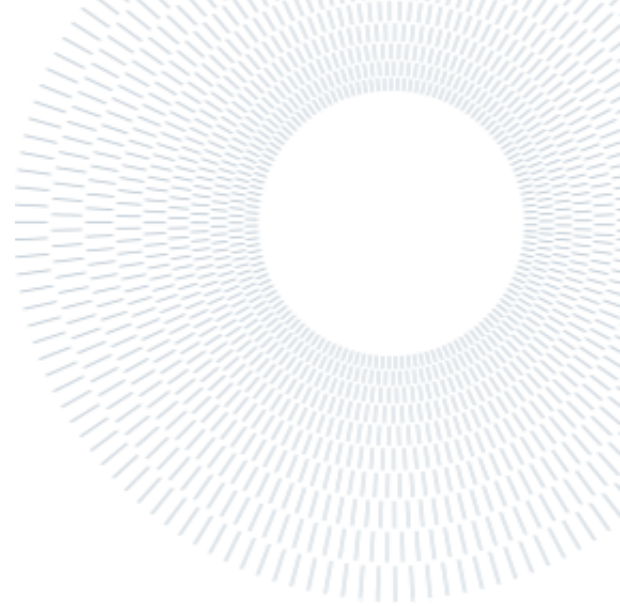




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EXECUTIVE SUMMARY OF THE THESIS

# The Support of Digital Startups to Design Thinking Processes: the Structure of the Ecosystem and the Impact of Artificial Intelligence.

TESI MAGISTRALE IN MANAGEMENT ENGINEERING – INGEGNERIA GESTIONALE

**AUTHOR: RICCARDO BODINI**

**ADVISOR: LUCA GASTALDI**

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## 1. Introduction

In the last years design thinking practices attracted more and more practitioners and academics attention due to its novel approach to innovation and problem solving [1]. The modern concept of design thinking is attributable to Kelly and Brown, respectively the founders and the CEO of IDEO, according to them, design thinking is the application of designer's principles, approaches, methods and tools to problem resolution. It matches people needs with what is technologically feasible and, doing so, it creates new business strategies which exploit market opportunities [2]. One of the main characteristics is the user-centeredness, indeed, this kind of practice has always as a reference point the end users [1] which is actively involved during the development of the new solutions. In this sense, empathy becomes crucial to fully grasp the customers' needs, deeply understand the underline problem, generate insights and inspire innovation [2]. Another main pillar is the interdisciplinary collaboration [1], indeed, design thinking practices are performed by multidisciplinary teams; this allows to have

different points of view thanks to different people's backgrounds, and consequently better address the complexity of problem. Once the idea is generated it becomes crucial to experiment through iterative cycles, through rapid prototyping it is possible to test the new solution with potential customers and stakeholder [1]. Considering the characteristics of design thinking, it is more and more involved during its evolution in the development of new digital solutions [3]. If, on one hand, design thinking practices could enhance the use of new technologies by companies allowing them to reach innovation; on the other hand, it is true that organizations can provide service and products which support design thinking practices, particularly, with the use of innovative technologies. One example is provided by artificial intelligence, indeed, thanks to its capabilities it can carry out autonomously activities which are poorly performed by humans, for instance by extracting new insights from data sets, and work closely to humans augmenting their capabilities, for example by stimulating abduction providing new unrelated insights [4,5,6]. However, there are still few contributions about how the services and the products provided by

organizations can support design thinking processes. It has been decided to focus the studies on startups due to their capabilities to offer innovative solutions, often based on technologies, and to understand if there are presence of startups which effectively sustain design thinking. In this sense, the work is focused on how digital startups support design thinking through artificial intelligence, which, due to its capabilities, is impacting the ways companies manage their innovation [4]. All the above-mentioned considerations led to the launch of this research project which wants to explore two main aspects:

- (i) the mapping of the ecosystem of global startups capable to support design thinking processes;
- (ii) how artificial intelligence impact and enhance design thinking practices.

## 2. Research methodology

The first part of this research aims to illustrate the startup ecosystem related to the theme of design thinking. Desk research has been performed to understand the current scenario of the theme under analysis; and for each company several variables has been recorded in a database to categorize and describe them. Crunchbase.com is the starting point of this research, it is the leading platform for finding business information about private and public companies. After having selecting tags in line with the subject they have been utilized as filters to select companies potentially in line with design thinking. The total amount of startups extracted, at the end of February 2021, was 9,148. Then, after having observed each company through their web site, the outcome was of 612 startups which can support design thinking practices. These startups were further analyzed to enriching the database and give a complete description of the startup. Once the database has been completed, an analysis has been performed: it allows to generate graphs which illustrate the whole ecosystem of digital startups capable to support design thinking practices. The results obtained after the analysis are clustered as follow: funding to digital startups, organizational structure, design thinking approaches metaphases supported by digital startups; technological families and business model of digital startups. The next step, to answer the second research question, consisted in eight semi-structured

interviews. The startups which accepted to be interviewed represent a complete cluster of offering; indeed, as it possible to observe in the following table, each metaphase is covered at least from one digital company.

	M1	M2	M3	M4	M5	M6	M7
S1		***		***			
S2						***	***
S3		***	***	***	***		
S4		***		***	***	***	
S5	***	***					***
S6	***	***		***			***
S7	***	***		***			
S8		***		**			

Table 1 - Metaphases covered

M1='sensing and emphasizing'; M2='interpreting and framing'; M3='team building and task management'; M4='ideating and conceiving'; M5='collaborating and codesigning'; M6='prototyping and learning'; M7='launching and measuring'

The semi- structured interviews had a duration of 30-45 minutes. Consequently, the interviews were written down in documents to analyze them. Once all the interviews were transcribed a coding procedure was performed: it consists in analyzing line by line each interview, looking for specific insights, to define "concepts". The next step consists in categorized a group together labels according to the sphere of pertinence; so, the label which belong to same category were clustered together. trying to understand if the concepts developed was consistent with the literature and it allows to explain the phenomena observed. This process led to the formulation of five propositions.

## 3. Results

The mapping of the ecosystem of startups which can support design thinking led to a full description of the geographical dispersion of the ecosystem with a total of 612 located all over the world and most of them are in North America (283), Europe (183) and Asia (117). Consequently, a consideration about the organizational structure of these ventures has been done, it emerged that the ventures are increasing their structure with more and more employees. Successively, the design thinking approaches adopted have been inspected, as results it is possible to observe a balance presence between creative problem-solving approach (42%) and the creative

confidence one (41%), it follows the sprint execution one (13%) and in the last position the innovation of meaning approach (4%). Then, how the metaphases are covered by the startups have been analysed, showing a major focus of these ventures on the first metaphases of the design thinking process. To fully understand the reason behind these numbers an analysis on the technologies used by these companies has been performed. Showing a dominant presence of AI, which is used by the 92% of the companies that base its service on at least one innovative technology.

Moreover, the results from the analysis of the interviews leads to the following propositions:

1. *AI allows to better understand the problem and deeply emphasize with customers by facilitating the analysis of large amount of data from different sources and generating insights which human can access in an easy way.*
2. *AI can sustain the ideation phase helping the creation of knowledge, the discovery of new insights and the brainstorming activities which can enhance the stimulation of new ideas.*
3. *AI allows to fast test the design and refine the solutions thanks to its ability to capture and analyze large quantities of data and improve the comprehension of the feedback.*
4. *To maximize the effectiveness of the adoption of AI in design thinking process and reach superior performance, AI must automate the difficult tasks for humans while augmenting and enhance human capabilities.*
5. *It is important involve the end user and explain how AI elaborate the final output and why humans should work on it; this in order to build trust in the results and increase their reliability.*

## 4. Discussion

### 4.1 Mapping the design thinking startup ecosystem

The ecosystem of startups which can support design thinking practices is growing constantly over the years. This is confirmed by the fact that in less than two years the number of startups related to this innovation process is more than doubled; indeed, there were 279 startups in 2019 and 612 at the beginning of 2021. Together with the expansions of the ecosystem also the interest of investors is increased reaching an overall amount of funding of 5.8 billion dollars from the 2.1 billion

dollars of the 2019 and on average, each startup succeeds to attract more funds. It is possible notice the increasing attention in this subject also considering the geographical dispersion of these startups. In fact, design thinking is spreading all over the world demonstrating to not be a trend which belong just to the USA. Despite being predominantly present in North America with 283 startups also Europe and Asia start to have a large representation with respectively 183 and 117 startups. Moreover, it is interesting to see how some case of digital startups related to design thinking practices starts to emerge also in continent less developed such as South America (10) or Africa (4). The maturity of the ecosystem is confirmed by an increasing consolidation by the structure of the organization which compose these startups. The average number over employees per startups constantly increase and for the first time the threshold of 500 employees is overcome. To deeply understand how design thinking ecosystem is structured, a further analysis was performed regarding the design thinking approaches namely: creative problem-solving, sprint execution, creative confidence and innovation of meaning. What emerged is a balanced situation between creative problem-solving and creative confidence, showing a major adoption of these two approaches. This represent in some way an evolution of the adoption of design thinking practices which traditionally was focused just on the creative problem-solving approach. Indeed, nowadays it is possible to assert that this approach is used like the creative confidence one; meaning that companies are more interested in using design thinking to shape the organizational culture towards an innovative approach. In the third position is present the sprint execution approach while at the bottom there is the innovation of meaning one. The latter, despite the presence of just 25 startups, succeeds to be the second in the ranking based on the average of funds collected, meaning that despite these realities are not very diffused, they are very well perceived by investors. A further step is done to understand which of the most innovative technologies are more suitable to effectively sustain design thinking. The adoption is massive: indeed 70% of the startups have a service or a product relies on at least one of the following innovative technologies: artificial intelligence (AI), internet of things (IoT), cloud computing, big data and augmented reality (AR). Among these

technologies AI is the one which results dominant in the adoption; indeed, the 92% of the digital startups which rely on at least on technological families have an offer based on AI; confirming this technology as one of the most suitable to support design thinking process. Particularly, AI combined with big data almost completely support the understanding of the problem step, this is completely reasonable considering the ability of AI in extracting information from big data to generate valuable insights. Another interesting aspect is the adoption of the AR in the ideation of the new solution and the creation of the prototype to test by the innovation team. Indeed, this technology is often proposed with the virtual realities (VR), two technologies which leave freedom to experiment and create almost everything imaginable. This indicates a possible strong contribution from different technologies to the design thinking practices, allowing to support humans during the innovation process and consequently obtain and more reliable winning solutions with less effort.

#### 4.2 The support of AI to design thinking processes

The multiple business case analysis has produced relevant insights that are useful to understand which role AI could interpret to support design thinking. From the interviews it is clear how AI can help during the first part of the design thinking problem; namely 'sensing and emphasizing' and 'interpreting and framing' metaphases. One of reason is the ability of AI models in managing huge amount of data from different sources allowing to gain more valuable insights and better empathizing with the end users. In this sense, this could represent a new era in which AI provides more objective analysis for the understanding of user, substituting activities which were considered for long time not accurate due to the subjectivity of inputs [4]. It leads to the automation of activities related to the understanding of the problem, which enables organization to reduce cost, faster processes and ensure a better level of rationality and consistency [6]. This results in benefits for humans that are no more forced to do activities in which they have poor performances; and this could help to shift from monotonous and repetitive tasks to more creative and fulfilling ones [6]. Indeed, once set the algorithm, it performs autonomously the analysis and provides new information to

humans which will base their decisions on these insights. Furthermore, this is facilitated by the capabilities of the AI algorithms in understanding the language of the humans; indeed, people can ask directly to the algorithm questions in the natural language and the insights will be quickly provided. It results useful also in the consequent steps of the design thinking processes, the 'ideating and conceiving' one. Thus, the AI algorithm became a virtual assistant which can connecting dots of different topics and then provide the useful insights at the right moment in order to stimulate new ideas to humans during the abductive reasoning [5]. AI helps innovators on not relying just on their experience, which is limited both in scale and in scope, by providing sophisticated insights which are shortcuts in abductive reasoning. Another advantage which derives from the adoption of AI is the opportunity to manage tasks during brainstorm and to help in structure the new idea generation process. This is possible by recording conversation and rating the different contributions of the participants by analysing the questions asked during the brainstorm. Then, by analysing these data, AI is capable of suggest different tasks, for instance research on a certain topic, to different team members which will share the results of the individual activity with the group during the following iteration. This augmentation of humans' capabilities during ideation phase combined with the automation of the understanding of the problem allows to reach additional benefit and enables the creation of synergies which consequently lead to superior performances and foster innovation [6]. Considering all these elements it is possible to assert that AI can effectively sustain the ideation phase during design thinking processes. Furthermore, AI presents relevant benefits in the last phases of the design thinking process as well; the one related to the gather of feedbacks to refine the solution proposed. The first benefit is once again related to the capability of analyse large data sets which can be related to the feedback from customers or to empirical experimentations and the consequent analysis of images or videos to extract useful insights. Moreover, AI proposes innovative solutions in this field such as the predictive eye tracking which allows to identify where the attention of users goes on new design through heat maps. This method could replace the usual test performed with humans that are usually

long and expensive. The result is a quick test, which leads to a faster iteration and refinement of the new product, with the use of more accurate and less costly not biased insights. Overall, it is possible to assert that AI is capable to completely support the design thinking process resulting in a more accurate, less expensive and faster innovation process.

### 4.3 Theoretical contribution

First, the multiple business case analysis with in-depth direct interviews allows to enrich the study of Cautela et al. [4]. From this analysis it is possible to confirm the impact of AI on the “context of the (design) problem” thanks to the analytical capabilities of the technology. It allows to shift the focus on the “context of the solution” where humans are not left alone, moreover, AI as a virtual assistant, which effectively communicates through natural language processing, can provide interesting insights to stimulate ideas or suggest tasks to develop knowledge. This allows to support the central part of the design thinking processes, the ideation phase, as well. Moreover, the empirical evidence seems to reinforce the statements of the authors about a future scenario in which AI will be able to autonomously test products and provide feedback like humans, allowing to effectively cover the last part of the design thinking process. The evidence allows to reinforce the work of Raisch [6] in which the author considers AI in managerial tasks in practice. Indeed, the author states that the integration of automation, so the replacement of human activities by machine, and the augmentation, meaning that human and machine work closely together, leads to superior performances by firms and consequently foster innovation. This seems to be confirmed also in the design thinking realm by the results of the interviews in which both aspects emerged. On one hand, AI could replace humans in the first part of the design thinking process, allowing to have machines performing repetitive and monotonous tasks faster, with less costs and more reliability. On the other hand, virtual assistants based on AI can enhance humans' capabilities such as creativity and intuition providing right insights and so augmenting people skills. This integration allows to develop synergies which results in a faster and more effective design thinking process which allows organizations to

reach innovation. Garubio [5] studied the impact of AI on the generation of innovative ideas. Indeed, AI, with its capability of providing reliable insights related to different topics, can support the abductive reasoning. Also in this case the use of AI, as a virtual agents capable of providing new information, can represent a big advantage for companies which can develop new ideas at an higher pace.

### 4.4 Managerial implication

The results of this work want to provide useful information for managers and practitioners which want to better understand how digital startups could support design thinking practices and how to use artificial intelligence to support this innovation process. In particular, the insights result useful for both sides. On one hand, digital startups could understand how their offer can support design thinking, especially with the use of AI, because many times these ventures are not aware about this opportunity. On the other hand, organizations which decide to adopt the solutions provided by digital startups can understand how use them to support their innovation process. This research leads to the creation of a database of startup which can support design thinking practices and a consequently analysis has been performed. The sample is composed of 612 startups which operates all over the world. From this information it is possible to understand the structure of the ecosystem from many viewpoints. It could be in the interest of managers understand how design thinking is adopted and where the main investments are located to identify major opportunities. In this sense, it is useful understand the winning pricing strategies or the adoption of the different approaches. Moreover, it is possible to fully explore the various solutions which can sustain this innovation process: for instance, the impact of the new technologies on the different metaphases. Moreover, an in-depth multiple business case study investigates about the support of the artificial intelligence to the design thinking process. Again, the results might be useful to practitioners belong to both sides: the ones which provides the solution and the one which use it. It is possible to understand how effectively use AI during the different steps of the process, to grasps which are the major constraints and how could be used in the future.

## 4.5 Limitations

This study is clearly affected by limitations. The first one emerged during the creation of the startups database: indeed, at the beginning of the extraction of data from crunchbase.com it is possible that the set of tags was incomplete to extract all the startups related to the theme. Moreover, the selection of the startups was performed with a subjective choice and, it is possible that valid startups have been excluded from the sample due to the consideration or not of startups which were in a 'borderline' situation. The second limitation is related to the results deriving from interviews, although cover all the metaphases of the design thinking process, exclude some interesting viewpoints such as the impact of AI on the team formation or on rapid prototyping. This limitation is present also if it is considered the design thinking approaches indeed, there is not the presence of a companies which support the 'innovation of meaning' approach.

## 4.6 Future work

This field is still unexplored, so there is vast room for improvements in further research. First, it could be of interest conduct a map of the ecosystem periodically to understand the evolution and the development of the scenario. This can lead to the generation of useful insights in terms of new trends and consolidation of the practice. Moreover, considering the second limitation, it could be of interest perform new interviews to confirm (or confute) the results of this research and enlarge them with a complete view also considering business cases which regard the use of AI in 'team building' or 'prototyping' steps as well as the 'innovation of meaning' approach. Another interesting analysis could regard how other kind of technologies support the design thinking processes, for example how AR and VR could enhance the collaboration and the co-designing of new solutions or how 3D printing can facilitates the generation of fast prototypes. The same analysis could be extended to incumbents and how they impact the realm of design thinking providing new useful insights to enrich this field of study.

## 5. Conclusion

From the state-of-the-art research as well as from the results of the current work, there have been enough evidence to fully describe the ecosystem of startups which effectively support design thinking practices and to recognize the impact of AI on this kind of process. Specifically, it is possible to identify the spread all over the world of ventures related to design thinking practices. Moreover, considering the increasing interest of funders to this young companies, design thinking appears to be a subject which opens opportunities to many entrepreneurs. This is due also to the development of new technologies such as AR and VR, which foster collaboration and codesigning, or AI. Regarding the latter, it is possible to assert that its capabilities allow to effectively support the design thinking process. Indeed, from the direct observation through interviews, emerged the capabilities of AI to replace humans in the first part of the process, support them by collaborating during the ideation phase and allow the team to refine products thank to a better comprehension of the feedback. Overall, it is possible to think the technology as a virtual assistant which provide multiple benefits to design thinking process, indeed: it allows to speed the generation of insights from large data set in a scalable way, the results obtained are less biased and more reliable thanks to the objectivity of the insights and it enhances the creativity and intuition during the idea generation. From the mapping of the ecosystem and from the evidence related to adoption of AI in design thinking practices it is clear that the field is still at the first phases, it could represent a great opportunity for managers, that on one hand could better understand how effectively implement the various service in order to reach innovation inside their organizations; on the other hand, it shows new opportunities for entrepreneurs who want develop services to support the design thinking process for companies. Lastly, the work can be considering as a starting point to better investigates how AI could give benefit to companies to reach innovation, nowadays the technology is developing at a high pace, and so it would be of interest understand which will be the future directions and how it can effectively impact design thinking practices.

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