



Research Exposé:

Integrative view of crowd testing barriers

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Abstract

The rapid development of digital transformation is speeding up organizations' decision-making processes making it harder for them to keep delivering consistent and top-quality experiences to final users and customers. One approach to overcome these issues is crowd testing. This paper focuses on organizations' adoption of crowd testing for digital asset optimization. Despite the advantages of using crowd testing in the developing phase such as quality, cost, time, and success of a digital asset in the market, organizations' trends are to adopt it in the late development process, increasing the cost of fixing errors or making changes. This study aims to give an integrative perspective of the barriers that lead a company to this decision. To have insights from the actual organizational contexts, a qualitative study is carried out. The latter takes into account the results from 6 case studies of Italian companies, varying in industry and size, that used crowd testing to optimize digital assets such as platforms, e-commerce, and apps. Researchers' experiences with this approach have led to guidelines that could help organizations establish crowd testing in their organizations.

Keywords: crowd testing, crowdsourcing, crowdsourced testing, crowd testing adoption, crowd testing barriers, qualitative

Table of Contents

Abstract	iii
List of Abbreviations	v
List of Figures	vi
List of Tables	vii
1. Introduction.....	1
2. Theoretical Framing.....	3
2.1 What prevents crowd testing adoption.....	4
2.1.1 Structural concerns.....	6
2.1.2 Organizational strategy	8
2.2.3 Organizational environment.....	10
2.2.4 Organizational factors.....	11
2.2.5 External knowledge	13
2.2.6 Market orientation.....	15
2.2.7 Transformational leadership	16
3. Literature Review.....	17
5. Methodology	21
6. Expected Contributions.....	23
6.1 Scholarly Contributions	23
6.2 Implications for Business and Society	23
7. Chapters Overview.....	25
8. Work Plan	26
9. References.....	27

List of Abbreviations

HBR-AS	Harvard Business Review Analytic Services
NPD	New product development
IS	Information systems
IT	Information technology
IMC	Information management capability
IC	Internal capability
EC	External capability
EO	Entrepreneurial orientation
SMEs	Small , and medium enterprises
CS	Crowdsourcing
CIA	Crowdsourcing of inventive activities
SCA	Sustainable competitive advantage
SDL	Service-dominant logic
CTO	Chief Technology Officer
CMO	Chief Marketing Officer
CDO	Chief Digital Officer

List of Figures

Figure 1: Relationships among IT resource, Crowdsourcing and Crowd testing	5
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List of Tables

Table 1: Literature review20

Table 2: Sample22

Table 3: Work Plan26

1. Introduction

Faced with an increasingly dynamic environment (Carolin Marx, 2021), an improving performance needs (Yuanyuan Jiaoa, 2021), faster strategic decisions (Francesco Paolo Appio, 2021) and customers' desire to be involved in the product development process (Geetika Jain, 2021), a larger number of organizations have been introduced to a software testing practice called crowdsourced testing, or crowd testing. It consists of the use of crowdsourcing in software testing activities. (Sultan Alyahya, 2017). Being a crowdsourcing phenomenon, crowd testing is the act of a company or institution of outsourcing testing tasks to a large network of people in the form of an open call. (Howe, 2006).

A recent survey shows that 72% of the Harvard Business Review Analytic Services' (HBR-AS) executives affirm that they understand the consumer needs, and prospective. However, only 35% of consumers believe that businesses truly understand them. (Janelle Estes, 2021). In this situation, according to scholars, leveraging collective wisdom to test a digital asset would benefit both, companies as well as users. Indeed, it allows gathering, and combining objective insights closer to the market (Mladenow, 2014), and recognizing features, qualities, and advantages that attract customers (Bhuiyan N. , 2011). In addition, through a new customer interaction channel, customers can be involved in the user-centered design (Leicht, Blohm, & Leimeister, 2017), and their degree of interests, likes, preferences, and intent to buy can be measured (Bhuiyan N. , 2011).

Crowdsourced testing not only tends to fulfill the "Empathy Gap" between organizations and users (Janelle Estes, 2021), but also gives the opportunity to verify the stability of a digital asset during periods of peak usage, having many users simultaneously accessing various devices (Mladenow, 2014), and decrease the likelihood of failure in launching a digital asset (Bhuiyan N. , 2011).

Hence, crowdsourcing testing is an innovative decision-support technology that can improve the processing of market information (Mark Langa, 2016) as well as provide benefits in terms of quality, cost, time, and success of a product in the market (Baxter, 2018). However, these challenges do not seem to be as apparent in companies' behaviour. Organizations' trend is to take advantage of the wisdom of the crowd only once the digital asset has been launched in the market. In this case, the cost of fixing errors or making changes increases dramatically

(K.T. Ulrich, S.D. Eppinger, 2004). That raises the question of why firms tend to introduce crowdsourced testing late in digital asset development.

Therefore, there is a need to go further into the subject, and gain more insightful knowledge. In this scenario, a qualitative study that brings insights from the actual organizational contexts is essential (Donepudi, 2020). Not only academics but also organizations will benefit from the research. They need guidance, and analytic support to facilitate the integration of collective wisdom in business processes (B.J. Allen, 2018) (Michele Grimaldi, 2022).

Addressing the research gaps, this work will contribute to understanding the social crowd integration for the testing practice. It will also be addressed if and how a firm sector, product, service, and capability influence the effectiveness and success of crowd testing for digital asset optimization (B.J. Allen, 2018) (Mladenow, 2014).

In doing so crowd testing will be analyzed from a theoretical point of view as a crowdsourced phenomenon as well as an IT adoption. Scholars establish that crowd testing is one of the stages of the new product development (NPD) process in which collective wisdom can be deployed (Michele Grimaldi, 2022). Moreover, the foundation of crowd testing is the organizational integration of technology platforms. Therefore, the theoretical discussion will be approached in terms of IT adoption, and implementation too.

The paper is structured as follows: Section II provides some background information about crowdsourced testing, and discusses the related work. Possible reasons why organizations do not use crowd testing in digital asset testing activities are also discussed in Section II. The methodology that will be used in the research is proposed in Section III, and the evaluation is presented in Section IV. Their implementation is shown in Section VI, and finally, the paper concludes in Section VII.

2. Theoretical Framing

In the last decades, digital asset testing has faced numerous challenges in adapting to the daily demand, in bringing optimum solutions, and in delivering on time, within the allocated budget, and with exceptional quality (Chiarini, 2020) (Sony, 2020). Due to the always more challenging scenario, organizations started to adopt crowdsourced software testing, also defined as "crowdsourced testing" or "crowd testing". The latter involves outsourcing testing tasks to testers chosen from a large pool of individuals.

Crowdsourced testing is composed of three main features: crowd testers, crowd solution seekers, and intermediation technology platforms (Padmanaban, 2014).

The crowd testers, also called the "crowd", are the backbone of crowdsourced software testing. They act in an extempore and independent manner (M. Sharma and R. Padmanaban, 2014). Testers come from various geographical and cultural backgrounds with different levels of expertise and knowledge (Niklas Leicht N. K.-B., 2016). They can be experienced or novice testers as well as real application users, or subject matter experts (Sultan Alyahya, 2017). The primary motivation that drives the community to complete crowd testing tasks is the monetary reward (Robin Brewer, Meredith Ringel Morris, Anne Marie Piper, 2016) but also social recognition, self-esteem, or development of individual skills are all key factors (Rimantas Gatautisa, Crowdsourcing application in marketing activities, 2014).

The crowd solution seekers (Koh, 2019) are organizations that submit the testing projects and that take advantage of the collective wisdom of the crowd.

The intermediation technology platform (Robert R. Morris; Mira Dontcheva; Elizabeth M. Gerber, 2012) plays a key role in managing the entire crowd testing process: it allows organizations to express their needs, and the crowd to answer them. Current crowd platforms also give information about the tester's demographic information, testing experience, operating systems used, and hardware since each solver has a profile (M. Sharma and R. Padmanaban, 2014). The use of crowdsourced testing platforms is analyzed in many papers both for what concerns usability testing and performance testing. The former, aims to test how effective, efficient, and satisfactory a digital asset can be for specific users to achieve planned goals in a controlled context (Leicht, Blohm, & Leimeister, 2017) (C. Schneider and T. Cheung, 2013) (Leicht, Blohm, & Leimeister, 2017). Whereas, performance testing, or functional testing,

seeks to remove defects that cause software errors (Leicht, Blohm, & Leimeister, 2017) (R. Musson, 2013) (Leicht, Blohm, & Leimeister, 2017).

Previous studies enlighten us that usability assessments as well as functionality and device compatibility tests are receiving more attention over time. They also assert that internal testing teams are being involved earlier in the product life cycle than what they used to be. However, organizations often lack qualified personnel, time, or resources in doing testing activities (Ricarda B. Bouncken, Sascha Kraus & Norat Roig-Tierno, 2019) (R. Musson, 2013) (Leicht, Blohm, & Leimeister, 2017). Indeed, only a limited number of solvers are available for in-house testing (Mladenow, 2014) (Leicht, Blohm, & Leimeister, 2017). In this framework, crowdsourced testing allows us to overcome the limitations intrinsic to in-house testing, as well as, to integrate solvers that are not directly involved in the project. Not being part of the organization, crowd testers are free from any biases, and conditioning caused by internal company concerns (Mladenow, 2014). They are also able to give unexpected helpful feedback to the organization (Leicht, Blohm, & Leimeister, 2017), subsequently boost market-oriented projections (e.g. customer preferences), and business forecasts (e.g. sales or profits) (Mark Langa, 2016). In contrast to other conventional approaches, it encourages users to personally contribute while utilizing their creativity and problem-solving abilities. Additionally, crowds testing offers particular conditions to enhance the efficacy and efficiency of the products and services (Richter, 2015).

2.1 What prevents crowd testing adoption

In analyzing crowd testing from a theoretical perspective, it has to be taken into consideration that it is often described by scholars as one of the stages of the new product development (NPD) process. "The NPD process consists of the activities carried out by firms when developing and launching new products" (Bhuiyan N. , 2011). In the NPD, an organization can take advantage of the collective wisdom to generate ideas, help with product design and development, screen and evaluate candidates, and to test concepts and prototypes. During the idea generation phase of the NPD, the collective wisdom may contribute as ideators by posting their concepts on the platform. In idea screening, external solvers may be deployed to evaluate ideas that are presented on a platform, saving time compared to more conventional screening techniques. The social crowd may also be used throughout the conceptualization phase proposing ideas or responding to questions. Within this context, crowd testing is analyzed in the NPD as a crowdsourced phenomenon. (Michele Grimaldi, 2022). Being one of

the crowdsourcing phases, crowd testing can be studied as a crowdsourcing phenomenon from a theoretical point of view. Both of them are in fact based on a crowd, a crowd solution seeker, and an intermediation technology platform.

The latter is one of the main features of crowd testing. In other words, crowd testing is rooted in the development and organizational integration of technology platforms. This IT-based perspective offers a strong theoretical foundation. Since crowd testing is based on technology platforms, the analyses can be approached in terms of IT implementation. Therefore, to have a complete understanding of crowd testing it is not enough to study that as a crowdsourcing phenomenon but it also needs to be discussed in terms of IT adoption and implementation.

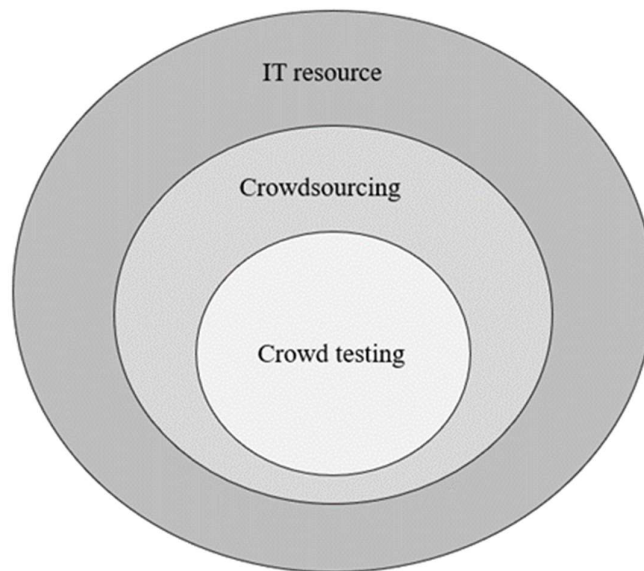


Figure 1: Relationships among IT resource, Crowdsourcing and Crowd testing

For concerns of IT implementation and obtaining the expected outcomes from it, an increasing number of studies in management information systems recognised the importance of IT resources and capabilities in the last decade (Carlos Devece D. P.-M.-S., 2019). Indeed, according to scholars it can be found as a relationship between the adoption of IT and IT-complementary intangible assets (Sebastián Bruque-Cámara, 2004). Moreover, literature has addressed how a successful IT-based initiatives implementation requires a mix of capabilities and resources. (Carlos Devece D. P.-S., 2016).

Following, the different capabilities and resources that could prevent companies from crowd testing adoption will be analyzed.

In doing so, the terms “crowd testing”, “crowdsourcing”, “IT initiatives”, “IT resource”, “IT project”, and “IT” will be used interchangeably. Since crowd testing could be described as crowdsourcing and an IT phenomenon from a theoretical point of view.

In the following paragraphs, it will be addressed how structural concerns, organizations’ projects that crowd testing involves, and environments in which the organization is settled, could affect crowd testing usage. It will also be discussed how factors such as culture, organizational structure, as well, how the ability to efficiently absorb and use external knowledge influence crowdsourced testing acquisition. Last but not least, it will be taken into account the role played by transformational leadership.

2.1.1 Structural concerns

In this scenario, it will be taken into account the authors’ discussion about structural concerns about crowd testing that could prevent its adoption. It can also be framed as an IT resource barrier that an organization can encounter.

To understand the structural concerns that might arise refer to these three overarching concepts: validity, reliability, and representativeness.

Validity has been described as the “confidence that a given finding shows what it purports to show” (McGarty, 2003). In applying the validity concept to crowd testing, scholars defined “a valid measurement” as the organization’s aim in using the crowd. However, they point out how it might be compromised by biased testers or researchers, as well as making the wrong assumptions (Fabrice Guillemin, 2020). Another issue that can be observed in crowdsourcing acquisition is that platforms and tools can be ill-adapted: in some cases they can be too complicated, and in others not sophisticated enough to answer the crowd seeker’s request (Eric Schenk, 2011). In case the request of the crowd seeker is ill-defined, the contribution provided by crowd testing will likely be unsatisfactory. Taking into account ill-defined requests in in-house testing, they can be resolved thanks to “feedback loops in the shape of problem reformulations” (Eric Schenk, 2011). However, feedback loops cannot be easily constructed in the case of crowdsourcing, mostly due to the large, and distributed number of potential solvers. Another potential consequence of unclear requests is that the organization

can receive an excessive volume of potential solutions from the tester, making it difficult to evaluate and prioritize contributions (Eric Schenk, 2011).

Reliability has been defined as the “confidence that a given empirical finding can be reproduced” (McGarty, 2003). It can represent an issue for companies in applying crowd testing since the effectiveness of the results provided is affected by the engagement and involvement of the crowd, (Fabrice Guillemin, 2020) as well as the applied security standards. Moreover, the organization can have concerns regarding both the knowledge of the crowd community and the risk of a lack of solvers (Valérie Chanal, 2012). Scholars’ discussion pointed out how arriving at the “critical mass” of contributions can represent a barrier in utilizing crowd testing, since it is based on voluntary participation. On the other hand, crowdsourcing platforms should “enhance the matching between seekers and providers” (Eric Schenk, 2011).

Representativeness “is the degree to which the data sample is representative for the assumed population, or that an outcome is representative for the targeted population” (McGarty, 2003). In adopting crowd testing, representativeness can represent an issue since the test object could necessitate a lot of functional knowledge. The knowledge of the crowd may prevent a company from adopting crowdsourcing methods. However, it is not the only factor. A scare awareness of the Web 2.0 environment is a playing factor. In fact, a case study shows how being relatively slow in adopting new technologies (Djelassi & Decoopman, 2013) affects crowd testing adoption. Moreover, the representativeness of the sample of respondents and the given results can be questioned according to scholars since the respondents are paid for participating.

Additionally, according to the literature, managers decide to adopt an IT resource taking into consideration the relative advantage that the new technology offers, its complexity, and implementation costs (Sebastián Bruque-Cámara, 2004). For the concern of financial constraints that may be a factor of resistance, especially for companies that face challenges in using Web 2.0 technologies, there can be a lack of awareness regarding the useful exploitation of results and the creation of economic value. “It’s very difficult to quantify what will come of it, it’s very complicated to measure growth has been generated” (Djelassi & Decoopman, 2013).

Proposition 1: Structural concerns affects the adoption of Crowd testing

2.1.2 Organizational strategy

An organization's main concern in adopting crowd testing is not only relative to its structural consideration, but also surrounding the projects that the new resource involves.

Among scholars, it has long been acknowledged that one of the most significant challenges that managers face when implementing IT initiatives is coordinating IT and business strategy. In fact, according to the scholars, what often prevents the organization from IT investments is the risk that the latter will not provide the intended benefit due to a lack of alignment with the current business strategy (Carlos Devece D. P.-M.-S., 2019). Thus, it is required to integrate IT into operational activities that support the firm's strategy (Carlos Devece D. P.-S., 2016). Following, the different approaches that the literature suggests referring to the implementation of a new IT resource and the involved IT project are analyzed.

Previous studies indicate that in implementing IT it is necessary to have a solid information systems (IS) strategy (Chen J. L., 2012). Moreover, according to some researchers, the IS strategy should be independent from the organization's business strategy. In this scenario, two distinct organizational approaches to the IS strategy can be adopted: the conservative IS approach and the innovative IS approach.

The former approach is used by organizations that follow the best practice of the industry leaders' (Doherty, 2009). Therefore, they tend to adopt a new information system practice after the industry leaders have done so. In this way, they can assess the success or failure of their competitors by examining the actions of rivals who use an innovative IS approach. On one hand, it allows organizations with a conservative approach to follow the best practice of the industry leaders' (Doherty, 2009) on the other hand it excludes using IT to gain a competitive edge (Chen J. L., 2012).

Choosing between an innovative and a conservative IS approach depends on "IT characteristics of the firm's core activities, and the IS imitability" (Doherty, 2009). According to empirical results, companies that opt for a low-cost competitive strategy should use an innovative IS strategy in IT adoption and investments.

On the other hand, companies that base their strategy on marketing and innovation business strategies should adopt a conservative IS strategy since the other approach can be very risky. Indeed, it is really easy for competitors to imitate IT-based marketing, and R&D

activities. IT initiatives for marketing and R&D activities are less attractive since the innovator assumes the expense and risk of the new IT adoption but it can benefit from the invention for only a brief period since competitors will quickly duplicate the innovative IT project (Carlos Devece D. P.-M.-S., 2019).

Literature discussion addresses also the effect that the adoption of crowdsourcing has on the development process of a product. For instance, it affects the timing in which a digital asset is launched as well as the organization's marketing function (Djelassi & Decoopman, 2013). The temporal dimension is an issue, especially for companies that have scarce knowledge of the Web 2.0 environment (Djelassi & Decoopman, 2013).

For what concerns the marketing function, on one hand, crowdsourcing allows businesses to improve their connections with their customers and to introduce innovative products to the market. On the other hand, organizations may be hesitant to utilize crowdsourcing because it means integrating customers into an internal value-creation process. The latter requires an organizational restructure and a reevaluation of the company's marketing approach. As a result, crowdsourcing adoption is likely to be seen as riskier than an in-house approach. It can even cause some anxiety, and apprehension inside the organization (Loren, 2011).

Organizational, psychological constraints, and fears can play a key role in implementing crowd testing. To overcome that, the company might decide to use a methodical, progressive application of crowdsourcing that fits with its structure. A good strategy can be to expand business operations over time by incorporating more customer resources. The use of crowdsourcing, therefore, requires procedures to efficiently screen, and take into account the ideas that are provided by the crowd (Gatautisa R, 2014).

This systematic approach also enables organizations to progressively build expertise, and, at the same time, earn the client's confidence and support. It also helps to establish a culture that gradually promotes a willingness to search outside the organization for creative solutions and business opportunities. Companies should also encourage customers to take on an advising or co-producing role in order to strengthen their relationships with them (Chen J. T., 2011)

However, scholars also claim that interactions between people and organizations in a collaborative process like crowd testing are likely to create a certain level of inherent friction that a corporation must take into account.

Academics have repeatedly affirmed that the successful adoption of individual IT projects must be clearly linked to the company strategy.

Preposition 2: Organization strategy affects the acquisition of crowd testing

2.2.3 Organizational environment

Several models were proposed by scholars to explain how other factors might explain the intensity with which organizations adopt crowd testing. Among them, numerous authors have highlighted that the environment in which the organization is settled affects the implementation of crowd testing. The environment context provides opportunities as well as restrictions for technological innovation.

Fundamental studies on the influence exercised by the environmental context is the TOE framework (Tornatzky, 1990). According to the latter industry, competitors, and the government might influence firm decisions about IT. The TOE framework is also able to explain intra-firm innovation diffusion (Hsu, 2006). In addition, scholars point out how evolving technological information needs of an organization can also be due to “the dynamic nature of the competitive, collaborative, and regulatory environments” in which organizations act (Narver, 1994). Other studies emphasized the role of environmental factors taking into account the sector's structure, the number of competitors, and the competitive pressure in IT adoption or the impact of governmental regulations (Gonçalves, 1999). Environmental factors such as market stability, government regulations, and competition were discussed too (Subhasish Dasgupta, 1999).

The literature developed the theoretical framework taking also into account the following environmental characteristics: the competitive pressure exerted by partners who have already adopted the technology, the dependence of partners who have not yet done so on those who have, the climate of trust, and business transactions between partners, and, finally, the support that partners who have not yet adopted the technology are given by partners who have (Sebastián Bruque-Cámara, 2004).

The importance of the external environment in implementing IT is also taken into account from the external capability (EC) point of view. The capacity to cooperate and share information with external partners (such as upstream, and downstream suppliers and manufacturers), and the capacity to adapt to the external environment might be a key factor in crowd testing implementation. Under the EC perspective, scholars focus in particular their attention on partnership management, market reaction, and organizational agility (Hulland, 2007).

Preposition 3: The environment in which the organization is settled affects crowd testing utilization

2.2.4 Organizational factors

Among the variables that may “mediate or moderate the implementation of IT-based initiatives (Carlos Devece D. P.-M.-S., 2019) the organizational factor has been highlighted by numerous authors as essential for the effective implementation of crowd testing (Wade M, 2004). Theoretically, it may be established a relationship between IT adoption, and IT complementary intangible assets (Bruque S, 2004).

Among the others, sociotechnical theory demonstrated that technology is closely related to human behaviour (Trist, 1951). Numerous research in management information systems state also that the deployment of information systems must take into account culture, organizational structure, routines, shared understanding of the company's objectives, and commitment to them (Carlos Devece D. P.-M.-S., 2019).

In addition, other scholars suggest taking into account capabilities related to business management (Bruque S, 2004). Capabilities are defined as the ability to deploy resources in a generally coordinated way to achieve the desired goal (Devece C, Palacios D, Martinez-Simarro D, 2016). According to the literature, the information management capabilities (IMC) depend on: “the firm’s information policy, practices, and the organizational routines that promote information sharing, and storing” (Carlos Devece D. P.-S., 2016).

Studies in IMC identified three main practices: IT practices, information management practices, and information management behavior and values. For information management practices scholars intend practices such as detecting, collecting, organizing, processing, and maintaining information. Whereas integrity, formality, control, transparency, sharing, and

proactive information use have been described among information management behavior and values (Marchand DA, 2002).

Moreover, IMC's literature examined the functions that guide the information throughout its life cycle: collection, processing, coding, storage, access, and distribution of the information (Jessup LM, 2008). These phases are crucial in adopting and benefiting from crowd testing activities.

Later studies have added other functions that are essential in integrating IT information such as information identification and categorization, information validation and valuation, information capture and storage, information distribution, and information modification and updating (Carlos Devece D. P.-S., 2016). In making the most of crowd testing, it is necessary to take into account that the distribution of information frequently requires negotiation processes, and agreements inside the organization (Carlos Devece D. P.-S., 2016).

In this scenario, information policy inside the organization and organizational culture, collective mind, managers' leadership, and relationships between a variety of stakeholders have been analyzed for IT acceptance. According to scholars the latter often failed due to poor management of information policies (Lim ETK, 2005) (Neil F. Doherty, 2009) (Carlos Devece D. P.-M.-S., 2019)

Among the different organizational capabilities, it has taken into account internal capabilities (IC) too. "This category includes the ability to utilize resources that can enhance internal control capabilities, strengthen cooperation performance between the departments, and improve the capacity of the system and development" (Ting-Peng Liang, 2010). IS planning, management expertise, and IT experience are typical examples of the capacity to handle internal connections (Hulland, 2007).

Other organizational factors that influence the extent, and the speed, with which firms adopt IT are high management support, the existence of product champions, organizational size (PREMKUMAR G, 1997) (Berberon, 1996), highly creative, and trained technical staff (Bruque S, 2004). But also, the ability for technical staff and management to communicate easily and the absence of organizational conflict. Scholars also point out the key role played by the adaptability of procedures, use of interdepartmental working groups, top management's explicit leadership, organizational memebr's propensity for change, and the compatibility of information use (Sebastián Bruque-Cámara, 2004).

Concerning the size of the organization, enterprise-type organizations are more apt for implementing services like crowd testing. Seeing that they have more slack resources at their disposal. As well, they are inclined to have better-equipped technical departments (Sebastián Bruque-Cámara, 2004). Size may also be a result of the organization's favorable background (Marvin B. Lieberman, 1988). In this case, the company may have made an early investment in technology (Barney, 1986). (Philip H. Mirvis, 1991) In this situation, the age of the business can only benefit IT development if it is combined with a number of other favorable factors such as the presence of the right intangible assets or enough financial resources.

Moreover, organizations that introduced mature technologies earlier tend to adopt future innovations more deeply, and possibly more swiftly in terms of experience in the usage of basic technology. To put it another way, innovative firms may benefit from a form of "positive inertia" that keeps them technologically ahead of the curve over time, particularly when a firm's adoption of a new technology depends on the firm having a previous technology (Sebastián Bruque-Cámara, 2004).

Additional organizational elements that affect how quickly and to what extent businesses adopt crowd testing is the perceived risk of doing so. In case managers are confident that the IT adoption will have a substantial impact on the company's economic, and financial success, the perceived risk will diminish (Philip H. Mirvis, The implementation and adoption of new technology in organizations: The impact on work, people, and culture, 1991). Indeed, in firms where the conditions of internal communication, organizational consensus, , and propensity toward change are favorable, the management is more propense to risk financial and human resources by introducing new technologies (Bruque S, 2004). "The favorable scenario created from these expectations of good performance may accelerate the introduction of IT, and therefore its extent of adoption in the organization" (Bruque S, 2004). In other words, organizations that have favorable levels of complementary intangible assets for IT will implement IT more quickly, and intensely (Bruque S, 2004).

Preposition 4: Organizational factors affects the implementation of crowd testing

2.2.5 External knowledge

Among the organizational factors, the effect of internal capabilities necessitates further explanation to understand their impact on crowd testing adoption. They were described by

scholars as the absorptive capacity of an organization (Daghfous, 2004) and, therefore, the organization's ability to efficiently absorb and use external knowledge that influences its innovations (Daghfous, 2004) (Fichman, 2004). Since, a company's absorptive capacity might impact the efficiency of innovation activities (Cockburn, 2003) it plays a key role in crowd testing adoption.

Scholars address that companies should have methods and tools for acquiring, sharing, and utilizing knowledge that can result in fresh organizational innovations (Daghfous, 2004). In particular, authors point out that companies should create procedures for effective filtering and considering crowdsourced ideas in order to avoid noise returned by the crowd (Rimantas Gatautisa, Crowdsourcing application in marketing activities , 2014). By being able to acquire, disseminate information within the company and then use it, the organization will avoid being imitated by competitors, and better compete with its market rivals (Rahimli, 2012). With the aid of crowd testing, companies might also increase product and service images, boost customer loyalty, and build their brand (Rahimli, 2012). In light of past research on the NPD, it has also been addressed how accessing, choosing, absorbing, and gaining external knowledge encourages creative thinking, fresh ideas (Zhao Y, 2012) and enhances an organization's product innovation (Ricarda B. Bouncken B. D., 2016)

According to discussions on Entrepreneurial Orientation EO, which “encompasses the three dimensions of innovativeness, proactivity, and willingness to take risks” product innovation specifically benefits from absorbing, and integrating partners' knowledge. Additionally, thanks to internalized knowledge the decision making process can be enhanced, and channel ideas facilitated (Ricarda B. Bouncken B. D., 2016). On the other hand, external knowledge can be “ambiguous, context-bound, and highly firm-specific” (Ricarda B. Bouncken B. D., 2016). For what concerns ambiguity, it might be difficult for an organization to understand the logical connections between causes and effects revealed by external knowledge, and it may need additional comprehension, and sense-making procedures (KE, 1995). In fact, it was claimed that crowd testing adoption might be time consuming. Managing crowdsourcing projects could take a lot of time, become complicated depending on how many projects are done, and how much feedback is received from the crowd (Rimantas Gatautisa, Crowdsourcing application in marketing activities , 2014).

Moreover, according to Crowdsourcing of Inventive Activities theory (CIA), it can be risky to apply external knowledge when the organization's industry requires tacit knowledge

or there is high risk of opportunistic behaviour from the crowd (Eric Schenk, 2011). In this situation, risk-taking, and proactive businesses will work and make use of the benefits of external information despite the challenges they must overcome.

In using crowd testing the external knowledge given by the crowd needs to be assimilated, analyzed, comprehended, incorporated, and applied (Ricarda B. Bouncken B. D., 2016). In this process, the recombination of existing knowledge, and the combination of old and new knowledge play a significant role (Phelps, 2012). In this sense, risk-averse behavior prevents the creative use of the acquired knowledge. However, external knowledge is crucial for products and services in information-intensive sectors (McEvily S, 2002), and in SMEs (Ricarda B. Bouncken S. K., 2013).

Preposition 5: Organization concern toward external knowledge affects crowd testing adoption

2.2.6 Market orientation

The approach toward crowd testing is also affected by the organization's market orientation. In particular, according to the literature, market orientation exerts an effect on the implementation of crowd testing. Organizations with a high market orientation are more aware of crowdsourcing's value and therefore they are more likely to implement it (Carlos Devece D. P.-M.-S., 2019). Market orientation has been defined as "the organization culture that most effectively and efficiently creates the necessary behaviors for the creation of superior value for buyers and, thus, continuous superior performance for the business" (Slater, 2013). Therefore, a firm that is focused on the market continuously investigates alternative sustainable competitive advantage (SCA) sources to determine how it may best provide sustainable superior value for its current and potential target customers. Among the different ways in which the market orientation conducts organizations to innovate, IT development, such as crowd testing, is the one that improves the most organizational performance (Carlos Devece C. L.-A.-M., 2017).

Nevertheless, the organization's development of market orientation is strongly influenced by the use of crowd testing (Carlos Devece D. P.-M.-S., 2019). According to the SDL perspective, customers are important actors in firms' networks. They are important sources of knowledge, insight, and information for businesses (Djelassi & Decoopman, 2013).

Considering that crowd testing involves the customer in the innovation process of digital assets, both the innovation rate and the success rate of an organization will benefit from it. In addition, adopting crowdsourcing increases an organization's likelihood of gaining a competitive advantage against businesses that do not use it (Carlos Devece C. L.-A.-M., 2017).

Preposition 6: Organization's market orientation affects crowd testing

2.2.7 Transformational leadership

Moreover, empirical evidence has demonstrated that transformational leadership is a key factor in investigating new business models as well as in the implementation of innovation-related practices such as crowd testing. Transformational leadership is favorably connected “to leader effectiveness ratings, leader and follower satisfaction, follower efforts, support for innovation, and overall organizational performance” (John H. Humphreys, 2003).

A catalyst, mentor, facilitator, and trainer in organizational learning are all roles that the transformational leader will play. In technological organizations, he or she promotes shared mental models that favor continuous learning, and make it easier to employ new technologies (Senge et al., 1994).

Leadership style is emphasized in the strategic literature as having a particularly significant impact on organizational innovation (EF., 2000). There is already widespread agreement that transformational leadership styles, which emphasize collaboration, and participation, are more likely than transactional ones to foster innovation inside an organization (V́ctor Jeśs Garća-Morales, 2012).

Preposition 7: Transformational leadership affects the decision to adopt crowd testing

3. Literature Review

To develop the research's theoretical framework was used online research only. The following databases have been used: Business Source Premier, Google Scholar, ACM Digital Library, Science Direct, JSTOR, Web of Science, ResearchGate, Elsevier and IEEE Xplore.

Numerous key words such as “crowd testing”, “crowdsourced testing”, “crowdsourcing”, “open innovation”, “crowdsourcing innovation” were taken into account for the queries. They were combined with the conjunction AND in various orders. From the research, it was taken into consideration the title of 1000 papers written between 2017 and 2022. For the purpose of drawing the most recent insights about crowd testing, articles published earlier were not taken into account. Unpublished works, such as internet articles and non-scientific sources, were never taken into account in order to draw from a wide range of scholarly evidence. Non-English articles were not included because this paper uses English terminology.

In reviewing the literature, it was firstly looked at crowdsourcing as a general phenomenon. It was decided to do so to have a broad and general knowledge both about the topic and the literature discussion. In this phase emerged how a lot of papers framed crowdsourcing into the new product development process analysis (B.J. Allen, 2018) (Baxter, 2018) (Michele Grimaldi, 2022) (K.T. Ulrich, S.D. Eppinger, 2004) (Yuanyuan Jiaoa, 2021). It was then decided to narrow down the research on crowd testing. Unfortunately, the amount of papers that are specifically focused on crowd testing is residual compared to the ones about crowdsourcing. It can be due to the fact that crowd testing is one of the crowdsourcing stages (Mladenow, 2014), and therefore scholars tend to look at the wisdom of the crowd from a broader point of view.

Since the beginning, it was decided to exclude from the analyses all the papers about crowdfunding and crowd counting. Since their aim and usage of the crowd are not in line with crowd testing. Moreover, since it was decided to focus the research on the relationship between crowd testing and organizations rather than internal crowd testing dynamics, articles regarding crowd management, crowd participation, and motivation. It was also decided to not take into account discussions about the use of crowdsourcing for Covid 19 pandemic since it could restrict the research to a particular case.

Every paper whose title respected inclusion and exclusion criteria has been opened and quickly examined to understand whether it could be useful or not. In total, the number of downloaded papers was ninety, of which seventy-eight have been used in this research. Follows a table containing the most significant publications discovered for this study with a brief analysis of its content and proper references.

	Reference	Content
1	Sultan Alyahya, D. A. (2017). Process Improvements for Crowdsourced Software Testing. <i>International Journal of Advanced Computer Science and Applications</i> 8 (6), 32-41. https://doi.org/10.14569/ijacsa.2017.080605	This paper outlines the crowd testing phenomenon taking into account its three main features: “the crowd testers, the crowd seekers and the intermediation platform”. Specifically, it analyzed the workflow utilized to manage the crowd testing process, starting with the submission of testing requirements, and concluding with the review of the testing report.
2	Leicht, N., Blohm, I., & Leimeister, J. M. (2017). Leveraging the Power of the Crowd for Software Testing <i>IEEE Software</i> 34 (2), 62-69. https://doi.org/10.1109/ms.2017.37	This study addresses the three different approaches that can be used by an organization in adopting crowd testing: “engage an external crowd of Internet users, engage their employees, or engage their customers” In doing so, three case studies were used. The aim of this paper was to discover advantages, challenges, and potential solutions to different crowd testing approaches’ challenges.
3	Michele Grimaldi, S. V. (2022). Investigating the role of crowdsourcing in improving the quality of production processes: a systematic literature review. <i>The TQM Journal</i> , 1754-2731. https://doi.org/10.1108/tqm-07-2021-0206	This study develops a systematic literature review of the use of crowdsourcing for the production processes. In particular, the new product development (NPD) process was taken into account. Crowdsourcing was analyzed in its different phases and particular attention was given to the description of crowd testing. The paper outlined situations, methods, and to what extent the usage of crowdsourcing can be profitable for the creation of products and services.

4	<p>Carlos Devece, C. L.-A.-M. (2017). Market orientation, organizational performance, and the mediating role of crowdsourcing in knowledge-based firms. <i>Psychology & Marketing</i>, 1127-1134. https://doi.org/10.1002/mar.21053</p>	<p>This study examined the influence of market orientation on crowdsourcing adoption. Moreover, it addresses the relationship between market orientation and organizational performance. The goal of the study was to demonstrate how crowdsourcing can mediate the link between organizational performance and market orientation.</p>
5	<p>Donepudi, P. K. (2020). Crowdsourced Software Testing: A Timely Opportunity <i>Engineering International</i>, 8(1), 25-30. https://doi.org/10.18034/ei.v8i1.491</p>	<p>This study investigated the concept of crowdsourced software testing from a broad perspective, including crowdsourcing intermediaries, the crowd's level of knowledge and crowd testing implications. In doing so, the paper carries out a systematic literature review. Specifically, crowd testing advantages and disadvantages were discussed</p>
6	<p>Carlos Devece, D. P.-M.-S. (2019). IT-based strategy, capabilities, and practices: crowdsourcing implementation in market-oriented firms. <i>Review of Managerial Science</i>, 15-32 https://doi.org/10.1007/s11846-019-00369-w</p>	<p>This paper presents the implementation of crowdsourcing as an IT-based practice. This IT-based view of crowdsourcing is analyzed under the resource-based view. Through an empirical study and the RBV, the paper studied the role of organizational capabilities and competencies in implementing crowdsourcing. In particular the role of market orientation, transformational leadership and organizational learning capability were taken into account.</p>
7	<p>Djelassi, S., & Decoopman, I. (2013). Customers' participation in product development through crowdsourcing: Issues and implications. <i>Industrial Marketing Management</i>, 42(5) 683-692. https://doi.org/10.1016/j.indmarman.2013.05.006</p>	<p>The purpose of this work is to investigate the role of crowdsourcing in the product development process of five case studies. In particular, it analyzed how the participation of customers affects the elements of a current business model and of the marketing function. It also underlines the advantages of using crowdsourcing for consumer goods companies as well as the issues that</p>

		they can find in crowdsourcing adoption.
8	<p>Sebastián Bruque-Cámara, A. V.-S.-O. (2004). Organizational determinants of IT adoption in the pharmaceutical distribution sector. <i>European Journal of Information Systems</i>, 13(2) 133-146.</p> <p>https://doi.org/10.1057/palgrave.ejis.3000490</p>	<p>The objective of this study was to suggest organizational factors that might explain the differences in IT adoption and the speed of its application. Thanks to the analysis of 16 cases it was discussed how fluid communication, low levels of conflict, open channels of communication between departments, explicit management support for IT adoption, learning, and creative abilities of the IT staff influence the extent and the speed of IT adoption.</p>
9	<p>Gatautis, R., & Vitkauskaitė, E. (2014). Crowdsourcing Application in Marketing Activities. <i>Procedia - Social and Behavioral Sciences</i>, 110, 1243-1250.</p> <p>https://doi.org/10.1016/j.sbspro.2013.12.971</p>	<p>The purpose of this article is to examine crowdsourcing phenomena, analyze variables influencing consumer participation in crowdsourcing activities, and examine the use of crowdsourcing in marketing initiatives. It analyses the different tasks in which crowdsourcing may be used such as market research, communication, the development and testing of new goods and the creation of creative ideas, and others. It also mentions the issues that an organization can face in adopting crowdsourcing.</p>
10	<p>Mladenow, A., Bauer, C., & Strauss, C. (2014). Social Crowd Integration in New Product Development: Crowdsourcing Communities Nourish the Open Innovation Paradigm. <i>Global Journal of Flexible Systems Management</i>, 15(1), 77-86.</p> <p>https://doi.org/10.1007/s40171-013-0053-6</p>	<p>The goal of this study was to examine how crowdsourcing can be integrated into the different stages of new product development (NPD). Moreover, it discusses the different roles and tasks that the crowd can take. It also focuses on preconditions and the nature for crowdsourcing adoption.</p>

Table 1: Literature review

5. Methodology

The main objective of the research is to obtain a deep understanding of crowd testing practices and to investigate why companies tend to introduce crowdsourced testing late in digital asset development. To this end, a qualitative study will be carried out (Donepudi, 2020). It was decided to use this approach because in the literature there are not any existing hypotheses that explain the situation.

This study considers six cases of digital asset crowd testing acquisition. Among them, four organizations adopt crowd testing late in the developing phase and two utilize it in the developing phase. It is done to better understand the motivations that influence the decision to take advantage of crowdsourced testing in different moments of digital asset development.

In order to avoid any potential biases in the analyses (Janice M. Morse, 2002), it will be taken into account organizations from different industries and with diverse sizes.

Since organizations tend often to utilize “closed models based on their internal resources” (marketing department and IT department) rather than crowd testing in the new product development (Djelassi & Decoopman, 2013), it is important to consider different digital assets when examining the motivations and aversion toward crowd testing adoption in the developing phase (Djelassi & Decoopman, 2013). In accordance, it will examine organizations that use different digital assets such as eCommerce, digital platforms, apps and websites.

In addition, the studied organizations have to belong to the same country to remove any possible conditioning toward crowd testing due to different cultures such as country's uncertainty avoidance orientation, power distance orientation and economic development (Wen Guang Qu, 2011). Therefore, only Italian organizations will be examined.

Company	Industry	Revenues 2020	Digital Asset	Crowd testing in the developing phase	Country
Milestone	Gaming	50.34.47	Videogame	Yes	Italy
Costa Crociere	Tourism	1.274.301.547	Ecommerce	No	Italy
Candy	Retail	982.36.00	App	No	Italy
Decathlon	Retail	1.137.276.458	Ecommerce	No	Italy
Reale Mutua	Insurance	2.101.878.514	Platform	No	Italy
Pirelli	Automotive	148.18.40	Booking service	No	Italy
Flexa	Education		E-Learning platform	Yes	Italy
Quixa	Insurance	50.00.00	Platform	No	Italy

Table 2: Sample

Semi-structured interviews will be conducted with marketing and IT professionals in the companies surveyed. In particular, the following job titles will be interviewed: IT manager, Chief Technological Officer, Chief Digital Officer, Digital manager, Chief Marketing Officer and Marketing manager. They are the ones involved in setting up a crowd testing operation in their companies as well as the ones that will be more impacted and will benefit the most from crowd testing. In addition, they are digital asset experts either from a functional or experiential point of view. Thus, they will be able to give the right insights to understand why companies tend to introduce crowdsourced testing late in digital asset development.

These six professionals will be invited to recount in detail their crowd testing experiences such as possible reluctance, misgivings and drawbacks in the utilization of it in the developing phase as well as their expectations toward crowd testing and how its acquisition was conducted. The interviews will last between 30 minutes and 1 hour each on average and they will be carried out online with Google meet.

All of the interviews with professionals will be transcribed. The data coding will be based on an iterative content analysis (Matthew B. Miles, 1994). Every interview will be read multiple times in order to fully comprehend the data. This thorough reading of every interview will allow for a more efficient codification process. Interpreting the textual data it will identify a list of code that will be connected based on any theoretical connections between them. The data will be analyzed with MAXQDA.

6. Expected Contributions

The main contribution of the present study is to bridge the gap between the literature knowledge about the benefits of adopting crowdsourced testing in the developing phase and organizations' trends in acquiring crowdsourced testing after releasing the digital asset.

6.1 Scholarly Contributions

To achieve its purpose, this study examined the emerging practice of crowd testing for digital asset optimization. Despite crowdsourcing researchers, this practice is not a focus of marketing research, nor in strategic management researchers or management information systems studies. Indeed, the amount of papers that are specifically focused on crowd testing is residual compared to the ones about crowdsourcing.

Thanks to this research it will be possible to reveal the motivations behind organizations' trend to adopt crowdsourced testing late in the development phase. Being a qualitative study, it will bring insightful knowledge from the actual organizational contexts filling gaps in literature (Donepudi, 2020). As such, this study will extend the work on crowd testing adoption by providing a framework for examining if and how firm sector, product, or service, and capabilities influence the effectiveness and success of crowd testing. It will address the identified literature's gaps (B.J. Allen, 2018) (Mladenow, 2014).

The contribution of the research is not exhausted here. It will integrate different aspects and barriers in crowd testing acquisition. This approach will not only advance the research on crowd testing but also the ones on crowdsourcing, since they have the same main features such as a crowd, a crowd solution seeker, and a platform.

Last but not least, there was not found any exhaustive models in the literature explaining the adoption of external sources such as crowd testing. Therefore, this paper can represent a starting point for future research to deepen in the topic from a quantitative point of view.

6.2 Implications for Business and Society

From the 1990s onward, academics started to analyze the influence of IT in society since it plays a significant role in job creation and in renewing the economic system. In the past

50 years, IT has been one of the most significant economic and social drivers. It has transformed organizations, markets, industries, societies, and individuals' lives. (Rosa M. Muñoz, 2016). Taking into account the crowd testing phenomenon, this research will contribute to analyzing which are the barriers for organizations in adopting crowd testing. In other words, it will give the analytical support and guidance that, according to previous research, organizations need (B.J. Allen, 2018) (Michele Grimaldi, 2022).

By exploiting crowd testing for digital asset optimization at the right timing, organizations will improve their competitive strategies and performances as well as save time and costs (Mladenow, 2014) (Bhuiyan N. , 2011) (Leicht, Blohm, & Leimeister, 2017) (Janelle Estes, 2021) (Mark Langa, 2016) (Baxter, 2018).

In particular, inside the organization, the following job titles were identified as the ones that will benefit from this research in their daily life. It will help CTO and IT managers: to reduce the time required to test and implement new technologies, to quickly respond to requests for digital assets' corrections, to timely resolve malfunctions, and to ensure that the applications are always updated and functioning. In addition, it will support CDO and Digital managers to engage potential customers by focusing on different digital platforms, to execute a digitization project to perfection in the right timing, and face a lack of dedicated IT Skills. It will assist CMO and Marketing managers to find a solution for limited users' feedback and insights, to shorten the time for identification and resolution of problems, and solve consumers' disengagement and low retention rate.

Not only organizations will benefit from this research but also customers. They will have available digital assets with better quality and performance. Thus, they will be more satisfied with their user experience. In addition, they will be more pleased with the interaction and perceive the Empathy Gap (Janelle Estes, 2021) fulfilled.

Last but not least, as organizations will become aware of the power of using crowd testing in the developing phase, there will be the need for a bigger and more specialized crowd. It might be the case that it will increase the number of people being paid thanks to crowd testing.

7. Chapters Overview

Follows a chapter-by-chapter and section-by-section outline of the research division.

Abstract. It briefly describes crowd testing background and which are the research aim, the methodology, and the sample. It also mentions which are the expected contributions.

1. Introduction. This section examines the phenomenon, its scholarly discussion and its advantages. The research aim is clarified and research gaps and expected contributions are analyzed.

2. Theoretical Framing and Research Propositions. In this chapter, crowdsourced testing is deeply studied in its features and characteristics. In particular, the analysis adopts an organizational perspective. In addition, it explains the theoretical approach used in the study. In fact, all the different barriers that can prevent crowd testing adoption in the developing phase are analyzed. In particular structural concerns, organizations' projects, and companies' environment are taken into account. Moreover, factors such as culture, organizational structure, as well as external knowledge and transformational leadership are investigated.

3. Literature review. In this section, the inclusion and exclusion criteria as well as the used databases are explored.

4. Methodology. In this chapter the type of study as well as the sample are analyzed motivating each decision.

5. Data analysis. Data collection and analysis procedures are explored.

6. Research findings and Discussion. In this section the interviews' findings are studied and discussed.

7. Limitations. Possible limitations and the need for future research are described in this paragraph.

8. Work Plan

The estimated work plan is shown in the following table, which will be constantly updated.

MONTH	WEEK		TASK	DETAILS			
September	12/09/2022	18/09/2022	Reading Papers and Write Introduction	Research Problem, Scholarly discussion			
	19/09/2022	25/09/2022	Write Introduction	Introduction: Gaps, contributions, chapter overview			
	26/09/2022	02/10/2022	Write Exposé	Theoretical Framing			
	03/10/2022	09/10/2022	Write Exposé	Literature Review and Propositions			
October	10/10/2022	16/10/2022	Preparation of interviews	Methodology, Expected Contributions, Chapter Overview		DEADLINES	
	17/10/2022	23/10/2022	Preparation of interviews	Prepare interviews' questions		23/10/2022	Exposé submission
	24/10/2022	30/10/2022	Interviews	Research and contact interviews		13/01/2023	Thesis submission
	31/10/2022	06/11/2022	Interviews	Conduction and transcribing interviews		17/01/2023	Thesis defense
November	07/11/2022	13/11/2022	Interviews	Conduction and transcribing interviews			
	14/11/2022	20/11/2022	Interviews	Conduction and transcribing interviews			
	21/11/2022	27/11/2022	Data analysis				
	28/11/2022	04/12/2022	Data analysis				
December	05/12/2022	11/12/2022	Thesis writing	Results			
	12/12/2022	18/12/2022	Thesis writing	Discussion of findings, Contributions and Limitations			
	19/12/2022	25/12/2022	Thesis writing	Conclusions			
	26/12/2022	01/01/2023	Thesis review				
January	02/01/2023	08/01/2023	Thesis review				
	09/01/2023	15/01/2023	Thesis submission				
	16/01/2023	22/01/2023	Thesis defense				

Table 3: Work Plan

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