de chaussures innovantes: Preuve empirique de l'indonésie] [dezvoltarea unor modele de încălăminte inovatoare: Dovezi empirice din indonezia]. *Leather and Footwear Journal*, 20(4):413–424, 2020. doi: 10.24264/lfj.20.4.7.

V. Kumar. *101 Design Methods: A Structured Approach for Driving Innovation in Your Organization*. Wiley, New York, 2012.

J. Kurikka, T. Utriainen, and L. Repokari. Challenge based innovation: Translating fundamental research into societal applications. *International Journal of Learning and Change*, 8:278, 01 2016. doi: 10. 1504/IJLC.2016.081642.

J. Liedtka. Learning to use design thinking tools for successful innovation. *Strategy Leadership*, 39: 13–19, 09 2011. doi: 10.1108/10878571111161480.

J. Liedtka. Innovative ways companies are using design thinking. *Strategy & Leadership*, 42:40–45, 2014.

J. Liedtka. Perspective: Linking design thinking with innovation outcomes through cognitive bias reduction. *Journal of Product Innovation Management*, 32(6):925–938, 2015. doi: https://doi.org/10.1111/jpim.12163. URL `https://onlinelibrary.wiley.com/doi/abs/10.1111/jpim.12163`.

J. Liedtka and T. Ogilvie. *Designing for Growth: A Design Thinking Tool Kit for Managers*. Columbia University Press, Boston, MA, 2011.

K. Linde and S. Willich. How objective are systematic reviews? differences between reviews on complementary medicine. *Journal of the Royal Society of Medicine*, 96:17–22, 01 2003. doi: 10.1177/014107680309600105.

X. Lub, R. Rijnders, L. Caceres, and J. Bosman. The future of hotels: The lifestyle hub. a design-thinking approach for developing future hospitality concepts. *Journal of Vacation Marketing*, 22, 12 2015. doi: 10.1177/1356766715623829.

J. Macdonald and M. Elahee. Design thinking in online communities: Suggestions for overcoming crowdsourcing issues. *International Journal of Innovation and Learning*, 19(3):286–298, 2016. doi: 10.1504/IJIL.2016.075655.

S. Mahmoud-Jouini, S. Fixson, and D. Boulet. Making design thinking work: Adapting an innovation approach to fit a large technology-driven firm. *Research-Technology Management*, 62:50–58, 09 2019. doi: 10.1080/08956308.2019.1638485.

R. Martin. *The Design of Business: Why Design Thinking Is the Next Competitive Advantage*. Harvard Business Review Press, Boston, MA, 2009.

J. Masajtis, E. Kędzia, A. Szumigaj-Badziak, and A. Wereszka. Everlasting design thinking [myślenie projektowe od zawsze]. *Fibres and Textiles in Eastern Europe*, 24(6):39–44, 2016. doi: 10.5604/12303666.1221735.

J. Ortiz and J. He. Sustainable business modeling: The need for innovative design thinking. *Journal of Cleaner Production*, 298, 03 2021. doi: 10.1016/j.jclepro.2021.126751.

A. Osterwalder and Y. Pigneur. *Business model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley, 2011.

A. Osterwalder, Y. Pigneur, G. Bernarda, and A. Smith. *Value Proposition Design*. Wiley, 2014.

S. Pandey. Proto design practice: Translating design thinking practices to organizational settings. 27: 129–158, 01 2015.

J. Park, N. Mostafa, and H. Han. "storyweb": A storytelling‑based knowledge‑sharing application among multiple stakeholders. *Creativity and Innovation Management*, 29, 04 2020. doi: 10.1111/caim.12368.

S. Pericu. Designing for an ageing society: products and services. *The Design Journal*, 20(sup1):S2178–S2189, 2017. doi: 10.1080/14606925.2017.1352734.

C. Pham, S. Magistretti, and C. Dell'Era. The role of design thinking in big data innovations. *Innovation: Organization & Management*, 03 2021. doi: 10.1080/14479338.2021.1894942.

A. Polaine, L. Løvlie, and B. Reason. *Service Design: From In- sight to Implementation*. Rosenfeld Media, Brooklyn, NY, 2013.

R. Price and C. Wrigley. Design and a deep customer insight approach to innovation. *Journal of International Consumer Marketing*, 28:1–14, 12 2015. doi: 10.1080/08961530.2015.1092405.

L. Przybilla, K. Klinker, M. Lang, M. Schreieck, M. Wiesche, and H. Krcmar. Design thinking in digital innovation projects—exploring the effects of intangibility. *IEEE Transactions on Engineering Management*, pages 1–15, 2020. doi: 10.1109/TEM.2020.3036818.

C. Rau, A. Zbieck, and J. Jonas. Creating competitive advantage from services: A design thinking case study from the commodities industry. *Research Technology Management*, 60, 04 2017. doi: 10. 1080/08956308.2017.1301003.

R. Redante, J. Medeiros, G. Vidor, and C. Cruz. Creative approaches and green product development: Using design thinking to promote stakeholders' engagement. *Sustainable Production and Consumption*, 19, 05 2019. doi: 10.1016/j.spc.2019.04.006.

D. Roach, J. Ryman, and J. Makani. Effectuation, innovation and performance in smes: an empirical study. *European Journal of Innovation Management*, 19:214 – 238, 05 2016. doi: 10.1108/ EJIM-12-2014-0119.

J. Roberts, T. Fisher, M. Trowbridge, and C. Bent. A design thinking framework for healthcare management and innovation. *Healthcare*, 4, 01 2016. doi: 10.1016/j.hjdsi.2015.12.002.

M. Rodriguez, F. Paredes, and G. Yi. Towards future customer experience: Trends and innovation in retail. *Foresight and STI Governance*, 10:18–28, 09 2016. doi: 10.17323/1995-459X.2016.3.18.28.

J. Rowley and F. Slack. Conducting a literature review. *Management Research News*, 27, 06 2004. doi: 10.1108/01409170410784185.

A. Scuttari, H. Pechlaner, and G. Erschbamer. Destination design: A heuristic case study approach to sustainability-oriented innovation. *Annals of Tourism Research*, 86:103068, 01 2021. doi: 10.1016/ j.annals.2020.103068.

L. Seeber, B. Michl, G. Rundblad, B. Trusko, M. Schnjakin, C. Meinel, U. Weinberg, G. Gaedicke, and B. Rath. A design thinking approach to effective vaccine safety communication. *Current Drug Safety*, 10:31–40, 04 2015. doi: 10.2174/157488631001150407105400.

V. Seidel and S. Fixson. Adopting design thinking in novice multidisciplinary teams: The application and limits of design methods and reflexive practices. *Journal of Product Innovation Management*, 30, 12 2013. doi: 10.1111/jpim.12061.

D. Selloni and M. Corubolo. Design for social enterprises: How design thinking can support social innovation within social enterprises. *The Design Journal*, 20:775–794, 11 2017. doi: 10.1080/ 14606925.2017.1372931.

H. Shapira, A. Ketchie, and M. Nehe. The integration of design thinking and strategic sustainable development. *Journal of Cleaner Production*, 140:277–287, 2017. ISSN 0959-6526. doi: https: //doi.org/10.1016/j.jclepro.2015.10.092.

Y. Shen. Instrumenting an agile data ecosystem for intelligent infrastructure research, education, and development. *New Review of Information Networking*, 23(1-2):59–82, 2018. doi: 10.1080/ 13614576.2018.1537801.

Y. Shen. Intelligent infrastructure, ubiquitous mobility, and smart libraries – innovate for the future. *Data Science Journal*, 18(1), 2019. doi: 10.5334/dsj-2019-011.

T. Silva and J. P. Marques. Human-centered design for collaborative innovation in knowledge-based economies. *Technology Innovation Management Review*, 10, 09 2020. doi: 10.22215/timreview/ 1385.

A. Sklar and S. Madsen. Global ergonomics: Design for social impact. *Ergonomics in Design: The Quarterly of Human Factors Applications*, 18:4–31, 03 2010. doi: 10.1518/ 106480410X12737888532921.

M. Sorice and C. Donlan. A human-centered framework for innovation in conservation incentive programs. *Ambio*, 44, 04 2015. doi: 10.1007/s13280-015-0650-z.

M. Steen. Co-design as a process of joint inquiry and imagination. *Design Issues*, 29:16–28, 04 2013. doi: 10.1162/DESI_a_00207.

M. Steen, J. Buijs, and D. Williams. The role of scenarios and demonstrators in promoting shared understanding in innovation projects. *International Journal of Innovation and Technology Management*, 11, 02 2014. doi: 10.1142/S021987701440001X.

M. Stickdorn and J. Schneider. *This Is Service Design Thinking*. BIS Publishers, Amsterdam, 2010.

K. Straker, G. Mosely, and C. Wrigley. An approach to integrating market research with customer insights through the development of iot products. *Journal of International Consumer Marketing*, 33, 07 2020. doi: 10.1080/08961530.2020.1792387.

A. Thies. On the value of design thinking for innovation in complex contexts: A case from healthcare. 27: 159–171, 01 2015.

W. Tushar, L. Lan, C. Withanage, S. Karen, C. Yuen, K. Wood, and T. Saha. Exploiting design thinking to improve energy efficiency of buildings. *Energy*, 197, 02 2020. doi: 10.1016/j.energy.2020.117141.

L. Valentine, T. Kroll, F. Bruce, C. S. C. Lim, and R. Mountain. Design thinking for social innovation in health care. *The Design Journal*, 20:755–774, 11 2017. doi: 10.1080/14606925.2017.1372926.

D. van der Westhuizen, N. Conrad, T. Douglas, and T. Mutsvangwa. Engaging communities on health innovation: Experiences in implementing design thinking. *International Quarterly of Community Health Education*, 41(1):101–114, 2020. doi: 10.1177/0272684X19900880.

C. White, A. Talley, D. Jensen, K. Wood, A. Szmerekovsky, and R. Crawford. From brainstorming to c-sketch to principles of historical innovators: Ideation techniques to enhance student creativity. *ASEE Annual Conference and Exposition, Conference Proceedings*, 13, 06 2010.

C. Williams. Research methods. *Journal of Business & Economic Research – March*, 5, 01 2007. doi: 10.19030/jber.v5i3.2532.

F. Zurlo and C. Cautela. Design strategies in different narrative frames. *Design Issues*, 30:19–35, 01 2014. doi: 10.1162/DESI_a_00246.