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**CÁTIA SOFIA COSTA
DE CARVALHO**

**EVALUATION OF REMOTE WORKERS'
PREFERENCES FOR THE PROPOSAL
OF A SYSTEM ON WORKSPACE
SEARCH**

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Dissertação apresentada ao IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia, para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Design de Interação realizada sob a orientação científica do Doutor Edirlei Lima, Professor Auxiliar da IADE, Universidade Europeia e da Hande Ayanoglu, Professora Auxiliar da IADE, Universidade Europeia.

Dedico este trabalho à minha família.

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Palavras-chave

Remote work, Working spaces, Coworking spaces, Third spaces, Think Aloud, User testing, User preferences.

Resumo

As novas formas de comunicação e o exponencial crescimento de novas tecnologias móveis permitem um alto grau de interação entre pessoas, lugares, e coisas, tornando possível o ato de trabalhar em qualquer lugar e hora. Isto levou à criação de novas formas de trabalho, onde um número crescente de trabalhadores independentes luta contra a linha tênue entre trabalho e vida pessoal. A ascensão de espaços de coworking, e a sua popularidade, vieram combater essa linha ajudando os trabalhadores remotos a combater e lidar com questões de solidão, promovendo o trabalho colaborativo e dinâmico. No entanto, estudos sobre as preferências e necessidades de trabalhadores remotos, relativamente a estes espaços de trabalho, são escassos na literatura. A presente dissertação, tem como objetivo identificar e avaliar as preferências dos trabalhadores remotos, na zona da capital de Portugal, de forma a propor o desenvolvimento de um sistema, com informações em tempo real, que pode ajudar os seus utilizadores na procura de um espaço de trabalho, aumentando a sua eficiência. Esta dissertação apresenta resultados do estudo, o desenvolvimento das interfaces do sistema proposto e os resultados de um teste de usabilidade, com recurso à avaliação heurística (10 Heurísticas de Nielsen). Os resultados indicam que trabalhar a partir de casa ou em espaços de coworking são as opções mais comuns entre trabalhadores remotos. A procura por um espaço que garanta conforto, que permita uma estadia a preços acessíveis e que proporcione uma interação social com outros trabalhadores, são motivações destes trabalhadores para a procura desses espaços. A qualidade da internet e um ambiente silencioso são as características mais valorizadas num espaço de trabalho. Os resultados da avaliação do sistema proposto revelaram 6 problemas de usabilidade e 2 das heurísticas de Nielsen foram violadas. No entanto, os resultados do SUS apresentaram uma avaliação geral de 91 pontos, considerando o sistema como “aceitável”. Os resultados apresentados nesta dissertação podem ajudar designers a projetar ou a desenvolver aplicações móveis relacionadas com espaços de trabalho. Poderá também ajudar proprietários destes espaços a criar um ambiente de acordo com as preferências dos seus trabalhadores.

Keywords

Remote work, Working spaces, Coworking spaces, Third spaces, Think Aloud, User testing, User preferences.

Abstract

New ways of communication and the growth of mobile technologies allows a high degree of interaction between people, places, and even things, making it possible to work anywhere, anytime. This has led to the creation of new ways of working, where an increased number of independent workers fight the blurred line between working and personal life. The rise of the coworking spaces and their popularity came to fight that line and, also, help remote workers dealing with loneliness, promoting a collaborative and dynamic working environment. However, little is found in the literature about the specific preferences of this space's users. The present dissertation aims to identify and evaluate remote workers' preferences of working spaces characteristics, in the capital area of Portugal, to design a real time system that can help user's efficiency when looking for a space to work in. The paper presents the results of the study, the interface design, and the Heuristic Evaluation (Nielsen's 10 Heuristics) of the proposed system. Results show that working from home or in a Coworking spaces are the most common options among remote workers and their main motivations to work in those spaces were looking for a space that brings them comfort, allows an affordable accommodation and social interaction with other workers. WIFI quality, location and a quiet environment are the most important characteristics when choosing a specific working space. The results of the proposed system' evaluation showed that 6 usability problems were found, and 2 out of 10 heuristics were violated. However, the overall SUS score evaluation show a score of 91 points, considered as "acceptable". These results can help designers designing or developing working spaces related applications, or even owners creating those spaces.

List of Acronyms and Abbreviations

CWS – Coworking Spaces

DN – Digital nomad

EFIP – European Forum of Independent Professionals

EU – European Union

GPS – Global Positioning System

IAQ – Indoor Air Quality

ICT – Information and communications technology

ILO – International Labour Organization

IOT – Internet of Things

IxD – Interaction Design

RFID – Radio-Frequency Identification

SDT – Self-Determination Theory

UCD – User Centered Design

UI – User Interface

US – United States

WHO – World Health Organization

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1. Introduction

1.1. Problem statement

The evolution in new ways of communication have led to changes in society. The advances of the internet have provided people with information from various places with fewer barriers. Today, people, goods, and information are moving quickly and easily to all parts of the globe (Frاند, 2000). The tendency is the daily use of communication devices, such as smartphones and mobile internet, along with the growing need for information while “on the go”. The mobile technologies allow a high degree of interaction between people, places and even things. According to Nascimento (2015), since the birth of the internet, the huge growth in new technologies have put on the market a legion of mobile devices that can allow the access of the internet, such as notebooks, netbooks, tablets, smartphones, and many others. As a result, the personal computer is no longer the primary source of web browsing and internet has become easily accessible (Nascimento, 2015).

The continued advancement of digital technology and the rise of the gig economy led to the growth of new ways of working¹ (Hannam et al., 2013), the constant need for workers’ flexibility (Gibson & Lizieri, 1999), the increasing number of self-employed workers, and the increasing use for public spaces as a workplace (Weijs-Perree et al., 2019). All these, along with the growth in the use of new technologies, decreased and changed the need for office space (Weijs-Perrée et al., 2019). These changes blurred the distinction between where a person lives (i.e., first place or home), where a person works (i.e., second place or office) and where a person spends time in between (i.e., third place) (Lee, 2018). Oldenburg (1989) defined this third place as a “generic designation for a great variety of public places that host the regular, voluntary, informal, and happily anticipated gatherings of individuals” and listed public places like cafés, coffee shops, community centres, general stores, and bars as exemplary third places. However, as mentioned, different changes blurred this distinction, as nowadays, cafés and coffee shops are loosely associated with work environments due, to the accessibility of tables and limitless coffee. (Lee,

¹ New ways of working refer to activities such as the possibility to work from various physical locations using ICT (Information and communications technology) devices and networks (Worthington, 2001).

2018). Aside from this, there are other advantages like fast WIFI and space to work for the cheap price of a cup of coffee. Flexible workers often choose to work at such third places that are neither their homes nor offices (Lee, 2018). Independent consultants, short-term contractors, and freelancers creating portfolios of work in lieu² of full-time jobs, keep transforming the way we work by disconnecting work from the office (Mulcahy, 2017).

With new ways of working and the increased number of independent workers it is possible to witness the rise of new types of workplaces (emerging as third places) to work in the digital age. Mulcahy (2017), refers to Coworking spaces as the optimum third places to work, since they can combine the best of both first and second places (i.e., working at home and traditional office), offering “control, autonomy, and scheduling flexibility of remote work, combined with optional access to the structure and community of an office if and when the worker wants it”. These spaces have risen in prominence globally along with the growth of the gig economy (Cheng, 2018), and gain popularity over the past years (e.g., Huwart et al., 2012; Moriset, 2013; Parrino, 2015). Their popularity can result from the increasingly looking for a workspace, by self-employees and other remote workers, outside their home, due to feelings of loneliness, when working from home, and the need for a better balance between their work and personal life (Fuzi et al., 2014; Moriset, 2013), increasing their efficiency and performance (Bouncken & Reuschl, 2018).

There are some studies focusing on specific subjects of co-working such as their proximity in knowledge dynamics (Parrino, 2015), and promoting entrepreneurship on co-working spaces (Fuzi, 2015), however, little is found in the literature about remote workers preferences for working spaces characteristics (Weijs-Perree et al., 2019). Therefore, the aim of this dissertation is to identify and evaluate remote workers’ preferences of working spaces characteristics for the design of a real time system that can help user’s efficiency when looking for a space to work in. For this study, remote workers were defined as employees who work in a physically separate location as their teammates.

² When an employee has worked extra hours and instead of accepting overtime pay, they take extra time off.

1.2. Motivation

Recent technologies and new collaborative tools opened doors to remote work, where companies started to offer “work from home” days. According to Eurostat (2020), 5.4% of employees, in the European Union (EU), aged between 15-64, are working from home. Additionally, 9% work remotely a number of days. Data from Upwork (2020) reveals that 41.8% Americans are working remotely and it is estimated that, by 2025, 36.2 million Americans will be working remotely. As Figure 1 shows, in Portugal, the number of Portuguese citizens working remotely have grown between 2015 and 2019. Recent numbers have pointed to approximately 6.5% of Portuguese population working remotely, standing out from countries like Italy (3.6%), Spain (4.8%) and Germany (5.2%) (Eurostat, 2020).

Employed persons working from home as a percentage of the total employment, by sex, age and professional status (%)
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TIME: [dropdown] +
 Frequency: Usually [dropdown] +
 Unit of measure: Percentage [dropdown] +

GEO: [dropdown] +
 Age class: From 15 to 64 years [dropdown] +

Sex: Total [dropdown]
 Activity and employment status: Employed persons [dropdown]

	2012	2013	2014	2015	2016	2017	2018	2019
Greece	2.1	2.2	2.7	2.6	2.6	2.3	2.0	1.9
Spain	4.4	4.3	4.3	3.6	3.5	4.3	4.3	4.8
France	11.5	7.3	6.8 ^(b)	7.0	6.9	6.7	6.6	7.0
Croatia	0.9	1.0	1.4	1.2	1.4	1.4	1.4	1.9
Italy	3.3	3.1	3.2	3.4	3.3	3.5	3.6	3.6
Cyprus	1.0	1.6	1.7	1.5	1.6	1.2	1.2	1.3
Latvia	2.0	2.1	2.5	2.1	2.6	2.1	2.9	3.0
Lithuania	4.0	3.9	4.1	3.0	2.7	2.6	2.5	2.4
Luxembourg	11.4	12.4	14.1	13.2 ^(b)	12.0	12.7	11.0	11.6
Hungary	3.1	3.9	3.4	3.4	3.0	2.5	2.3	1.2
Malta	1.8	2.2	2.7	2.6	3.6	4.4	5.8	6.1
Netherlands	11.5	12.6	13.1	13.6	13.4	13.7	14.0	14.1
Austria	10.3	10.4	10.7	10.2	9.9	9.5	10.0	9.9
Poland	4.6	4.0	4.6	5.6	5.3	4.5	4.6	4.6
Portugal	6.3	6.7	6.6	6.2	6.3	5.9	6.1	6.5
Romania	0.4	0.3	0.4	0.5	0.5	0.4	0.4	0.8
Slovenia	6.6	7.1	7.7	7.6	7.5	7.7	6.6	6.6

Figure 1. Employment persons working from home as a percentage of the total employment, by sex, age (15-64) and professional status (employed) by Eurostat (2020).

Due to an increasing number of self-employees working from home, new types of working spaces have been born, in an attempt to pull people together in a collaborative and productive space. Those, known as coworking spaces or shared office environments, for independent professionals, have been increasing rapidly (Spinuzzi, 2012). In the capital area of Portugal, in 2009, the creative industry, including coworking spaces, represented 3.3% employment, meaning 38.287 employments (Lisboa: Economia Criativa, 2013). In 2017, the same creative industry included Incubators (18), Coworking spaces (+50), and Creative hubs (8) (Figure 2).

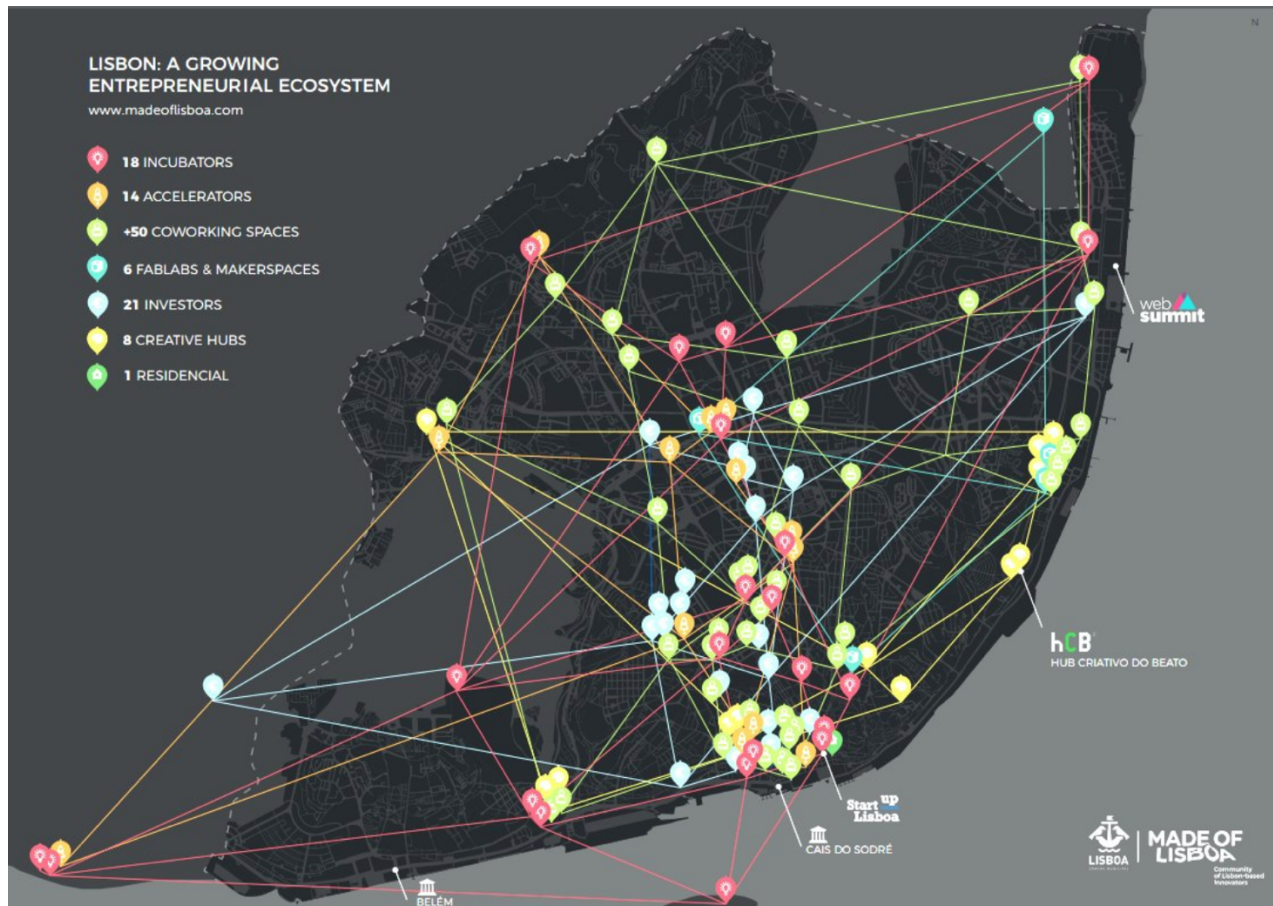


Figure 2. Creative industry ecosystem, in Lisbon. Made of Lisboa (2017).

The digital era, as we know, is prone to limit the contact between human beings, due to the evolution of communication channels, such as smartphones and computers. These new working spaces came to fight the disadvantages of working at home such as the lack of social and professional interaction, isolation, and the blurred boundary between a private and a professional life (Leclercq-Vandelannoitte & Isaac, 2016). The Self-Determination Theory (SDT) suggests that human beings thrive in social-environmental conditions that support the three basic psychological needs: autonomy, competence, and relatedness (Deci & Ryan, 2000). A study performed by Walton, et al. (2012) suggested that people draw motivations from a sense of belonging in an intellectual community. Additionally, SDT refers to the need of a human being to form and maintain at least a minimum quantity of interpersonal relationships as they are instinctively prepared to (Baumeister & Leary, 1995).

In this sense, the aim of this work is to identify and evaluate remote workers' preferences of working spaces characteristics, in the capital area of Portugal, to propose a real time system that can improve user's efficiency when looking for a space to work in. For this study, remote workers were defined as employees who work in a physically separate location as their teammates. This paper presents the evolution of an ongoing project that will propose a system that explores working spaces' characteristics and features, aiming for the comfort of remote workers when looking for a space to work. The objective of the ongoing project is to work on the design of an interface, considering remote workers preferences and frustrations, discovered through literature review, and during user studies. Furthermore, it presents the proposed design evaluation, through remote moderated usability tests, aiming to find usability problems and provide findings to improve it.

1.3. Objectives

The main goal of this project is to identify and evaluate remote workers' preferences of working spaces characteristics to design a real time system that can help user's efficiency when looking for a space to work in. To achieve the main goal, the following secondary objectives of this thesis are:

- Investigate the literature review on remote work, current working spaces' mobile applications and real time technologies.
- Analyze and evaluate remote workers' preferences and needs when looking for a space to work in.
- Design of the proposed system's interface, according to findings on remote workers preferences.
- Conduct remote moderated user tests with target users to identify and map possible usability problems regarding the proposed system design.

1.4 Methodology overview

The methodology used in this project was adapted from Vijay Kumar’s methodology (2013), presented in his book *101 Design Methods*, where the author suggests a 7 phases methodology: (1) Sense Intent, (2) Know Context, (3) Know People, (4) Frame Insights, (5) Explore Concepts, (6) Frame Solutions, and (7) Realize Offerings (Figure 3).

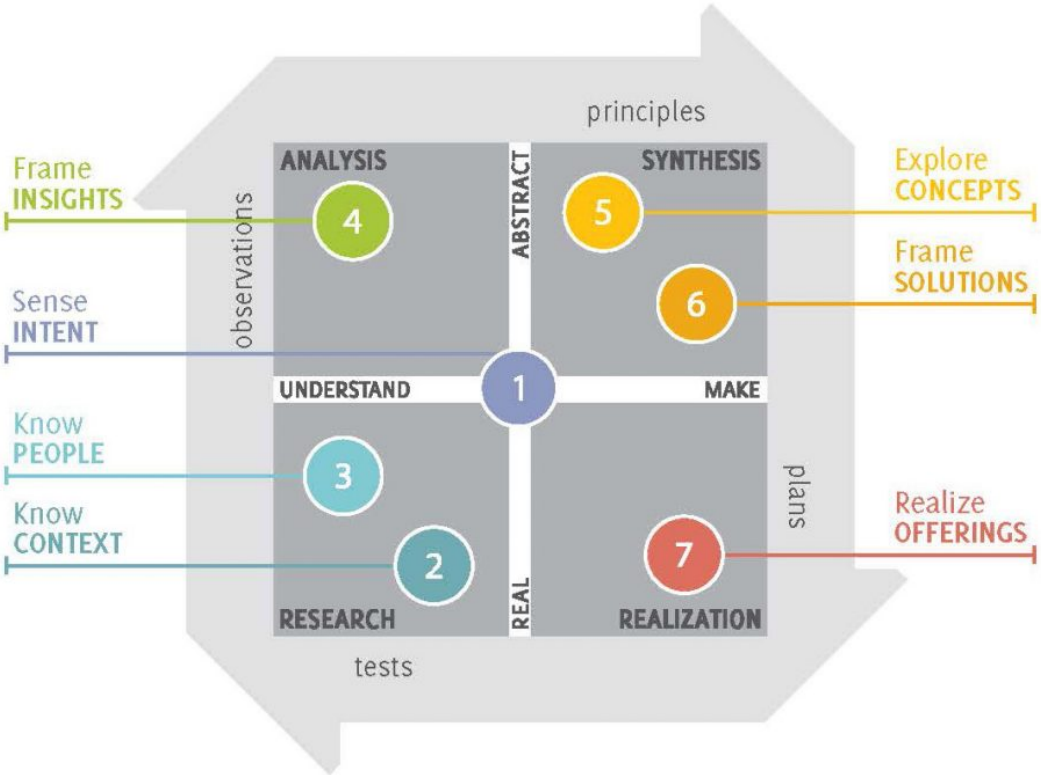


Figure 3. Kumar’s Methodology (2013).

The study diagram of the thesis is represented in Figure 4.

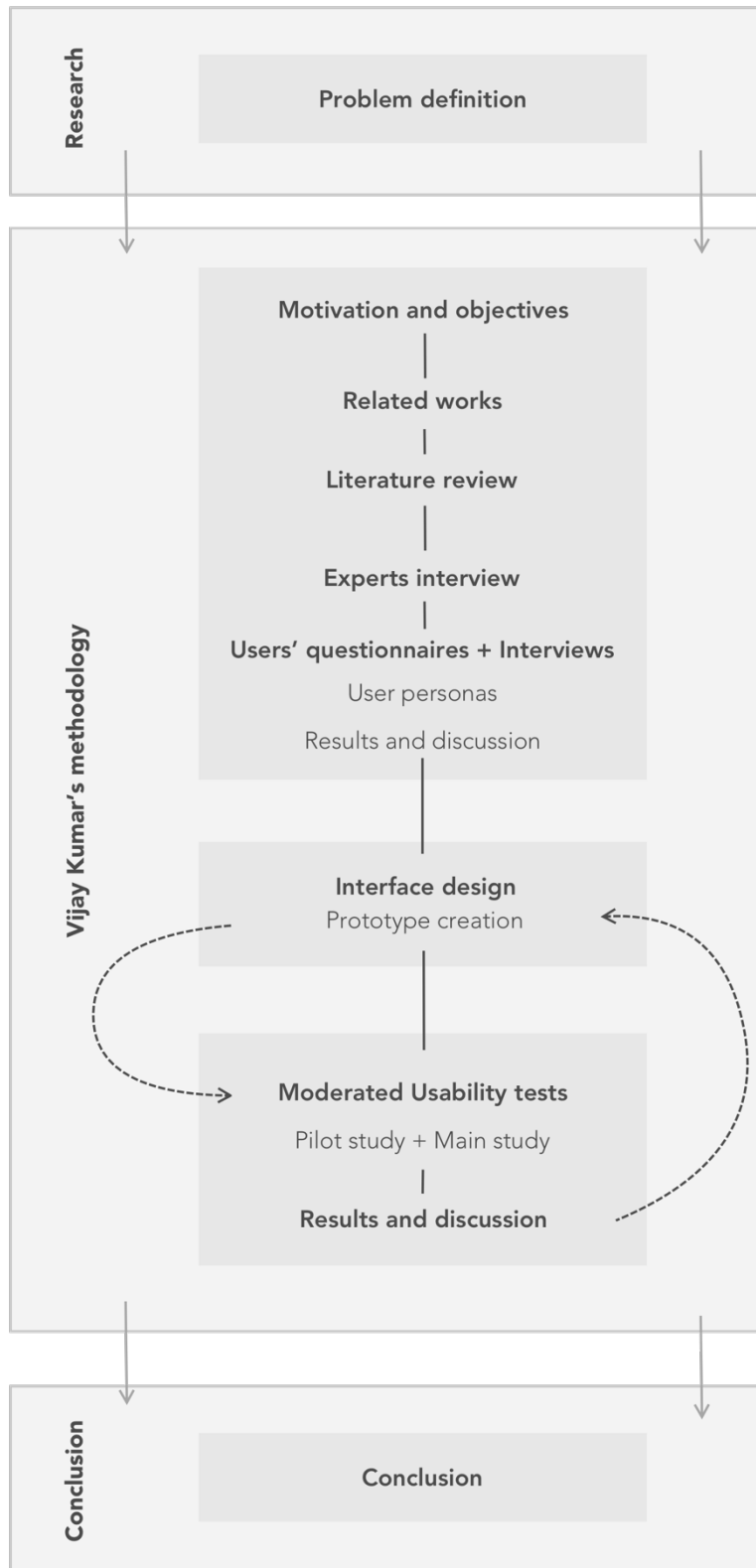


Figure 4. Study diagram

1.5. Thesis structure

This study is divided into five chapters which are included as follows:

Chapter 1 includes a general background, the problem statement, the motivation, the main research objectives, study diagram, and the organization of the present dissertation.

Chapter 2 exposes the literature review related to the main topic of this paper. It discusses about remote work, types of remote workers, coworking spaces and its growth and what motivates remote workers to work in those spaces. Also, it addresses the well-being and performance at work and smart environment technologies.

Chapter 3 provides and describes the methodology proposed for this project.

Chapter 4 describes the project development process of the proposed system – a real time system that can help user's efficiency when looking for a space to work in, presenting the ideation process, from the navigation plan diagram to the creation of low and high-fidelity prototypes. It also describes the usability evaluation, through remote moderated user testing and Think Aloud methodology.

Chapter 5 summarize the research work performed, providing an overall view of the study results, the limitations and contributions intended on this study. Also, it presents some future work.

2. Literature review

This chapter states out a literature review that describes the theoretical perspectives and already existing projects that contribute to a foundation of research objectives mentioned in Chapter 1. Chapter 2.1 to 2.5 presents the predominant research areas that contribute to this research work: Interaction Design; Remote Work; Coworking Spaces. Then, Chapter 2.6 presents a literature review on well-being and performance at work, and Smart Environments.

2.1. Interaction Design

Interaction Design, often abbreviated as IxD, can be defined as:

the design of interactive products and services in which a designer's focus goes beyond the item in development to include the way users will interact with it.

Interaction Design Foundation (2002).

Several terms have been used to emphasize various aspects of what is being designed or created. Winograd (1997), describes IxD as “designing spaces for human communication and interaction”. Thackara (2001), defines it as “the why as well as the how of our daily interactions using computers”, while Saffer (2010), views it as “the art of facilitating interactions between humans through products and services”. It is possible to talk about IxD when mentioning technology from our daily lives, such as smartphones, GPS (Global Positioning System) navigation devices or an automatic cash machine (popularly called ATM). The majority of these digital devices are created taking in consideration their user's expectations and needs, in order to provide them good experiences when using the final product. Interaction design is about how people interact with technology and creating user experiences enhancing the way people behave, work, communicate and interact with technology (Preece et al., 2002). It is all about understanding and studying the user's behavior.

2.1.1. User-Centered Design (UCD), User Experience (UX) and User Interfaces (UI)

Every day, products get designed for our comfort, well-being, and pleasure. There are many existent theories on how to design those products effectively, however there are still designers that overlook the user, even though we are getting consistently reminded that good designs allow users to create and perform tasks according to their preferences and needs. In 1986, in a book titled:

User-Centered System Design: New Perspectives on Human-Computer Interaction (Norman & Draper, 1986), Don Norman³ coined the term User Centered Design (UCD). For Don, UCD is an iterative design approach that puts user's needs, abilities, and behavior at first place, to ensure that designs match those needs, abilities, and behavior of intended users. Good design starts with psychology, technology, and people research, to understand the real problem that design should solve (Norman, 2013). The UCD process involves the target users in the design process, in order to understand their needs and requirements. It is important to perceive that users are different and have different needs, therefore different interactive products need to be designed accordingly (Preece et al., 2002). This involvement with the users leads to more effective, efficient, and safer products, contributing to the acceptance and success of products (Preece et al., 2002).

User Experience (UX) takes a broader view of the user's entire interaction with a product, application, system or service, as well as their thoughts, feelings, and perceptions, resulting from that interaction (Albert & Tullis, 2013). The international standard on ergonomics of human-system interaction, ISO 9241-210, defines UX as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" (ISO, 2018). UX is the result of a user's interaction with an artifact in a usage context. Therefore, the same product can have different perceptions of user experience regarding the user's context of use (Hartson & Pyla, 2012).

A User Interface (UI) is the first contact that users have with a product or system. The UI includes all components of an interactive system to provide information and controls to the user, such as buttons, icons, menu bar and other visual elements. In other words, UI enables users to effectively control the system or device they are interacting with (Hannah, 2019). When an interface is well designed, it becomes a seamless experience unnoticeable to the user, so the way the information is presented on the UI is crucial for users' better comprehension and usability of the system (Anderson et al., 2010).

³ Donald Arthur Norman, born in 1935, American researcher, professor and author. Co-founder and consultant in the Nielsen Norman Group. Known for his expertise in the fields of design, usability engineering, and cognitive science.

2.2. Remote Work

Considering the continued growth of the digitization and changing economy, work is increasingly not an identifiable place to go, but a virtual network containing individuals who still need to be connected and engaged as a community (Lee, 2018). This trend has fueled the rise of the Telecommuting phenomenon. Telecommuting, also called telework, teleworking, working from home (the most common term in the UK), mobile work, remote work, and flexible workplace, is a way of working outside of the traditional office/workplace, usually with the help of digital technology. In 2020, the ILO (International Labour Organization), defined teleworking as “the work performed through the use of Information and Communication Technologies (ICT’s), such as smartphones, laptops, and desktop computers, outside the employer’s premises”.

The term telecommuting was first coined by Jack Nilles⁴ in 1973. While working remotely on a complex NASA communication system, Nilles mentioned that he was “telecommuting”; The term was born. One year after, Nilles stated that “moving work to workers instead of moving workers to work” could possibly help reduce urban traffic and air pollution. However, in the 70’s, the existing technology could not support this idea since the companies could not acquire profit. The term started to become popular in the U.S. around the 2000’s, when a headline in Forbes confirmed how popular telecommuting has become and its potential (Rapoza, 2013).

According to Eurostat (2020), 5.4% of employees, in the European Union (EU), aged between 15-64, are working from home. Additionally, 9% work remotely a number of days. Data from Upwork (2020) reveals that 41.8% Americans are working remotely and it is estimated that, by 2025, 36.2 million Americans will be working remotely. In Portugal, the number of Portuguese citizens working remotely have grown between 2015 and 2019. Recent numbers have pointed to approximately 6.5% of Portuguese population working remotely, standing out from countries like Italy (3.6%), Spain (4.8%) and Germany (5.2%) (Eurostat, 2020). This evolution can be related to the creation of more “technological/digital jobs”, which are defined as tasks performed with the help of a computer. In addition, there are numerous tools that can contribute to the success of this

⁴ Jack Nilles, born in 1932, former NASA engineer and director of Interdisciplinary Program Development at the University of Southern California (UCLA). Known internationally as “the father of telecommuting/teleworking”.

type of work (such as shared and editable documents, mobile applications, and online conference rooms (meeting rooms) that allow people communicate at a distance with no face-to-face needs. Furthermore, some people stated that remote work can generate long term benefits, from flexibility to cost-effectiveness, such as: improved work/life balance, flexible working time, reduction in expensive office space, elimination of wasted commuting time, etc. (Nickson & Siddons, 2012).

2.3. Types of remote workers

As mentioned in the last sections, the continued advancement of digital technology made it possible to work remotely, performing tasks and activities from any country or city, from home, hotels, restaurants, parks, or libraries. From this, a new lifestyle emerged: Digital Nomadism. Dal Fiore et al. (2014), when examining the impact of new technologies on travel behavior, were unable to identify a definition other than Wikipedia's.

Digital nomads are individuals who use telecommunications technologies to earn a living and, more generally, conduct their life in a nomadic manner. Such workers typically work remotely – from home, coffee shops, public libraries, and even recreational vehicles – to accomplish tasks and goals that traditionally took place in a single, stationary workplace.

(Wikipedia 2014)

With the past of the years, different authors have tried to explore on a definition: For Lieg (2014), a Digital Nomad (DN) is “a mobile knowledge worker equipped with digital technologies to work anytime, anywhere”, while Matos (2018) refers to DN as people who aim for a lifestyle that does not depend on a single place (i.e., a job or a fixed home address), where everything is mobile. Digital nomadism became recognized as a mainstream phenomenon in 2014 when dedicated online communities emerged, coworking spaces opened and conference series began (Schlagwein, 2018). Of course, DN are not the only professionals to work remotely. Plenty of other professions require individuals to work on the same basis (remotely), such as self-employers. A self-employed person is an individual who earns a living by working for themselves, not as an employee of someone else and not as an owner of a corporation. Then, there are freelancers: Professionals who can work from wherever they please, who are not employed permanently for a specific job in the long term (Wood et al., 2018). Freelancers often offer their services through online tools, such as online ads

or personal websites to get jobs (Primastomo et al., 2015), making this professional's life fairly easy due to the vast sea of online tools, such as mobile phones and e-mail (Monticelli, 2010). Unlike a self-employed person, a freelancer does not necessarily have a license to practice a regulated profession.

Olson, et al. (1984) presented four distinct categories of remote workers:

After-hours work at home: People that perform their work tasks at home after work hours/ in addition to their routine 8-hour workday at the office.

Self-employed work at home: The majority of people that work at home are self-employed (writers, consultants, artists).

Occasional work at home: Their norm is to still attend a workplace during regular working hours (9-5), however, on occasion, these people can work at home.

Regular work at home for full-time workers: Permanent/ full-time work at home.

Kraut (1989) divided a remote worker into three distinct groups:

Substitutors: Those who substitute work done at home for work done in a more conventional work setting. These are primarily employees of large organizations.

Self-employed: Employees from a company that work from home, in order to enhance freedom.

Supplementers: People that perform their work tasks at home after work hours.

According to Upwork (2019), the United States (US) has witnessed a boom over the last five years, having approximately 57 million Americans working as freelancers. Additionally, the same press revealed that 43% of the American population will turn to freelancing work over the next five years. It is expected that, by 2027, the US workforce will consist of freelancers. A survey from EFIP (European Forum of Independent Professionals) and Malt, from 2018, shows that 7% of Europe's adult workforce are freelancers, meaning 11 million freelancers in the EU. For this particular study, remote workers were defined as employees who work in a physically separate location as their teammates.

2.4. The coworking phenomena

Co-working can be defined as the act of sharing a workspace (i.e., office) with others. The concept can be defined as a type of third place "at the boundary of two dominant spaces (home and office),

which is not fully part of either” (Dale & Burrell, 2007). Coworking spaces (CWS) are characterized as third places that allow workers to have flexibility to separate work from private life in various ways, without the repercussions of feeling lonely at home or being forced to work at the office. During this study’s research, different terms and definitions were found, however, for this particular study, the concept of “coworking” is interpreted with the definition by Oxford English Dictionary (OED):

(...) the use of an office or other working environment by people who are self-employed or working for different employers, typically so as to share equipment, ideas, and knowledge.

These spaces have risen in prominence globally along with the growth of the gig economy (Cheng, 2018), and gain popularity over the past years (Huwart, et al., 2012; Moriset, 2013; Parrino, 2015). The number of CWS has grown all over the world: from 75 in 2007 to 310 in 2009, 1130 in 2011, 3400 in 2013, and 7800 in 2015, with more than half a million members worldwide (Deskmag, 2016). In 2020, a study published by *CoworkingResources*, titled “Global Coworking Growth Study 2020”, registered approximately 2 million people working in over 20 million co-working spaces worldwide, crossing over 5 million by 2024 (Figure 5).

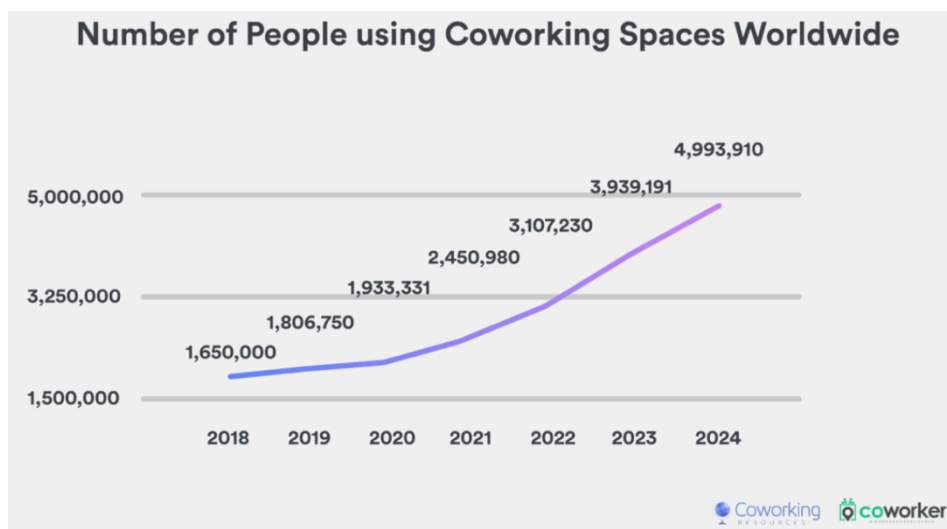


Figure 5. Number of People using Coworking Spaces Worldwide. Estimates based on proprietary data from CoworkingResources and Coworker (2020).

Portugal has been distinguished as one of the 20 largest markets by number of coworking spaces and the corresponding share over all spaces worldwide (280 spaces), followed by Hong Kong (255 spaces) and Vietnam (251 spaces) (Figure 6).

Top 20 Countries by Number of Coworking Spaces					
Country	Number of Spaces	World Share	Country	Number of Spaces	World Share
 United States	3,762	18.30%	 Philippines	368	1.79%
 India	2,197	10.69%	 Malaysia	364	1.77%
 United Kingdom	1,044	5.08%	 France	339	1.65%
 Spain	939	4.57%	 China	304	1.48%
 Germany	791	3.85%	 Italy	298	1.45%
 Canada	617	3.00%	 Indonesia	290	1.41%
 Australia	590	2.87%	 Colombia	282	1.37%
 Mexico	508	2.47%	 Portugal	280	1.36%
 Japan	411	2.00%	 Hong Kong SAR, China	255	1.24%
 Brazil	393	1.91%	 Vietnam	251	1.22%

Figure 6. Top 20 Countries by Number of Coworking Spaces.

Although the concept of CWS has existed since 1999, they started to become famous with the creation of the first CWS by Brad Neuberg, in San Francisco in 2005 (Weijs-Perrée et al., 2019). These spaces are often associated with the presence of heterogeneous workers, such as freelancers, employees, and self-employed workers (Parrino, 2015). However, according to multiple studies (Foertsch, 2011; Fuzi, 2015; Parrino, 2015; Sykes, 2014; Laing 2013), it is possible to distinguish several other users, namely self-employed workers, small firms, large firms, and even students. According to Deskmag (2017), 36% of the coworking members are employees, 41% are freelancers and 16% employers. The remaining 7% of members are engaged in other activities (e.g., studying).

CWS can be considered as the optimum third places to work as they combine the best of both first and second places (i.e., working at home and traditional office) by not only offering amenities that can help people perform their jobs, but also, they can offer ideal conditions for performing work with the highest performance with the lowest price possible (Laing, 2014), or even allowing to rent

a desk on a daily, weekly, or monthly basis (Olma, 2012). In addition, these spaces can offer a social network, knowledge sharing, and professional relations (Deskmag, 2015). Most independent workers who join CWS had previously worked from home, where they may have suffered from feelings of isolation, among other inconvenience problems (Spinuzzi, 2012).

In a study performed by Kojo and Nenonen (2016) it was possible to identify six different CWS typologies: public offices (i.e. libraries, and free co-working spaces), third places (i.e. public spaces where the purchase of services is required, such as cafés, collaboration hubs (i.e. public offices that focus on collaboration between workers), coworking hotels (i.e. shared office space with a short-lease contract and a compact service package), incubators (i.e. shared office space that focuses on entrepreneurship), and shared studios (i.e. shared offices where an organization or entrepreneur rents an office space based on flexible-lease contracts, with tenant requirements such as the fit to the community). For the purpose of this study, only users of public offices and third places were considered.

2.5. Motivations to work in a coworking space (third place)

As a result of the awareness of the disadvantages of working in a classic office or at home (Fuzi et al., 2014), such as the possible lack of social and professional interaction, isolation, and the blurred boundary between a private and a professional life (Leclercq-Vandelannoitte & Isaac, 2016), the first coworking space, created by Brad Neuberg, in 2005, in San Francisco emerged. Kojo and Nenonen (2017) suggested that the main drivers for the popularity and evolution of these working spaces are the new ways of working, attractiveness (i.e. increasing demand for more than only a workspace at a good location, reducing time spent on commuting), work/ life balance, supported by extended opening hours or accessibility on a 24/7 basis, economic efficiency (i.e. family-work balance, no commuting from work to home, flexible leasing policies (such as paying for the space only when it is needed) and sustainability (i.e. sharing facilities, equipment and services).

In a study performed by Weijs-Perrée et al. (2019), participants were asked what were their first, second and third motivations to work outside their houses/in a coworking space. It is possible to observe that “I was looking for a workplace outside home” was their first motivation. The motivation “inspiring and creative atmosphere in the co-working space” was found to be the most

important second motivation. Other important motivations were “affordable accommodation” and “social interaction with co-workers” (Figure 7).

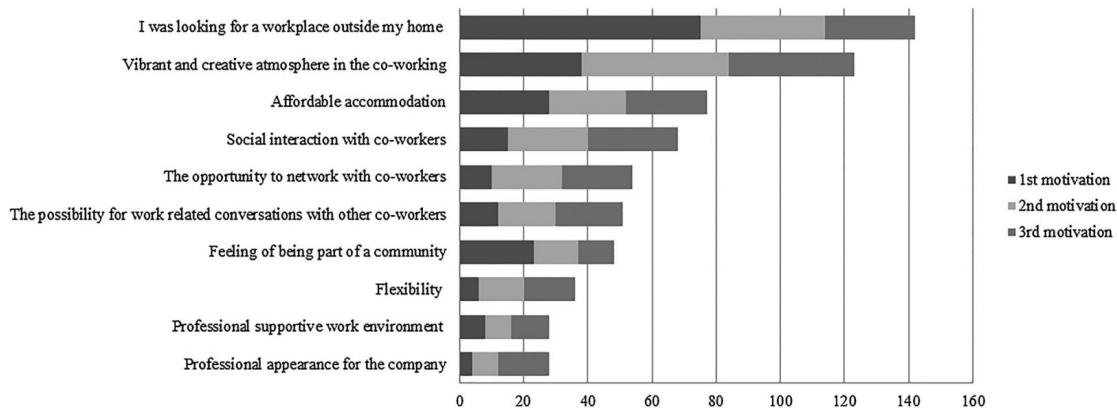


Figure 7. Motivations to work at a coworking space by Weijs-Perrée et al. (2019).

2.6. Work environment on well-being and performance

As the tendency to shared workspaces and non-fixed workstations rises, the local environment must be adapted to the needs and preferences of every user. Physiological responses to environment stimuli have been investigated intensively (Seals et al., 1991; Hori, 1995). Some work environment studies have shown that specific work environment factors, preferred by users, significantly contribute to their workspace satisfaction and performance. Performance can be defined as the outcome of all cumulative actions that an employee performs using his skills, abilities, and knowledge for a particular situation or task during a given time period (Prasetya & Kato, 2011). Some environment factors include lighting, natural light, and acoustic environment (Humphries, 2005; Veitch et al., 2004). Chandrasekar (2011), also mentioned poor ventilation, immoderate noise, and inadequate lighting as unhealthy and unsafe work environment conditions that can affect employees’ productivity and, also, health. An uncongenial workplace environment, such as noisy (much on unfamiliar sound), too low or high temperature, stuffy office, lack of natural light or even cramped working space, might affect individual performance and quality. In general, tasks that require concentration, memory and original thought are the most affected ones (Wyon & Wargocki, 2013). Badayai (2012), classified five main factors of unpleasant working

environment as shown in Figure 8. Four of the five the factors will be discussed individually bellow.

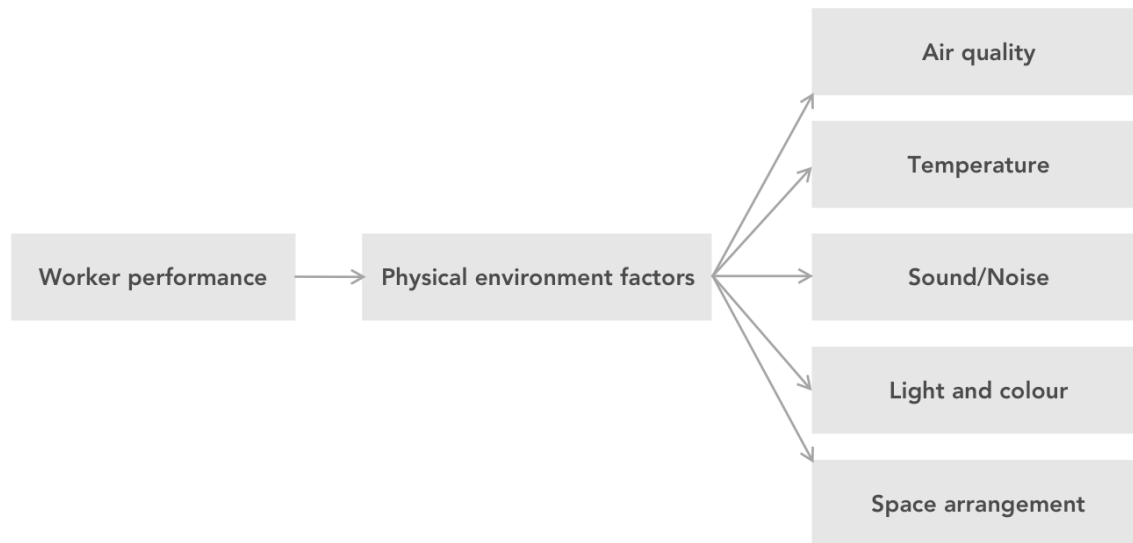


Figure 8. Physical environment factors that affect the worker. Source (The Authors, 2021).

a) Air quality factor

Indoor air quality (IAQ) refers to the quality degree of the indoor air of a building. A workspace with good air quality has higher work performance and productivity (Farahat & Alaeddine, 2020). IAQ has been considered incredibly significant to the health, comfort, and job performance among employees, which might lead to the uncongenial working environment (Abdou et al., 2006). According to Abdou et al. (2006), IAQ has become concerning, since indoor pollutant levels frequently exceed outdoor levels, and, on average, an individual worker might spend up to 90% of time indoors. Some of the most potentially dangerous indoor pollutants are environmental tobacco smoke, organics, odors, and dusts. Furthermore, several diseases are caused or aggravated by poor IAQ, such as allergic and asthma symptoms, pulmonary diseases, respiratory infections, cardiovascular mortality and morbidity and lung cancer (Farahat & Alaeddine, 2020).

b) Light and temperature factors

Light is an environmental cognitive map and a psychophysical driver of human perception (Tomassoni et al., 2015). A workplace without proper and sufficient light might alter the main course of the job efficiency and quality. Employees spend most of their time indoors thus office

tasks are dependent on indoor lighting or any available daylighting, the last one is considered the best source of light for human visual comfort, and creating a positive impact (Farahat & Alaeddine, 2020).

A pleasant room temperature increases productivity and reduces stress in workers as it plays notable role in workplace environment. Chandrasekar (2011) states that high temperatures can have a direct impact on health and lead to heat stress and heat exhaustion. Those can cause increased body temperature, individual lethargy, and tiredness. In general, tasks that require more cognitive, physical, and perceptual functions are the most affected by high temperatures (Badayai, 2012). A study performed by Seppanen & Lei (2006), showed a consistent decrease in tasks' performance when temperature increase above 24-26 °C.

c) Sound/noise factor

Sound is defined by the World Health Organization, (WHO) as any unwanted and unpleasant sound, from diverse sources, that is often loud and disruptive to hearing. Noise is identified as a source of irritation and stress for a lot of people, being a source for different health conditions, including disturbed sleep, hypertension, hearing impairment, disturbance of well-being, and psychiatric disorders (Kanjo, 2009; O'Neil, 2008). People's exposure to noise levels above 65 dBA can cause severe health problems (Kanjo, 2009). In the US, over 22 million workers experience exposures to potential high risk sound levels (Tak, et al., 2009).

Noise is another feature that is affected by the number of human beings in an ambient, being it possible to expect that the noise of a workspace will increase with the number of people there (Abade et al., 2018).

2.7. Smart environments

In order to experience a pleasant work environment and increase work performance, it is essential to know the environment quality in different areas, maximizing users' comfort.

In this context, new terms such as Internet of Things (IoT) and Smart Environments arise. The term IoT was coined by Kevin Ashton in 1999, presented in a context of supply chain management (Ashton, 2009). IoT enables the interaction between physical objects, such as computing devices, mechanical and digital machines, objects, animals, or people, and provides the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. In the

past decade, thanks to rapid advances in elemental technologies, the definition has evolved and became more inclusive, covering areas such as healthcare, domestic sphere, such as assisted living, smart homes, smart cars, and also, in the business sector, increasing quality and services (Shah & Yaqoob, 2016).

Smart Environments, defined as “acquire and applicable knowledge about the surroundings and its inhabitants to improve their experience in that ambiance” (Cook et al., 2007), have become popular in recent years, targeting the automation of everyday tasks in order to improve the quality of life, helping people make things better and faster. A typical example of a system in the context of a Smart Environment is the health monitoring and assistance technology to help elderly live independent lives in their own homes (Abade et al., 2018). Environmental data can be an excellent source of information regarding workspace characteristics (air quality, noise, occupancy, etc.). This particular study will focus on occupancy and noise detection systems. These were considered the key factors, by the authors, when looking for a workspace due to their increasing popularity and search (increasing the occupancy and, subsequently, noise volume).

2.7.1. Occupancy and noise detection

Occupancy detection systems can be classified according to two different approaches: The need of having a terminal or not (Lee et al., 2006). The ones requiring a terminal, it is necessary to attach an object or device to the occupants to keep track of them (e.g., Radio-Frequency Identification (RFID), WiFi and Bluetooth, or Global Positioning System (GPS)). The non-terminal methods require no such devices, instead, the detection can be based on monitoring areas (e.g., Cameras, Environment Sensors) (Abade et al., 2018). Figure 9 illustrates the occupancy detection systems ‘classification and respective examples.

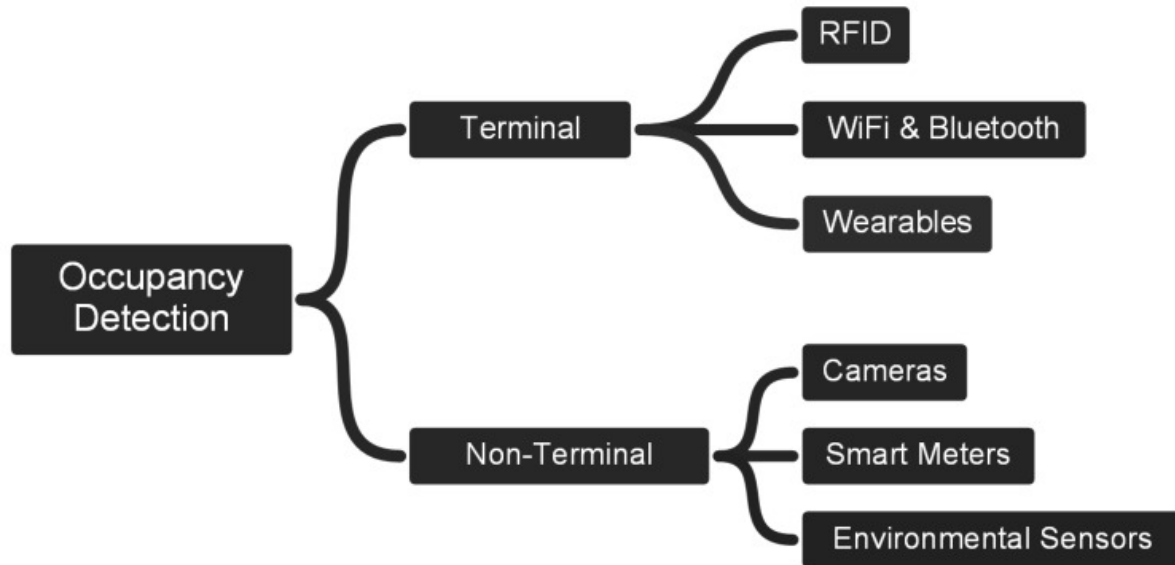


Figure 9. Data model to illustrate the relationship between the system sensors, devices, data objects and users by Abade, et al., 2018.

Many techniques are developed to detect the presence of people, using non-terminal occupancy detection systems. The most popular is to make use of algorithms based on image and video processing. An important issue that must be considered is that these types of devices suffer from privacy or intrusiveness issues, since the algorithms are based on the recognition of object's parts that can represent a person, such as faces, heads, etc. One of these challenges is related to how to preserve occupants 'privacy (Ozaita Araico, 2017). It is desirable to take advantage of the infrastructure available in the area to guarantee the preservation of privacy of the data collected. Nguyen et al. (2015) proposed two cheap and effective solutions to detect if specific seats at a shared public table are occupied. A capacitance sensor, which was placed under the tables to detect both people occupancy and seat hogging. A study performed by Zeeman et al. (2013), showed the capacity of capacitance sensors in occupancy detection on a minibus. Here, the sensor was placed under the minibuses' chairs to detect people's occupancy.

The traditional methods to measure sound pressure levels, according to requirements provided by International standard (2013), implies long and short measurements time periods, using expensive equipment for measurements and data management. Recent developments revealed some low-cost technology presented nowadays, such as inexpensive microphones or applications available for download onto personal smartphones (Hallett, L. et al., 2018). However, some of these solutions

are limited. As for the smartphone's applications they have limitations. In an evaluation of a mobile app, Roberts et al. (2016), found a limit of 90 dBA. Hallett, L. et al. (2018) proposed a low-cost compact noise sensor that measures sound levels and environment temperature, that consists of an electret condenser microphone, an amplifier circuit, and a microcontroller.

3. Methodology

Methodology is known as a discipline that studies, understands, and evaluates various methods available, in order to conduct a scientific study or research. When applied, it examines, describes, and evaluates research methods and techniques that enable data collection and process information, seeking to solve problems and/or questions (Prodanov & Freitas, 2013). The methodology applied for this specific project was an adaptation from Kumar (2013), where the author suggests seven different phases for the creation of a project as follows: Sense Intent (1); Know Context (2); Know People (3); Frame Insights (4); Explore Concepts (5); Frame Solutions (6); Realize Offerings (7). The last phase (Realize Offerings) was removed from this project, due to time and knowledge constraints.

3.1. Phase 1 - Sense Intent

The first step from the methodology before jumping into a project, with the objective of getting a context of the real world and what is changing around us. It is important to look at all changes happening in business, technology, society, culture, policy, etc. In this phase it was intended to gather all the latest news, projects, interviews or groups around the project thematic: Telecommuting and Remote Work. Two different methods were used:

3.1.1. Buzz Report

The intent of this method is to search and understand new developments in our daily lives that can drive to innovation. To understand relevant changes and information, about telecommuting and remote workers, a vast list of sources was used, such as: websites, social media groups, library searches, technology reviews and television documentaries. In this search, different mobile applications, which are famous along the remote workers community, were discovered, however it was possible to identify that the majority of these projects were focused on presenting solutions related to coworking spaces and not third places in general (such as coffee shops, libraries, and others). An example of this is *Liquid Space* (Figure 10), a mobile application where users can choose a coworking space, see their facilities and make their reservation through the application.

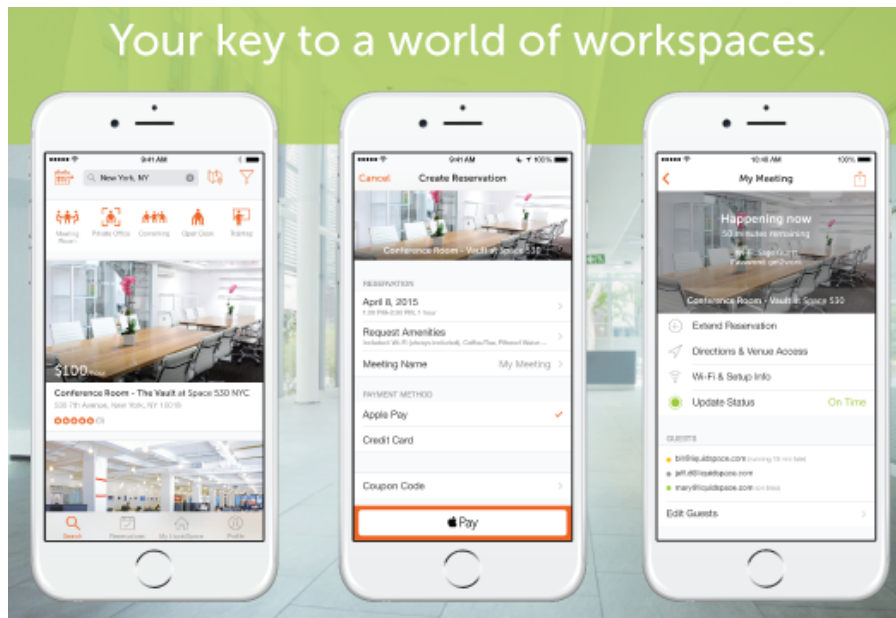


Figure 10. Liquid Space iPhone application (2015).

Another project is *Get Croissant* (Figure 11), where it is also possible to search coworking spaces while seeing what facilities they have. In this mobile application, users can check space’s availability in real time and “Hold a seat” or make a check-in.

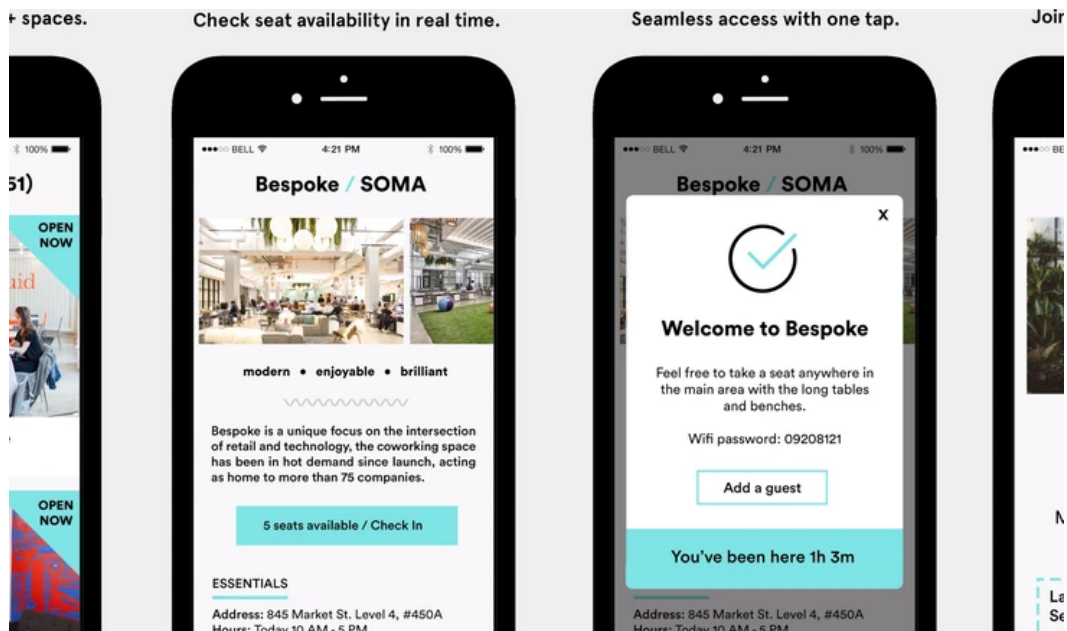


Figure 11. Get Croissant iPhone application (2018).

There are some mobile applications that include all third places as working spaces, however they lack updates (of spaces and information) or user’s contributions, not reflecting the current situation in Portugal. One example is the mobile apps *Workfrom* (Figure 12). *Waitz* (Figure 13) is another mobile application, specifically created for universities, to show how busy their libraries, and dining halls are, in real time. This is a good example of a mobile application that makes use of real-time sensors; however, this application makes use of WIFI and Bluetooth from user’s devices. An overview of this mobile applications features can be seen in Table 1.

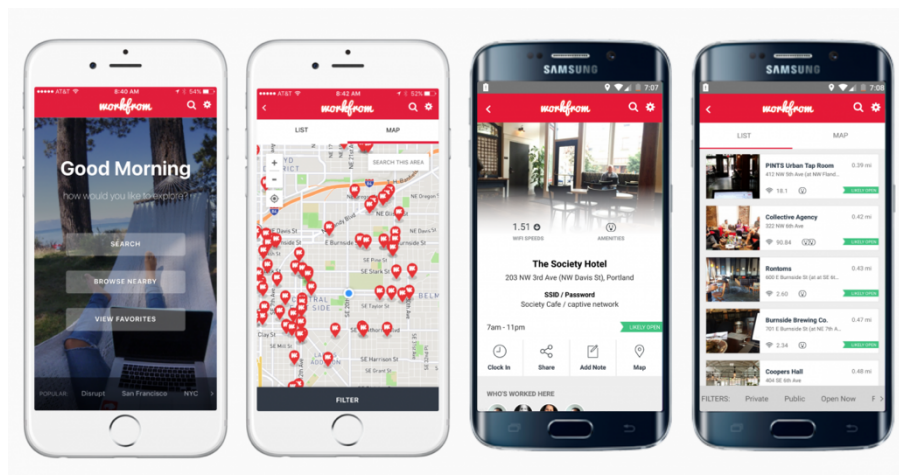


Figure 12. *Workfrom* iPhone application (2015).

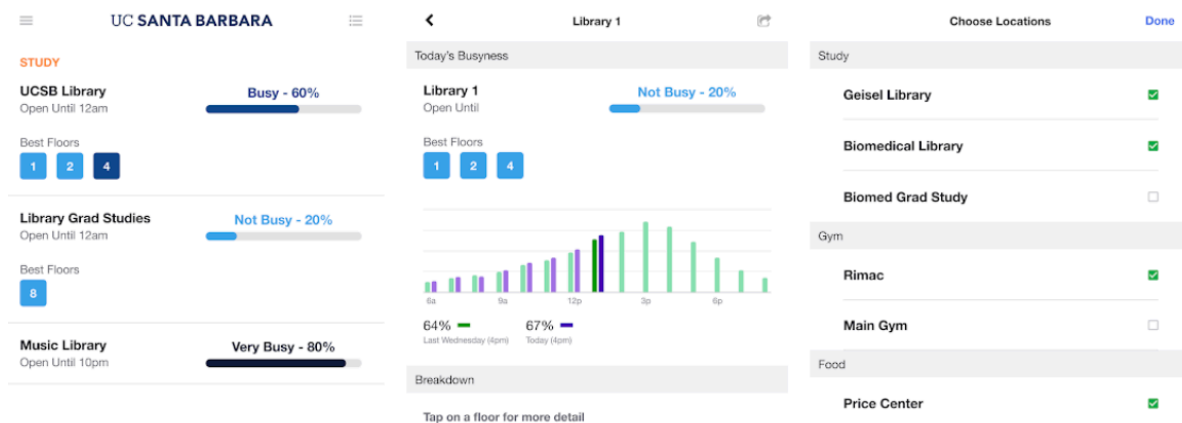


Figure 13. *Waitz University* iPhone application (2019).

Table 1. Mobile applications related to working space search.

	Workfrom	LiquidSpace	Waitz (University)	Get Croissant
Real time data			●	
Info about location, prices and contact details		●		●
Info about noise levels	●			
Info about WIFI speed	●	●		●
Info about facilities (sockets, cables, etc)	●	●		●
Info only on Coworking spaces		●		●
User preferences filter	●	●	● ¹	●
Data tracking sensors				
Device tracking (Bluetooth/WIFI)			●	
Available in Portugal		● ²		●

●¹ Only features about the campus.

●² There is only a few spaces (does not reflect the current situation in Portugal).

3.1.2. Key Facts

This phase's method has the objective of collecting pieces of information from credible sources, such as books, internet articles, educational sites, statistical data, and other places where relevant information, about the topic, may be found. In order to organize the information obtained, a table was created and divided into different categories: title, author, type of document, keywords, abstract and source (Appendix A). It is worth to mention that the table presented was not filled in for all books or scientific papers used in the literature review.

3.2. Phase 2 - Know Context

In the previous phase, it was possible to focus on trends and changes that happened in the world. Here, the purpose is to get a full understanding of the surrounding conditions in which those changes happen, in what context do they evolve. In this phase, the goal is to gain as many insights as possible about the thematic context to get prepared to explore solutions and opportunities.

3.2.1. Subject Matter Experts Interview

This method can help a lot since we are sharing a conversation with an expert in the area, with experience and knowledge. When searching about telecommuting/remote work, it was possible to come across different terms, such as coworking spaces, shared offices, and digital nomadism. When digging about digital nomadism and finding that this is a lifestyle where people work remotely everywhere, the name Krystel Leal kept appearing in the searches. Krystel is a freelancer and digital consultant who works remotely, as a Digital Nomad, since 2017. She is also the creator of the famous Portuguese blog "Nomadismo Digital" where she shares her experience as a digital nomad and helps whoever follows this lifestyle. It was possible to contact Krystel via LinkedIn and email where she kindly shared a vast list of contacts and numerous documents to look at. After, we scheduled an online meeting where I could share the ideas I had in mind and ask a few questions. Some of the questions asked were as follows: 1. Is a Digital Nomad (DN) a Remote Worker (RW)? 2. Can you define a RW? 3. What type of spaces does DN or RW look for? 4. RW look for coworking spaces? 5. How can people look for these particular spaces?

Krystel defined a RW as a person who work remotely in different locations, inside or outside their home country, so it is possible to consider that a DN is also a remote worker. The only difference

is that, unlike the remote worker, the DN is categorized as a traveler. Krystel mentioned that there are no studies focused on RW or DN in Portugal and, for this, it is very hard to validate a person to help.

In Portugal, there are a large number of foreign remote workers looking for spaces where they can concentrate and have all the essential conditions to work since they can guarantee resources, facilities, and a social and professional environment at a cheap price. The coworking paradigm, in Portugal, is growing, however, start-ups and small companies usually look for these spaces, unlike individual workers.

Communities and social media boards are important tools for RW when looking for popular spaces to work, such as coworking spaces. Krystel recognized that some of the existing solutions (related to mobile applications) are focused on the foreign user and never heard of a Portuguese based application.

3.3. Phase 3 - Know People

The main objective in this phase is to know people, our potential users, their motivations, what drives them and everything that is around them in their daily lives. This is known as the “insights phase” since we can get a lot of different insights by observing our user’s behavior in a determined context.

3.3.1. Remote Research

Due to due to COVID-19 pandemic situation, it was impossible to perform focus groups, interviews or any other activity that needed the participant’s presence. For this motive, a Remote Research method was the best option. This method relies on web-based tools for user’s self-documentation studies. With an Internet connectivity, the studies can be conducted simultaneously in multiple locations anywhere in the world without requiring researchers to be out in the field. In order to obtain information, an online questionnaire and interviews were performed through online tools.

i) Online questionnaire

With the help of the online tool *Google Forms*, a questionnaire was carried out, to a group of individuals (n =100). The questionnaire was shared through social media boards and communities (related to digital nomadism and remote work) and, also, sent individually (via *LinkedIn*). The questions concerned their daily life choices, their frustrations, preferences, and challenges when looking for a working space.

ii) Online interviews

The objective of the interviews is to retain qualitative data that, usually it is not possible through online questionnaires. 8 individuals were contacted, through email, and agreed to participate in semi-structured interviews, where open-ended questions were asked in a written format. The results can be found in the next chapter.

3.4. Phase 4 - Frame Insights

The purpose here is to structure all the information obtained and learned in the last three phases. With these frame insights it is possible to start moving from the research data to applying various analytical frameworks with the patterns that we have found until now.

3.4.1. Observations to Insights

Since research produces a number of observations about people and context, the objective of this method is to think through all of these observations and extract valuable insights. Insights for this study were gathered through research (literature review), questionnaires and interviews. Some of the insights obtained were as followed:

- Remote work is rapidly growing (In Portugal, 6.5% of the population is working remotely in 2020).
- Remote work is not only for Digital Nomads.
- Most of the remote work happens at home (Due to comfort, time constraints and family matters).
- Feelings of loneliness and distractions are reasons that lead people to different working spaces.

3.5. Phase 5 - Explore Concepts

According to Kumar, this is the phase to start thinking about our opportunities for the future and explore new ideas and concepts.

3.5.1. Persona Definition

The term “persona” was originally introduced by Cooper (2003). A persona is a fictional character that represents user's characteristics. The creation of personas can help designers understand, describe, focus, and clarify user’s goals and behavior patterns. A persona is originally composed by text and a picture representing the user (Cooper, et al., 2007). According to Pruitt & Adlin (2006), the ideal number of personas is three to five for each project. Based on the data collected from the survey, interviews and literature review, four personas were created, following four different variables: Demographics (1), Work interests and locations (2), Motivations and frustrations (3) and Preferences when working (4). (See chapter 4). The personas are represented in the next chapter.

3.6. Phase 6 - Frame Solutions

The last phase is characterized for the combination of compatible and valuable concepts into systemic solutions that are actionable for future successful implementation. Here, low-fidelity prototypes were created using *Invision* software, in order to perform moderated usability tests. For this phase we used two different methodologies, as follows:

3.6.1. Solution Diagramming (Navigation Plan)

Diagrams are visual tools that are used to visually represent different possible forms/solutions of navigation within an application. There are different diagram types that can be used, such as matrix, map, tree, bar, pie, flow, and Venn (Kumar, 2013). For this particular study, a flow diagram was used.

3.6.2. Solution prototype (Think Aloud)

A solution prototype is a method in which users are observed engaging with a system or a proposed solution. Through this observation, the researcher can understand if their proposed solution is

either valid or not (Kumar, 2013). Usually, these prototypes are tested in a simulated environment with the help, notes, audio, or video recording (Kumar, 2013). In order to get more information and insights about the proposed system, the Think-aloud method was proposed. Think-aloud protocol method refers to a type of research data used in empirical research processes. Data gathered is known as “thinking aloud”, meaning that participants in the test are asked to verbalize their thoughts, while performing a task (Nielsen, 2012).

4. Project Development

4.1. Definition of the project

According to the literature review on remote work on Chapter 2, this project will propose a system that can help remote workers' efficiency when looking for a space to work in, based on their analyzed preferences. According to Lee (2018), the new types of workers, such as the remote workers, are choosing to work in places such as coffee shops, libraries, or coworking spaces, knowing as third place, due to advantages like free WIFI and free or cheap space to work. Therefore, the project takes into consideration these spaces typology and their preferred attributes by remote workers. The findings on remote workers' preferences and the proposed system' usability, supported by this study, can provide insights for designers while designing or developing working spaces related applications, or even owners creating those spaces.

The proposed system is based on different environment sensors that send information to the users' device (e.g., smartphone) through a mobile application. The collected data will send users information about the space's occupation, noise levels and WIFI speed (mentioned on Chapter 4 as three of the most important attributes by remote workers). The proposed system is composed by an interactive smartphone mobile application. The illustration on Figure 14 can help identifying the relationship between the places, system sensors, data base and devices. In this thesis, the smartphone application interfaces were designed and evaluated.

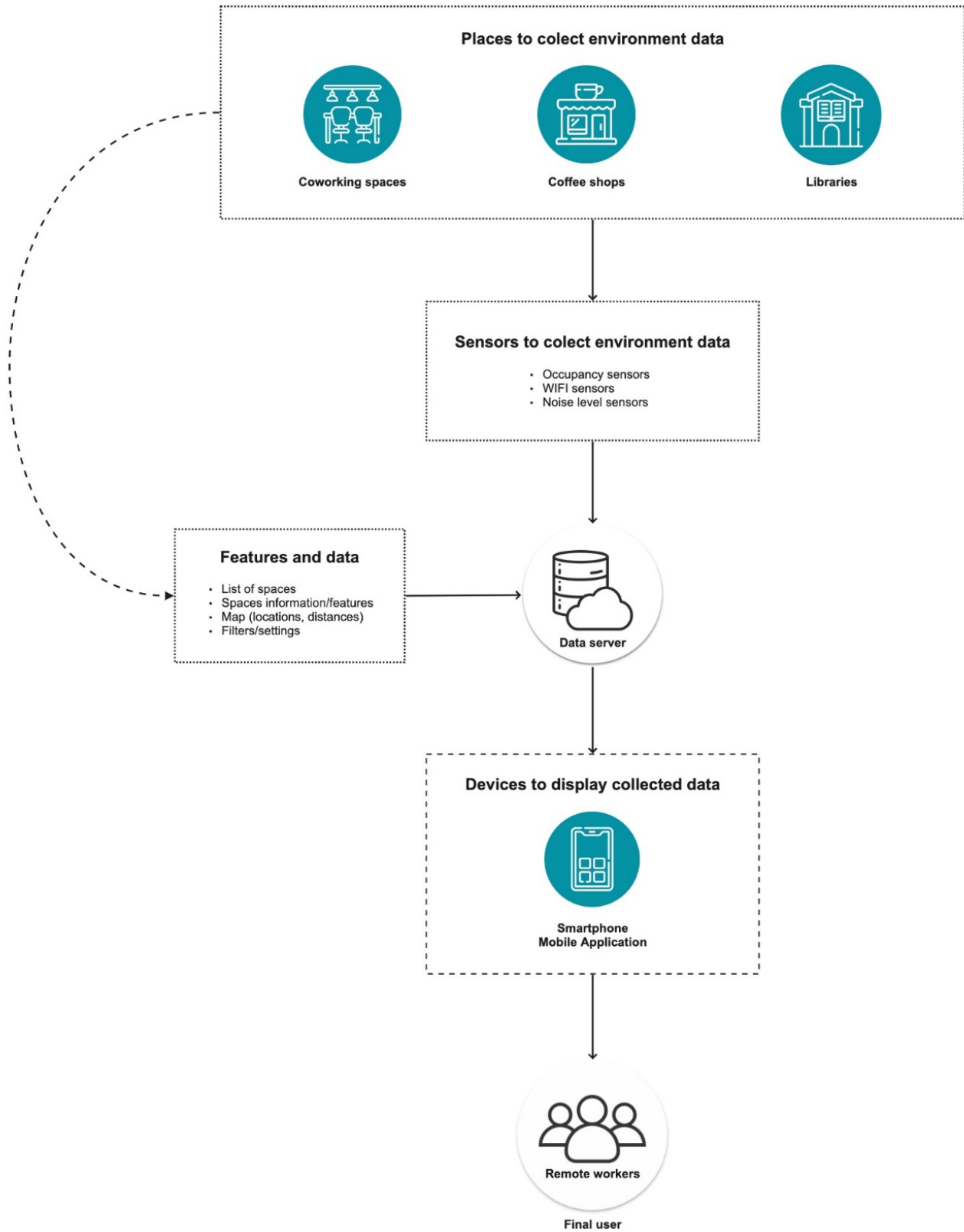


Figure 14. Data model to illustrate the relationship between the system sensors, server, devices, data objects and users.

4.2. Ideation

A flowchart is a diagram of user flows and tasks in a system process. The purpose of this method was to visually represent different possible forms of navigation in the application.

The proposed system was divided into four categories: (1) Map of spaces; (2) Filters' page; (3) Working spaces; (4) List of spaces, as represented in Figure 15 of navigation plan.

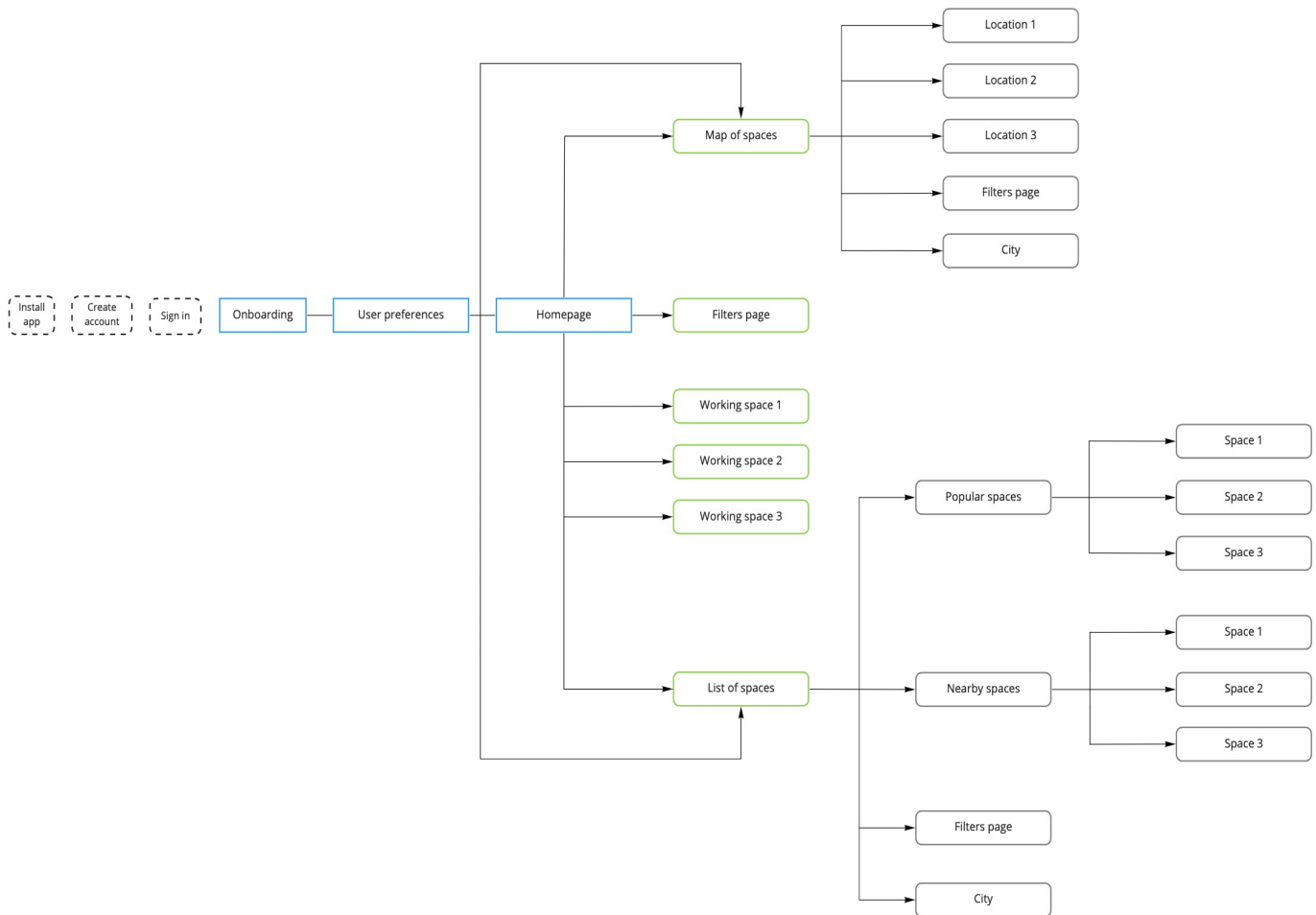


Figure 15. Navigation Plan.

4.3. Phase I – User studies

The primary research material was collected in the form of a questionnaire that contained open-ended questions that also served as a basis for the interviews, conducted in April-May of 2020.

The mentioned methods were the basis for the creation of this study' personas.

4.3.1. Questionnaire

Method

At first, a survey was carried out, which was tested in the form of an online questionnaire, through *Google Forms*. To validate the instrument, namely regarding any difficulties and doubts when filling it out, the questionnaire was presented to a small group of individuals (n =10). As this study takes place in Portugal, two different surveys were made, one in English and other in Portuguese, in order to reach the maximum number of people working remotely in the capital (since some could be foreigners). Finding participants for the questionnaire and the interviews was surprisingly tough, as most social media boards and communities do not really let users in or even publish posts asking for a response to surveys and research; However, it was possible to publish in a few social media groups related to digital nomadism and remote work. Another strategy found was to send it individually to people online (mostly through *LinkedIn*). The survey remained open until 100 answers were reached. The questions concerned their daily life choices, their frustrations, preferences, and challenges when looking for a working space. The full list of questions can be found in the Appendix B.

Procedure

The participants were invited to fill in a 5–10-minute online questionnaire with a total of 25 questions. The questionnaire was divided into 5 different sections: demographic data (age, gender, nationality, education, and occupation), company's stance on remote work (in order to filter who can work/works remotely), individual's preferences on working spaces, struggles and frustrations when looking for working spaces and opinions related to mobile applications and its information.

Results and discussion

The results of 100 respondents are shown in Table 2. Although this is a small sample, it is possible to see that it consists of a close number of male (53%) and female (47%) remote workers. These numbers can be compared with numbers provided by Deskmag (2019), where the survey showed that, compared to early years, female members in coworking spaces have been rising steadily for years, so, it is possible to note that the number of females working remotely is rising. The age of the remote workers is in the Y generation (30-45 years). Most respondents are highly educated

(89%), which means they have completed at least a higher vocational education. It is possible to divide the respondents into 5 different categories: Employers (43%), Self-Employers (16%), Freelancers (33%), Students (5%) and Out of work (3%).

Table 2. Participant's demographic data.

	Total (N=100) n (%)	EW (N=43) n (%)	SE (N=16) n (%)	F (N=33) n (%)	S (N=5) n (%)	OFW (N=3) n (%)
Gender						
Female	47(47)	20(47)	5(31)	17(52)	2(40)	3(100)
Male	53(53)	23(53)	11(69)	16(48)	3(60)	0(0)
Age						
18-29	35(35)	17(40)	4(25)	6(18)	5(100)	3(100)
30-45	62(62)	24(56)	12(75)	26(79)	0(0)	0(0)
>45	3(3)	2(4)	0(0)	1(3)	0(0)	0(0)
Nacionality						
Portuguese	87(87)	39(90)	13(81)	30(91)	5(100)	0(0)
European	4(4)	2(5)	1(6)	0(0)	0(0)	1(33)
American	6(6)	2(5)	2(13)	2(6)	0(0)	1(33)
African	3(3)	0(0)	0(0)	1(3)	0(0)	1(33)
Education						
High school graduate	12(12)	6(14)	4(25)	1(3)	0(0)	0(0)
Bachelor's degree	56(56)	25(58)	5(31)	18(55)	5(100)	3(100)
Postgraduate degree	11(11)	3(7)	3(19)	5(15)	0(0)	0(0)
Master's degree	19(19)	8(19)	2(13)	9(27)	0(0)	0(0)
Doctorate degree	3(3)	1(2)	2(12)	0(0)	0(0)	0(0)

EW = Employed for Wages; SE = Self-Employed; F = Freelancer; S = Student; OFW = Out of work.

The percentages of places where respondents work outside their formal office places/workplaces are shown in Table 3. Based on Kojo and Nenonen (2016) study (mentioned in Chapter 2), respondents were presented with the question “What location do you primarily work from?”, in order to identify which working spaces are more people among remote workers. The choice options were coffee shops and cafés (third places), coworking spaces (shared offices/spaces), libraries, and parks (public spaces) and homes. It is very interesting to find that the top choice is not coworking spaces. Instead, the first choice is Home which is chosen by more than a half of the samples (85%). Coworking spaces are the second highest chosen choices (6%), followed by Coffee shops and cafes (5%). The lowest rank was public spaces, such as Libraries and Parks (1%). There were also respondents that mentioned personal offices and shared offices (1%).

Table 3. Participant's preferences when choosing a location to work.

	Total (N = 80)	EW (N = 30)	SE (N = 16)	F (N = 32)	S (N = 2)
	n (%)	n (%)	n (%)	n (%)	n (%)
What location do you primarily work from? (N = 80)					
Coffee shop and cafes	4(5)	1(3)	1(27)	2(13)	0(0)
Coworking spaces	5(6)	1(3)	3(0)	1(8)	0(0)
Home	67(85)	26(87)	11(63)	29(73)	1(50)
Libraries	1(1)	0(0)	0(0)	0(0)	1(50)
Park	1(1)	0(0)	1(0)	0(0)	0(0)
Other (somewhere with a 4g internet)	1(1)	0(0)	0(0)	0(0)	0(0)
Other (Personal office / Shared office)	1(1)	2(7)	0(0)	0(0)	0(0)
What is the second most common location that you work from? (N = 80)					
Coffee shop and cafes	21(26)	7(23)	6(38)	8(25)	0(0)
Coworking spaces	23(28)	7(23)	5(31)	11(34)	0(0)
Home	15(20)	6(20)	2(12)	6(19)	1(50)
Libraries	12(15)	4(13)	3(19)	4(13)	1(50)
Park	7(9)	5(17)	0(0)	2(6)	0(0)
Other (somewhere with a 4g internet)	1(1)	0(0)	0(0)	1(3)	0(0)
Other (Personal office/ Shared office)	1(1)	1(4)	0(0)	0(0)	0(0)

EW = Employed for Wages; SE = Self-Employed; F = Freelancer; S = Student; OFW = Out of work.

Furthermore, participants were asked about the main motives to choose these places to work, to understand what drives remote workers' looking for spaces to work outside home. As can be seen in Figure 16, most participants mentioned "Comfort" (24%) as their main motive. This can be associated with the previous question "What location do you primarily work from?", in which people mentioned "Home" as their preferred location, since workers give high value to homelike environment (Weijs-Perree et al., 2019). "Affordable/Free accommodation" (13%) and "Social interaction with co-workers" (13%) were found to be the most important second motive, followed by "Peace and quiet" (10%), "Work resources" (10%) and "Productivity" (10%). A study performed by Kojo and Nenonen (2017) suggested that the main drivers for the creation and evolution of the coworking spaces phenomena were: New ways of working, Attractiveness, work-life balance, economy efficiency (low price, and short-term lease contracts) and sustainability (sharing facilities and equipment). It is possible to observe that some of those drivers were also mentioned by the participants of this questionnaire, such as "Affordable/Free accommodation" (as in economy efficiency) and "Work-life balance".

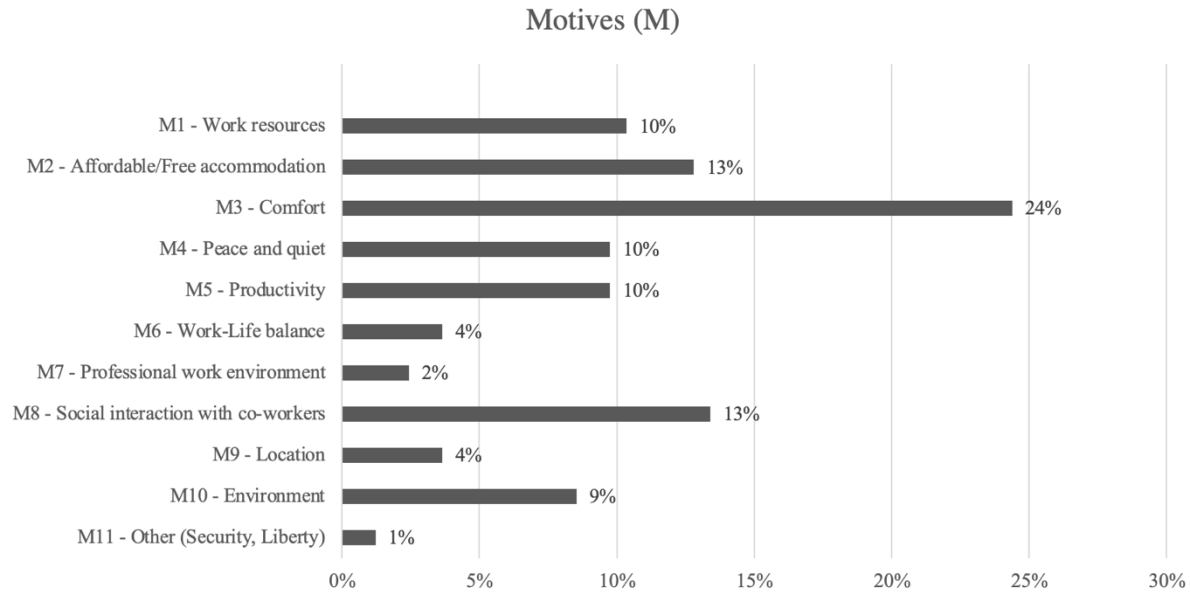


Figure 16. Remote worker's main Motives (M) when choosing places to work.

The preferred attributes of working spaces, rated by the participants, can be seen in Figure 17. The choice options were: Location, Silence, WIFI quality, Price, Space dimensions (such as number of chairs, tables), Supporting equipment (such as sockets, cables) and Environment quality (air, light). Respondents attach more importance to “WIFI quality” (25,1%), “Location” (22%) and “Silence” (17,5%). The least important workspaces attributes are “Supporting Equipment” (13,5), “Price” (11,2%) “Plenty of space” (5,8%) and “Environment” (4,5%). Respondents also mentioned Security, and Liberty as attributes (0,4%). It is possible to link these answers with the data from previous question “What location do you primarily work from?”, where people mentioned “Home” as their preferred location. At home, people usually have more control on the facilities and environment, such as silence and, for instance, a reliable WIFI connection. In Weijs-Perrée et al. study, in 2019 (mentioned on Chapter 2), participants mentioned accessibility by car or public transport as an important attribute along with atmosphere, which can be related to the answers “Location” and “Environment” by the participants of this questionnaire.

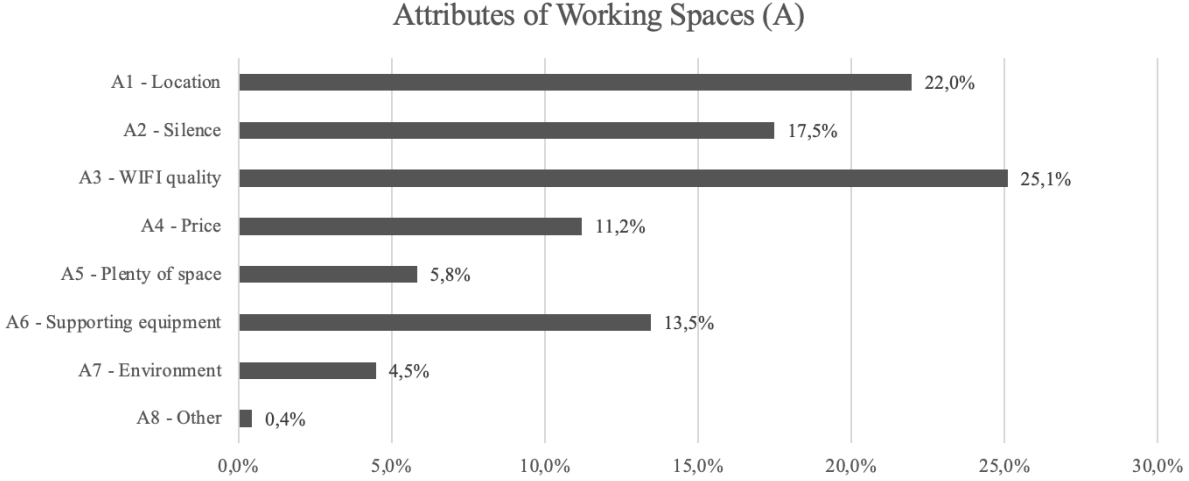


Figure 17. Most rated working spaces Attributes (A) by remote workers.

Respondents were asked to mention which struggles are the most common when working remotely. As can be seen in Figure 18, most participants mentioned “Distractions/Interruptions” (38%) as the most common struggle. The second most common struggle is “Feelings of loneliness/Lack of interaction with others” (28%), followed by “Other” (13%) which includes “Knowing when to stop working” and “Family duties”. As mentioned in Chapter 2, the possible lack of social and professional interaction, isolation, and the blurred boundary between a private and a professional life can lead to a search for different working spaces (Leclercq-Vandelannoitte & Isaac, 2016). This is logical as the mentioned struggles can be related to participants’ answers in this questionnaire.

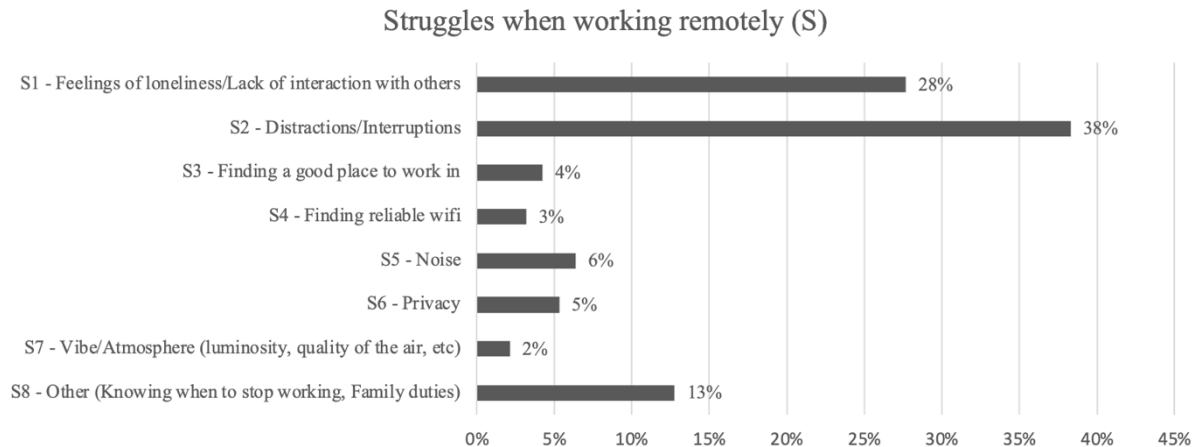


Figure 18. Struggles (S) that the majority of remote workers face when working remotely.

In order to understand what channels were used by remote workers when searching for a working space, they were asked about the platforms used in this situation (Figure 19). 40% of the participants refers a simple *Google* search as the only tool/platform. 26% do not use any platform when searching for a space and 13% mentioned “Other”, which includes *Trello*, *Slack*, *Timeout*, *Gitlab* and *OLX*. Only 2% of the participants mentioned “Coworking apps”. The fact that only 2% mentioned “coworking spaces” can be related to the lack of coworking spaces applications in Portugal, mentioned in Chapter 1.

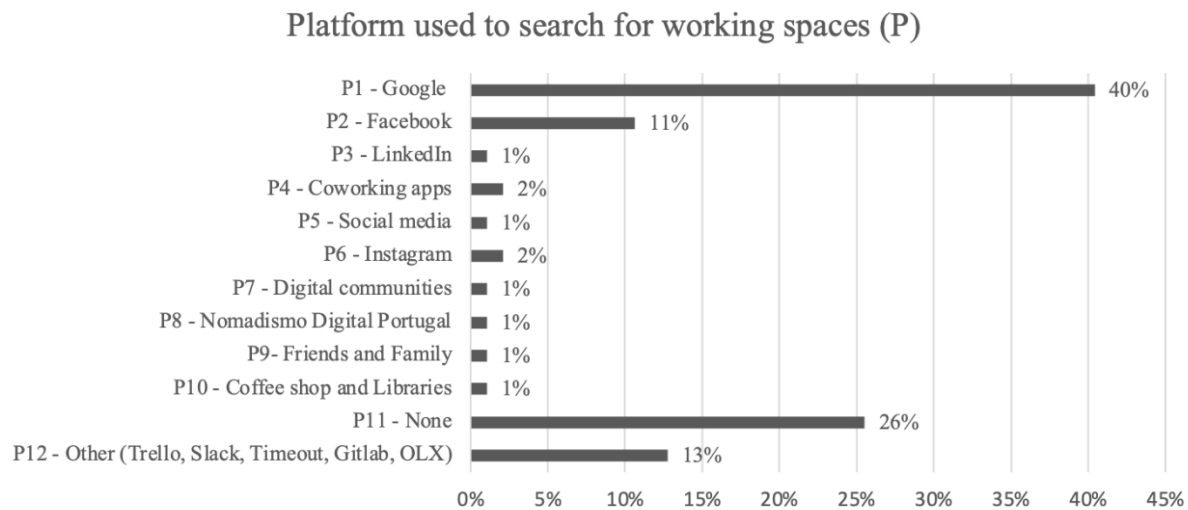


Figure 19. Most common platforms (P) used by remote workers to search for a working space outside home.

Participants were asked about their ease in finding a space to work. As seen in Figure 20, the majority mentioned 3 (28%) and 4 (28%) on the Likert scale. 23% of the participants finds it extremely easy to find a space to work outside their home. 5% considers extremely hard to find spaces to work.

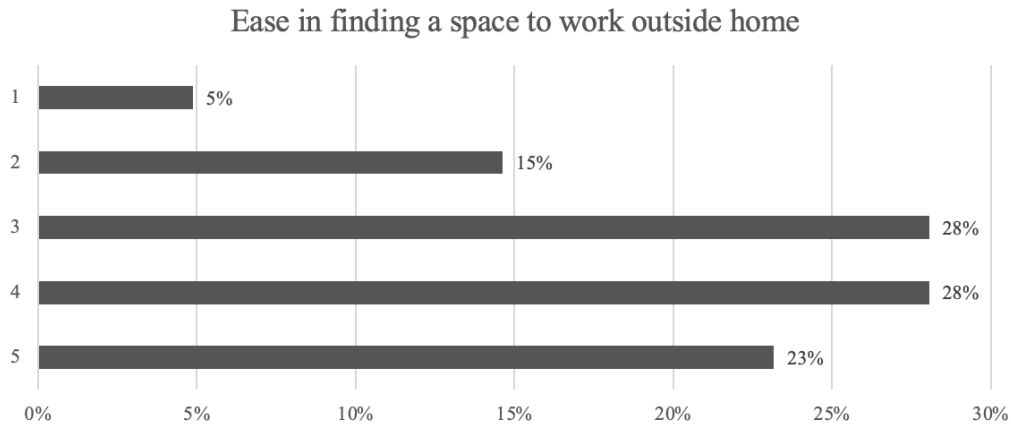


Figure 20. Remote worker's ease in finding a space to work outside home.

Participants were asked about their ease in finding information related to working spaces, such as location, price, and facilities. As seen in Figure 21, the majority mentioned 3 (38%) and 4 (25%) on the Likert scale, finding it somehow easy to find that information. 23% of the participants finds it extremely easy to find information online. 1% considers extremely hard.

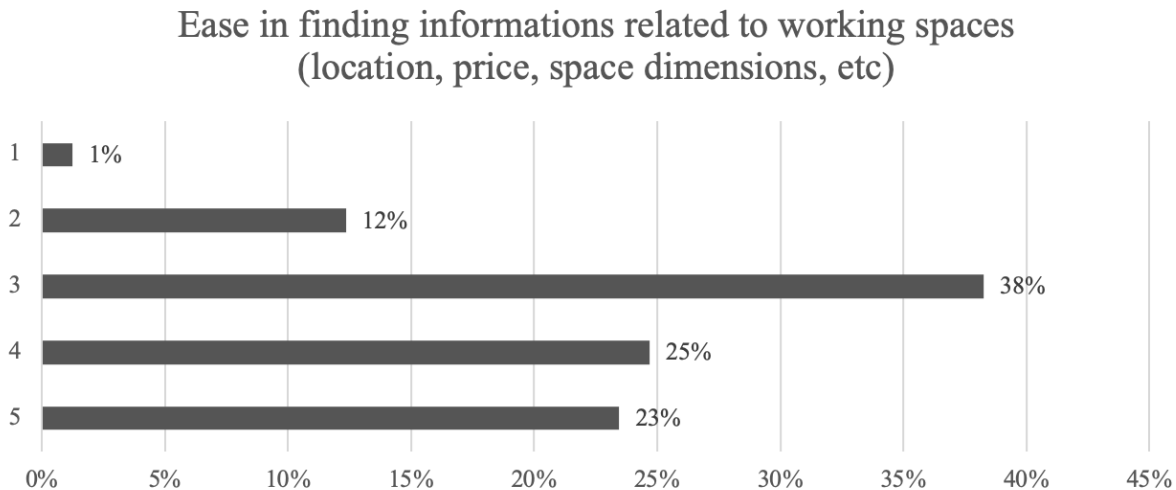


Figure 21. Remote worker's ease in finding information related to working spaces.

In order to understand if remote workers would use this study's proposed system, participants were asked how likely would be for them to use an application that could show them information about working spaces around them. The majority (30,5%) mentioned that it would be "Moderately

likely” that they use an app with these. 2,4% showed the most interest mentioning “Extremely likely”. 17,1% did not show much interest in this type of application, mentioned “Not at all likely” (Figure 22).

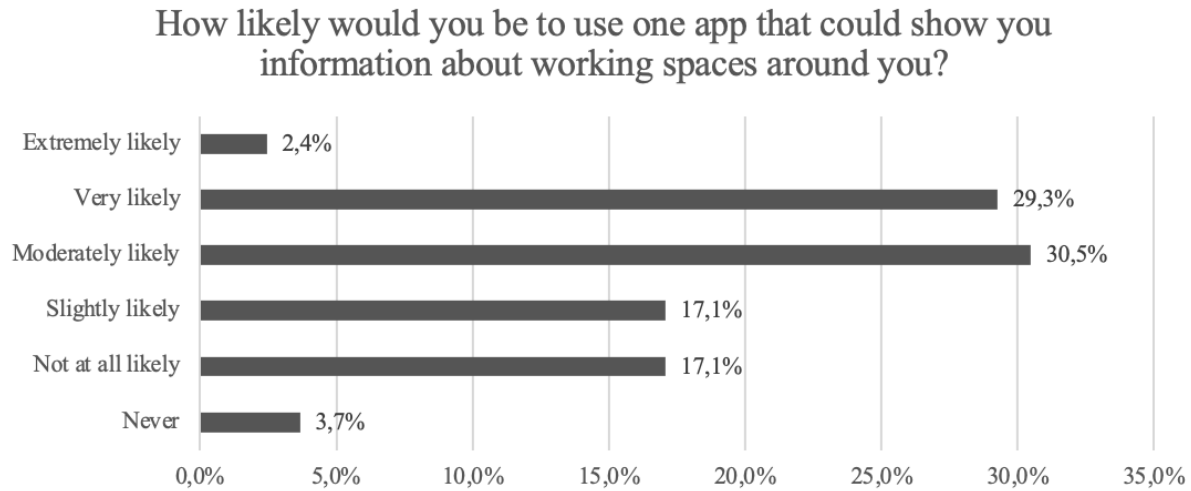


Figure 22. How likely Remote workers are to be use an app that can show them information about working spaces.

Since this study has a relatively small sample size (n=100), the results were interpreted with care. The sample consisted of a close number of male (53%) and female (47%) remote workers. Compared to early years, female members in coworking spaces have been rising steadily for years, so, it is possible to note that the number of females working remotely is rising (Deskmag, 2019). It is possible to conclude that this sample can be representative of the population.

This study also showed that remote workers prefer to stay at home, which can be related to their comfort and high value to homelike environment (Weijts-Perree et al., 2019). However, as a second choice they would go for third places (such as coworking spaces and coffee shops). They prefer these spaces probably because one of their motivations to work at a co-working space is the opportunity for interaction with other coworkers (Sykes, 2014). CWS have been referred as preferable than coffee shops due to distractions, self-motivation problems, and feelings of isolation (Spinuzzi, 2012). Distractions/Interruptions and feelings of loneliness/lack of interaction with others were struggles that remote workers mentioned in this study. These are considered a disadvantage of working at regular office or at home (Fuji et al., 2014).

The results showed that WIFI quality and location were the most preferred attributes in a working space. Regarding the type of workers that dwell these spaces (e.g., small and large firms, employers, freelancers) (Parrino, 2015), it might be important to rely on a good internet connection due to online meetings or other type of work that needs a stable WIFI connection. Also, coworking space members often choose a working space that is near their home for a better work-life balance (Capdevila, 2013). Price was also mentioned as one of the preferred attributes, which can be related to the increased number of self-employed people are looking for an affordable workspace outside their home (Moriset, 2013).

It was found that the majority of remote workers rely on Google to search for a working space that can meet their needs. Only a small percentage of workers in this study mentioned CWS' apps as a tool to search for these spaces. It is possible to relate this to the lack of coworking spaces applications working in Portugal (see Chapter 3).

4.3.2. Interviews

Method

The interviews occurred via email. Semi-structured interviews, with open-ended questions were sent to the participants in a written format. The objective of the interviews was to retain qualitative data that it was impossible to collect from the questionnaire.

Procedure

Despite the initial difficulties, it was possible to contact 8 individuals: 6 Freelancers, 1 Employed for Wages and 1 Self-Employed. The interviewees were aged between 26 and 45. ($M= 36$, $SD=6.67$) through email, who volunteered to participate in the semi-structured interviews. The full interview script can be seen in Appendix C. The topics of the questions and were as following:

- > What is your occupation?
- > Are you currently working on your occupation?
- > What is your main reason for exercising your occupation remotely? What influenced you to choose this lifestyle?
- > In your experience, after searching the Internet and finding a place to work, how easily do you find information about it? What kind of information is easier to find?

- > What need would make you use an application related to workspaces? (Ex: Price information; Information on the number of people / companies; Be quick and practical, etc.).
- > Do you currently know any application that provides you with some type of information regarding Workspaces? If so, which one/which ones?
- > Have you worked or currently work in a Coworking Space? If so, what do you like best when using these spaces?

Results and discussion

The majority of the interviewees mentioned schedule flexibility and freedom as the main reasons to pursue the remote lifestyle. Other standing reasons was comfort and a pacific lifestyle. The increased need for flexibility (DeSanctis, 1984) and freedom/ individual control over the pace of work are commonly mentioned advantages of working remotely (Olson et al., 1995).

Interviewees stated that it is somehow hard to find information about workspaces, depending on the type of information needed. The majority mentioned location as the easiest information to find online. Prices, internet speed, and spaces' schedule were considered the hardest information to find. This information can be compared to the question "How easy is for you to find information related to working spaces" mentioned in this study's questionnaire, where the majority of respondents answered 3 on a Likert scale, corresponding to a "ok".

Fast and consolidate information, and the necessity of social interaction with others were reasons, mentioned by the interviewees, to consider using a mobile application when searching for a working space. Professionals decide to join a CWS, or look for third places, when needed to find a space outside home, away from the distractions of home and with a social atmosphere (Oldenburg, 2002). Related to this, majority of the interviewees are working, or worked in a CWS before, and the presented reasons were distractions at home, social interaction with other remote workers and need to be part of a community.

When asked about mobile applications, related to working spaces information, the majority revealed having no knowledge about this type of applications. Only two of the interviewees mentioned the application "Workfrom". As mentioned in Chapter 1, this application includes all third places as working spaces, however it lacks updates (spaces, reviews, information) and or user's contributions, not reflecting the current situation in Portugal.

4.3.3. Creation of Personas

Based on the data collected from the survey, interviews, and literature review, four different personas were created, according to the four groups we were able to identify during this study: Persona that represents Employed for wages (Pedro), Self-employed (André), Freelancer (Ana), and Student (Maria). The personas created were important to identify the different remote professionals. For the precision of the proposed system, it is important to be tested with potential users, to verify if it meets their characteristics, needs, limitations, and expectations.

Each persona was defined according to the following variables:

- 1. Demographics:** such as age, gender, location, and employment status. This data was obtained by the first group of questions on this study's questionnaire. The most frequently answered was taken in consideration in order to define these variables.
- 2. Work interests and locations:** Data obtained from question "Where do you primarily work from" (questionnaire), and "What's the main reason for you to work remotely?" (interviews).
- 3. Motivations and frustrations:** Data obtained from question "What are your biggest struggles when working remotely" (questionnaire).
- 4. Preferences when working:** "Which of the following do you value the most in a working space" (questionnaire).

The personas are represented in Figures 23, 24, 25 and 26.

Employed for wage representative personas

Pedro, male, age 40 (Generation Y), Portuguese, bachelor’s degree, working remotely as a marketer for a marketing company. Pedro has a home office, and he is a total fan of working at home, since it is more profitable and comfortable. However, he gets a lot of distractions at home since he has a big family and a dog. At hard times, Pedro loves to work outside the house in coffee shops or libraries, since he can have some similar conditions to his home office (i.e., internet connection, tables and chairs, sockets). While looking for these spaces, Pedro seems to have some troubles when trying to find if the place is full, quiet or if it is free. Pedro is not a big fan of mobile apps, however, he mentioned that he would use an app that could show him some space’s features, such as seat availability, price, location and some descriptive photos. *“Would love to find a space to work differently than a coworking space. I’d love to see seat availability, location and prices in a search.”* (Figure 23).

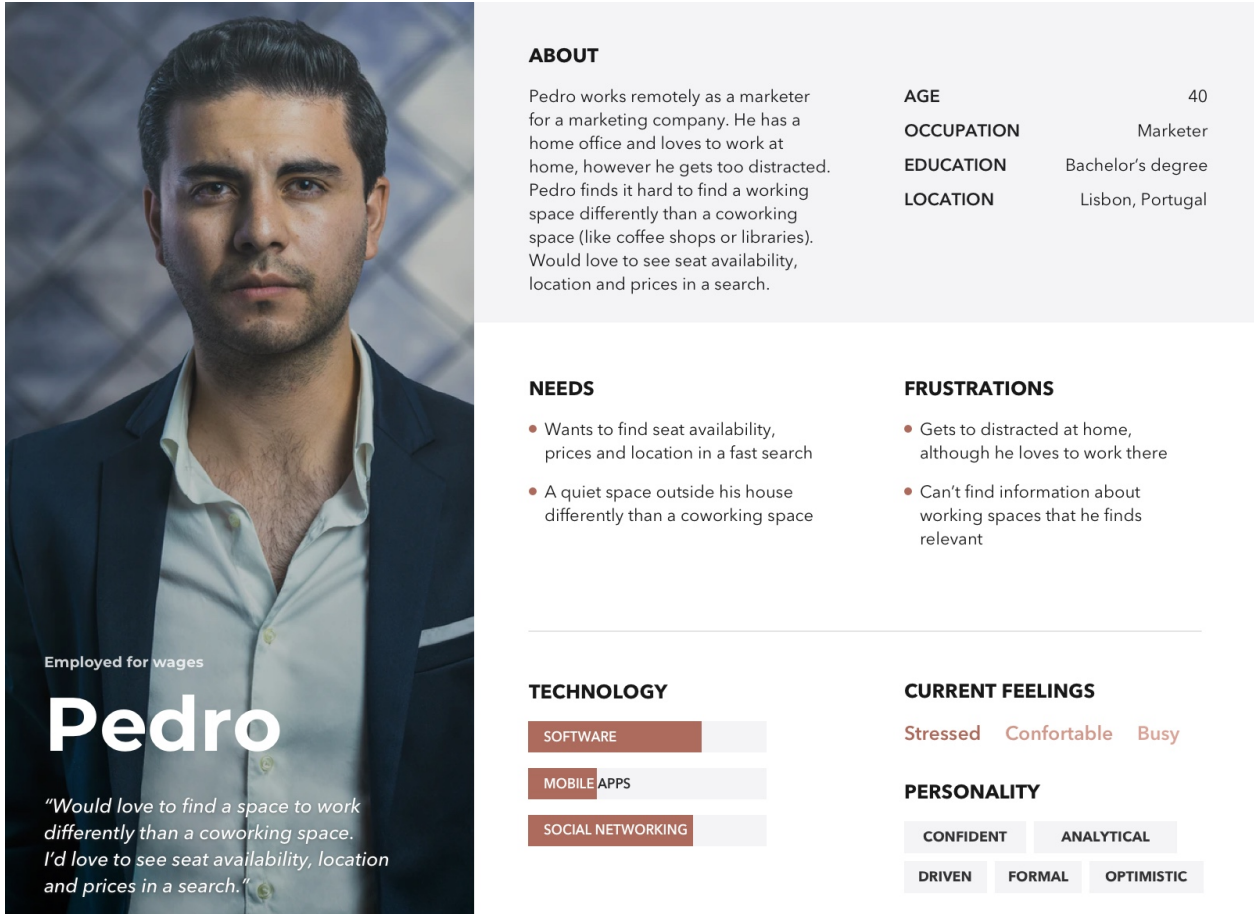


Figure 23. Summary of an Employed for wages representative persona.

Self-employed representative persona

André, male, age 30 (Generation Y), Portuguese, high school graduate, works remotely as a computer engineer for 7 years. Although his first choice, when looking for a workplace, is his home, since he can have a healthier lifestyle and some liberty with low costs, André loves coworking space’s communities, having it as his second option. When looking for a coworking space, André mentioned that he is sure that there are more spaces than the famous ones and would like to have an application in his smartphone that could show him a variety of spaces. *“Having an app in my smartphone that could show me every local where I could work without leaving the house would be great. It could show me the quality-price ratio and location.”* (Figure 24).

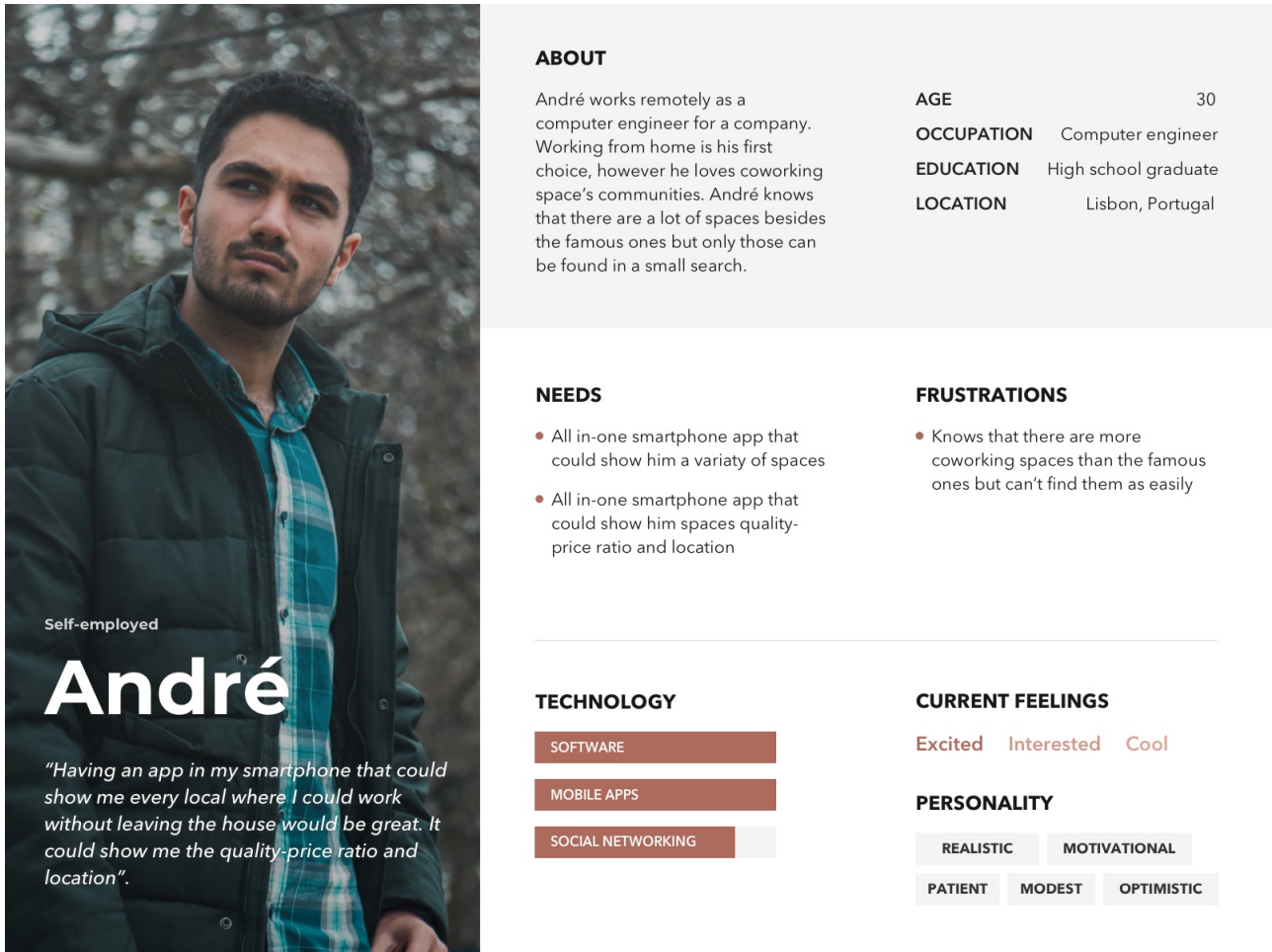


Figure 24. Summary of a self-employed representative persona.

Student representative persona

Maria, female, age 22 (Generation Z), Portuguese, bachelor's degree, student. Even though Maria was never employed in a company, she usually finds it easier to study remotely/outside her house. For that, Maria goes for Libraries as a first option. In libraries, she can focus, since she values silence and finds it hard to work with a lot of interruptions or distractions. She can also have access to work resources (books and academic papers). Maria wants to experience other workspaces; however, it is difficult for her to find a silent place such as libraries. Her biggest frustration is the lack of tools/sources to find good places to work in a fast way. Since she has no time to lose, due to college deadlines, she uses Google in order to find a place to work. *“When looking, I use Google, since it is faster, and I can easily find what I need.”* (Figure 25).

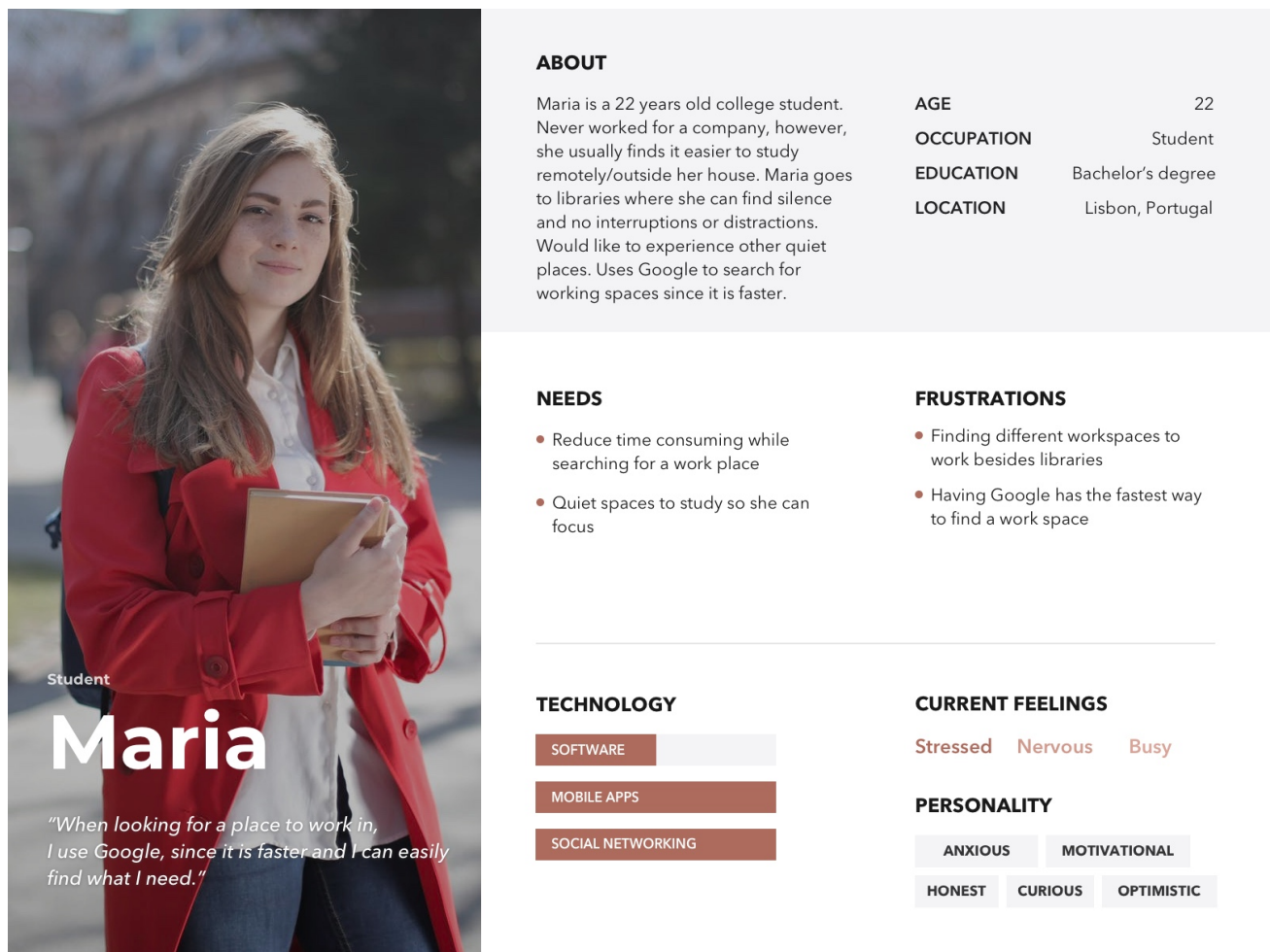


Figure 25. Summary of a student representative persona.

Freelancer representative persona

Ana, female, age 32 (Generation Y), Portuguese, bachelor’s degree, working as a digital product designer in a freelance regime. When looking for a place to work, she usually remains at home due to comfort, reliable WI-FI and good time flexibility. However, Ana usually feels lonely and misses the interaction with others and loses her focus on work, that is why, when looking for a second place to work in, the option lies in coworking spaces, libraries or coffee shops when it is close to her, since she values location. In workplaces, Ana has a preference for silent places and a fast WI-FI. When looking for a place to work in, internet search comes along as the first method to find the best place, although it does not show a lot of options, only the famous ones. A fan of new technologies and user of smartphone applications. *“If I could find a place with certain characteristics, by my preferences, in a single place such as my smartphone, I would definitely use it.”* (Figure 26).

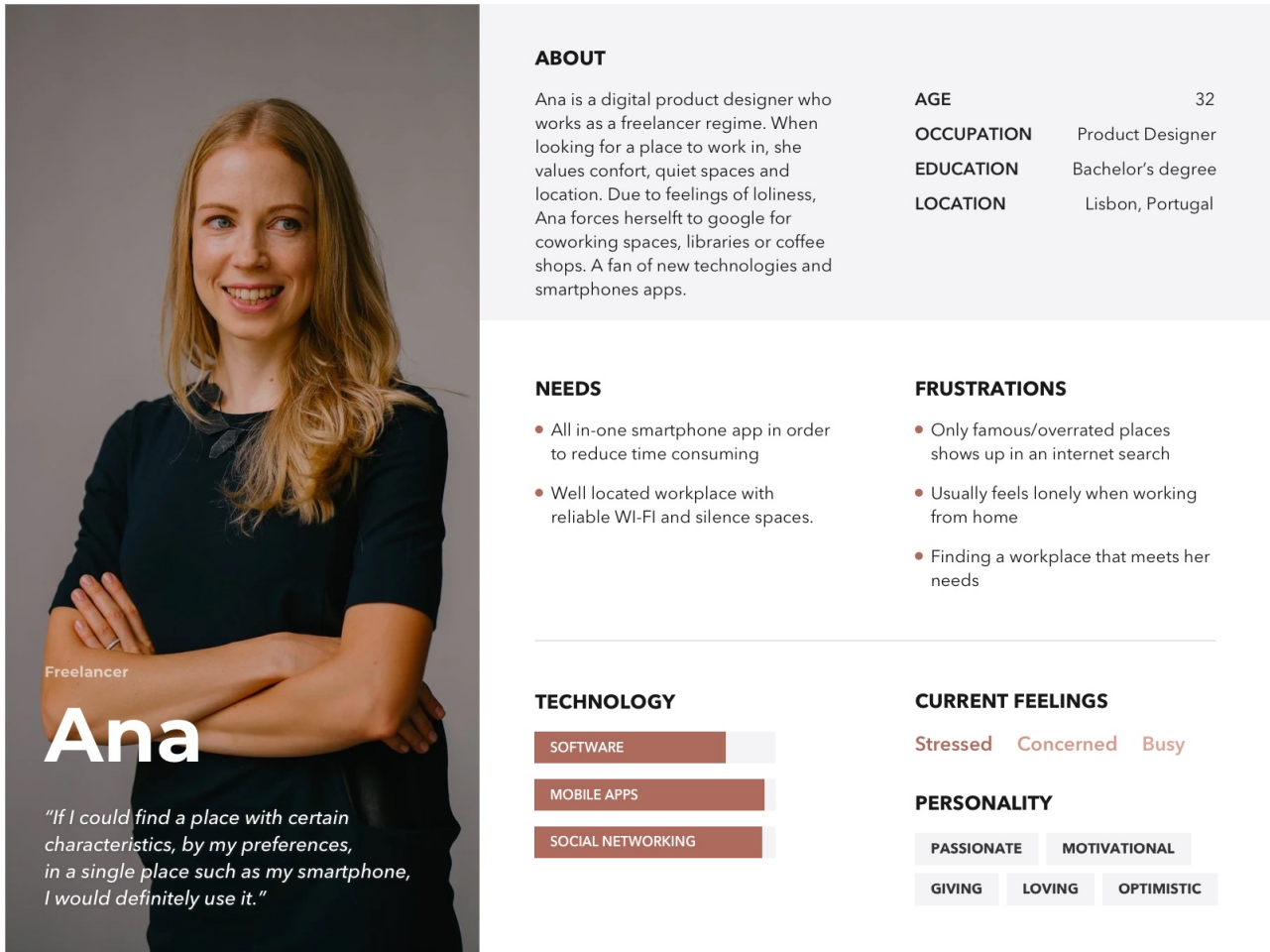


Figure 26. Summary of a freelancer representative persona.

4.4. Phase II: Prototyping and evaluation

On this thesis, two iteration moments were done to evaluate the usability of the proposed system prototype. The iterations were divided as: (i) Pilot Study, and (ii) Main Study.

(i) Pilot study. Where it was possible to test a small version of the main study, to ensure that the proposed methods were viable. It is considered a crucial process, even if it does not guarantee success in the main study, it increases that probability (Van Teijlingen & Hundley, 2002) Here, a low-fidelity prototype was tested with the help of the Think Aloud protocol. Think-aloud protocol method refers to a type of research data used in empirical research processes. Data gathered is known as “thinking aloud”, meaning that participants in the test are asked to verbalize their thoughts, while performing a task (Nielsen, 2012). The results are presented in section 4.4.1.

(ii) Main study. The same prototype had been further developed, after identifying and correcting errors and usability problems, and an internal moderated Think Aloud test was conducted. Additionally, participants were given tasks to perform. Results are presented in section 4.4.2.

4.4.1. Pilot study

In the pilot study a low-fidelity prototype was tested. The use of a low-fidelity prototype is an efficient way to search design space, predict preferences in the actual product, enhance user participation in the design process and enable visualization of the possible design (Virzi et al.,1996). The low-fidelity prototype plays an important role to check and test its functionality rather than the visual appearance (Hartson & Pyla, 2012).

The proposed system interfaces are presented on Figures 27 and 28. The low-fidelity prototype is available at:

<https://projects.invisionapp.com/prototype/where2workckeyb84f900218e01kfr00op6/play/5788cfe2>

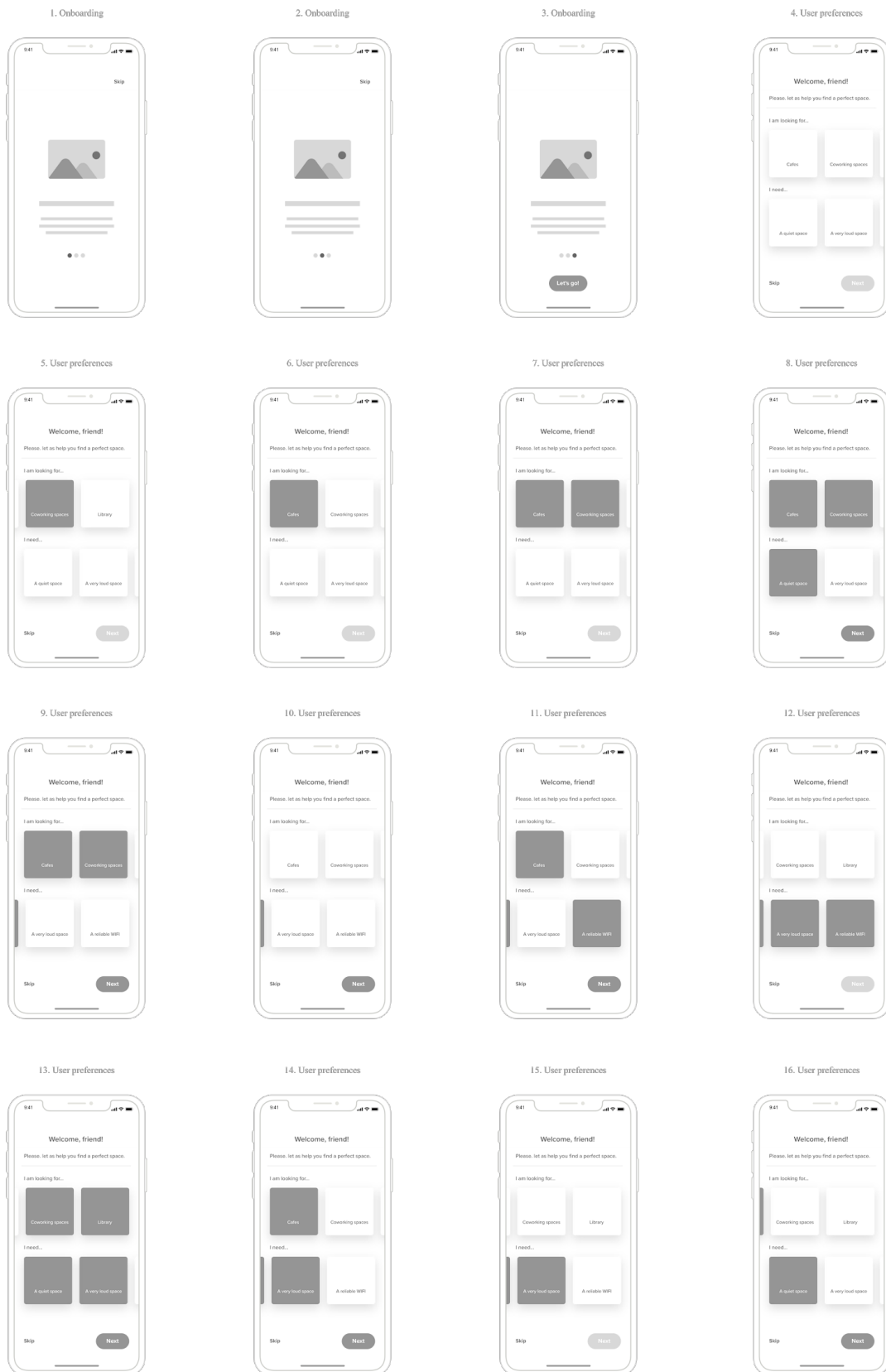


Figure 27. Low fidelity prototype interface. A higher resolution version of the figure is available at: <http://bit.ly/2NgccPm>

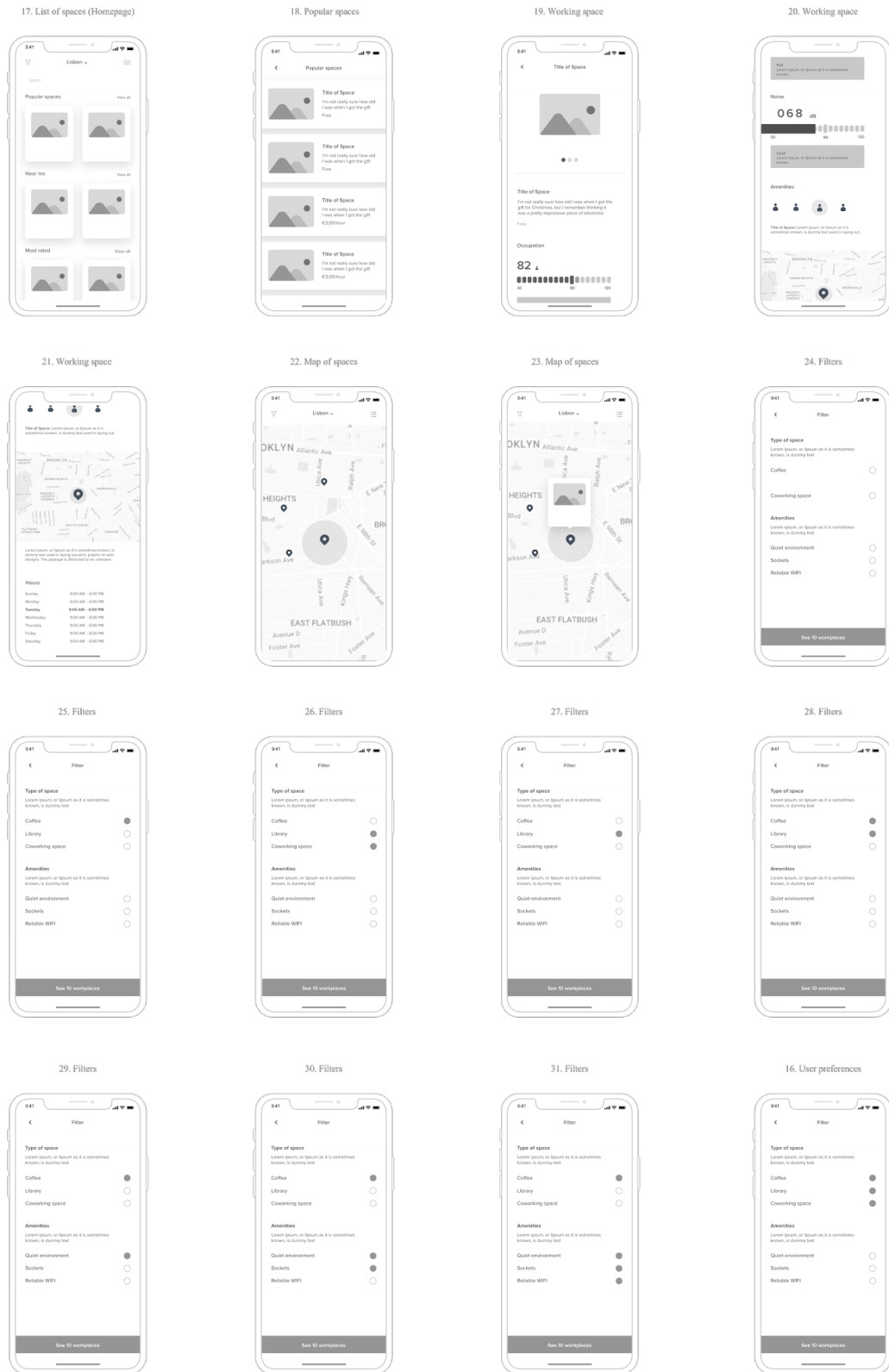


Figure 28. Low fidelity prototype interface. A higher resolution version of the figure is available at: <http://bit.ly/2LBKCM2>

Participants

Five participants, between 18 and 27 years of age ($M=23.8$, $SD=4.08$) volunteered in this experiment. Inclusion criteria were working remotely/telecommuting or desire to work remotely for a day. 1 participant was a student, 1 was a freelancer and 3 participants were employed for wages. Five users were considered enough for the emergence of a consistent pattern (Nielsen, 2000).

Procedure

The participants were informed about the general objectives of this study and signed an informed consent form before each session. All sessions were video recorded and then subsequently transcribed to produce verbal data. The sessions were scheduled individually and had a maximum duration of 15 minutes. Tests were conducted using a mobile device provided by the researcher. For security purposes, participants were asked to sit 2 meters apart from the researcher and the device's screen was properly sanitized between each session. Participants were asked to navigate through the application while verbalizing their thoughts. Procedure was done in 2 stages:

Briefing. The participants were informed about the general objectives of this study and signed an informed consent form to be recorded. A pre-questionnaire was applied to obtain participant's data regarding demographics, work experience and experience/contact with mobile applications related to working spaces. Additionally, a cover story was given to the participants so that they could get familiar with the objective and purpose of the study. Cover Story: Imagine you are working remotely for a company. You have a home office; however, you get too distracted and there is too much noise so you cannot focus on your work. There are a few working spaces from your knowledge, but you do not want to waste your time going there and turning back if they do not meet your expectations. Luckily, you know a mobile app that can help. Having this scenario in mind, you are invited to operate with the mobile application and verbalize your feedback and critics and describe what you are looking and/or trying to do.

Think-aloud protocol. The users performed think-aloud protocol to find usability problems they face within each interface of each given task.

Results and discussion

Although the pilot study consisted in a small sample, it was possible to find a consistent pattern related to interface, iconography, visual, and terminology. All participants were familiar with remote work and mentioned past experiences with mobile applications related to working spaces. Overall, the participants were able to navigate through the application without major problems and it was possible to notice that some interface options were already familiar (e.g., back buttons, filter options, search bar). Participants showed satisfaction and interest related to the real-time information shown on screen. Some of the iconography presented in the prototype raised some questions and the size was considered small (see Figure 29). Only one out of the five participants were familiar with the term “amenities” used in the prototype. The researcher highlighted and described each usability problem while participants were interacting with the system. The problems found were sorted into 4 categories: labelling, visual consistency, terminology, and interaction (see Figure 30) and, later, resolved in further development.

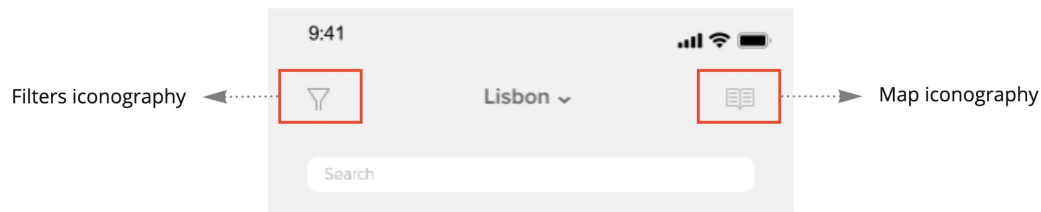


Figure 29. Prototype iconography: lack of labelling, small iconography and poor visual representation.

Usability problem	Category
Selecting only one filter option at the beginning prevents user from moving further in the process	Interaction
Overall small touch targets	Interaction
Lack of iconography labelling	Labelling
Iconography too small	Visual consistency
Wrong use of iconography for representation of a map	Visual consistency
User's weren't familiar with the terminology "Amenities"	Terminology

Figure 30. Usability problems categorized.

4.4.2. High fidelity prototype

After the first usability iteration, it was applied a design review on the low-fidelity prototype, according to the identified usability problems. With this review, the prototype evolved to a high-fidelity prototype. A high-fidelity prototype is a prototype which is more similar to the final product and often made with the same methods, interactions, and techniques as the final product (Walker, et al., 2002). The high-fidelity prototype takes into consideration more detailed interfaces, well-designed icons, more complete task sequences, and carefully worded messages (Hartson & Pyla, 2012).

To define a color palette for the high-fidelity prototype, the context of the product was considered first. The intention was to provide the sensation of trust, security, and confidence and for that reason the Blue teal color was defined as a primary color (Cantwell, 2015). The white and grey comes to bring contrast with the primary color (Figure 31).

The design review of the proposed system interfaces is presented on Figures 33, 34 and 35.

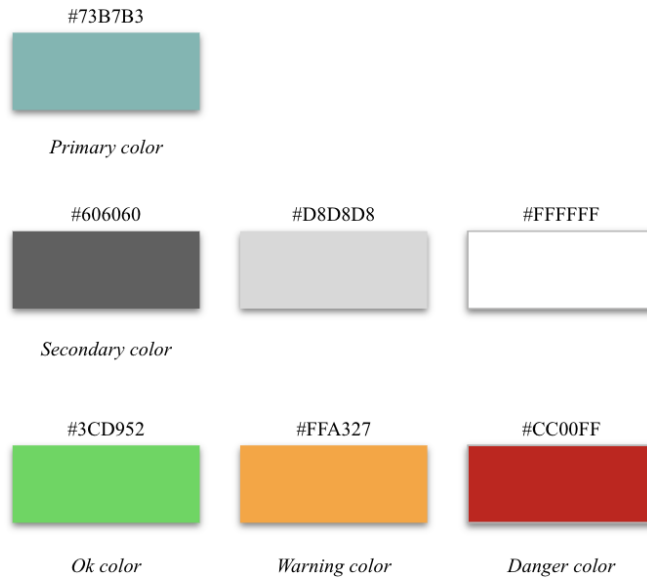


Figure 31. High-fidelity prototype color palette.

The chosen font was Montserrat (Figure 32).

ABCDEFGHIJKLMNOPQRSTUVWXYZ
 abcdefghijklmnopqrstuvwxyz
 1234567890
 !@#\$%^&*()_+=[]{}:;' "\|/.,

Figure 32. Montserrat font style

The high-fidelity prototype is available at:

<https://projects.invisionapp.com/prototype/where2workckipu0u4c002ktk012pvva4fh/play/5788cf-c2>

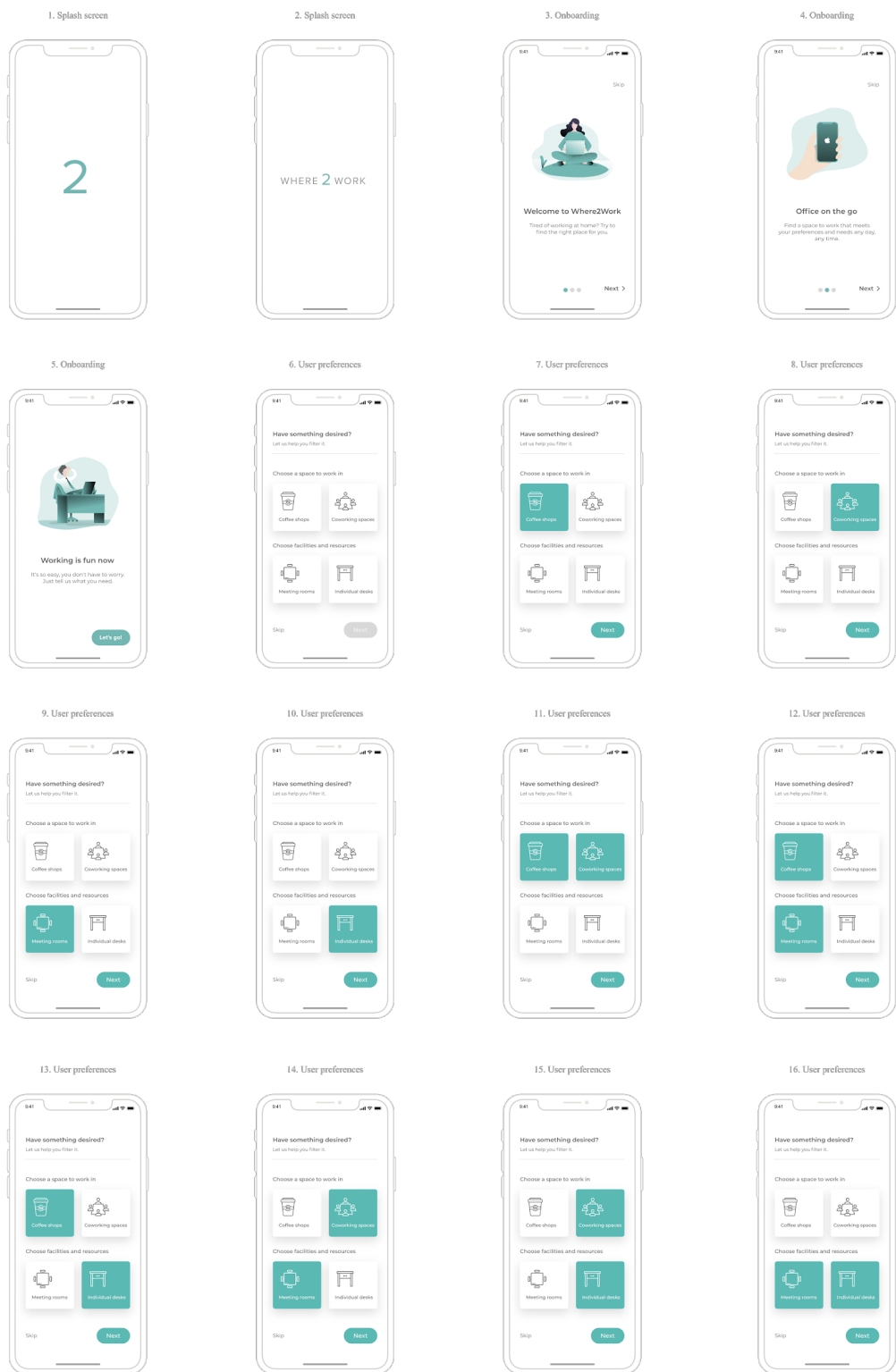


Figure 33. High fidelity prototype interface. A higher resolution version of the figure is available at: <https://bit.ly/3a5FQjk>

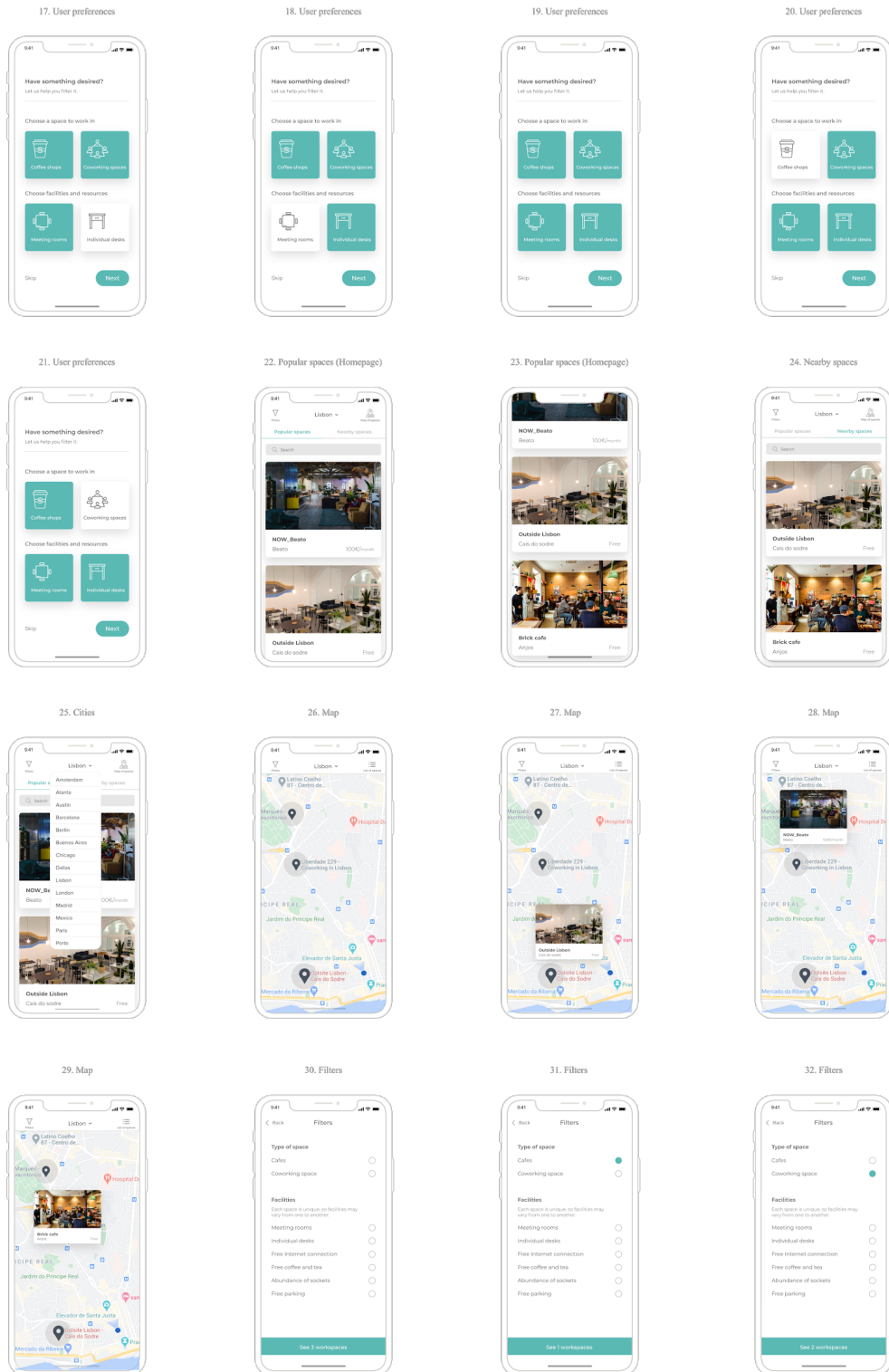


Figure 34. High fidelity prototype interface. A higher resolution version of the figure is available at: <http://bit.ly/3aUiaOg>

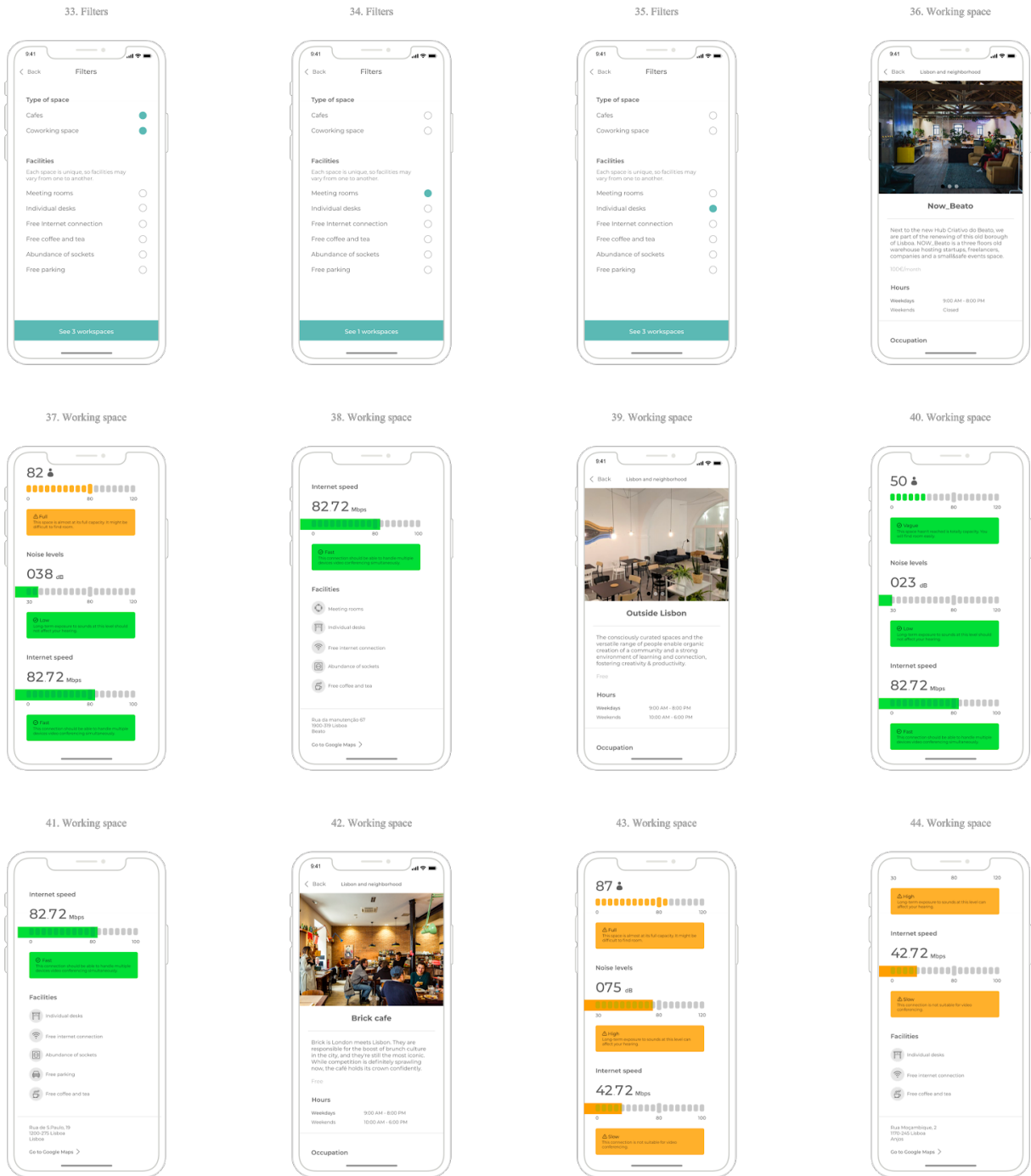


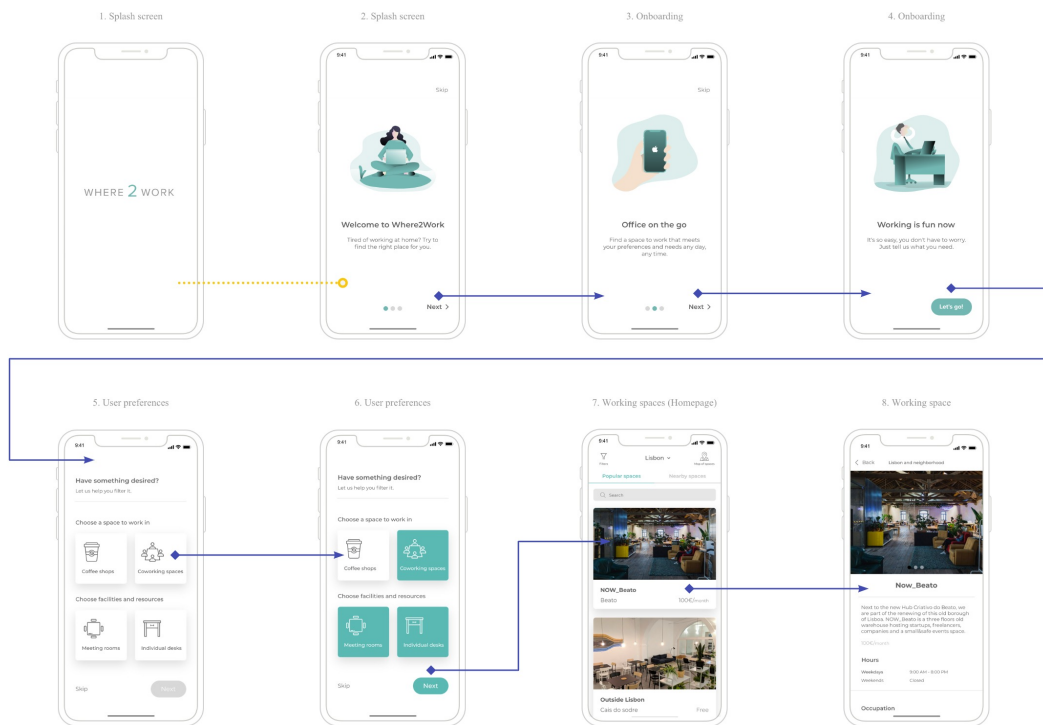
Figure 35. High fidelity prototype interface. A higher resolution version of the figure is available at: <http://bit.ly/2Z5JBis>

Participants

Ten remote workers, between 19 and 32 years of age ($M=25.7$, $SD=4.79$), participate voluntarily in this study. 3 participants were between the ages of 18 to 24 and the 7 remaining participants were aged between 25-34 years. 1 participant was a student, 1 was a freelancer and 8 participants were employed for wages.

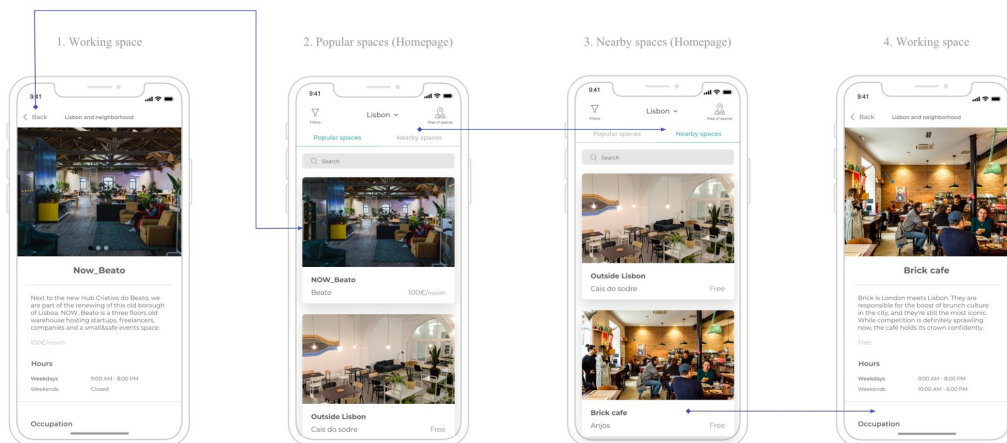
Procedure

The same procedure was applied as in the Pilot Study. Due to different circumstances, related with the COVID-19 pandemic, the main study was performed as online remote sessions through the application *Zoom*, where participants shared their computer screen while performing the given tasks. The flow of each task is shown in Figure 36, 37, 38, 39 and 40. Additionally, after each session, users evaluated the prototype according to the System Usability Scale (SUS), to quantify the users experience on product satisfaction. The SUS, developed by John Brooke in 1996, is a 10 items questionnaire using a 5-point Likert scale numbered from 5 (as “Strongly agree”) to 1 (as “Strongly disagree”) and, if any item gets no answer, it should be assigned as a 3 (the center of the rating scale) (Brooke, 2013).



miro

Figure 36. User flow of Task I: You need to work in a quiet space and also make video calls. Find a coworking space with individual desks and meeting rooms. A higher resolution version of the figure is available at: <https://bit.ly/3p4dNFr>



miro

Figure 37. User flow of Task II: You do not take public or private transportation but walk to the workplace. Choose a place that is closest to you. A higher resolution version of the figure is available at: <https://bit.ly/2Oss4iv>

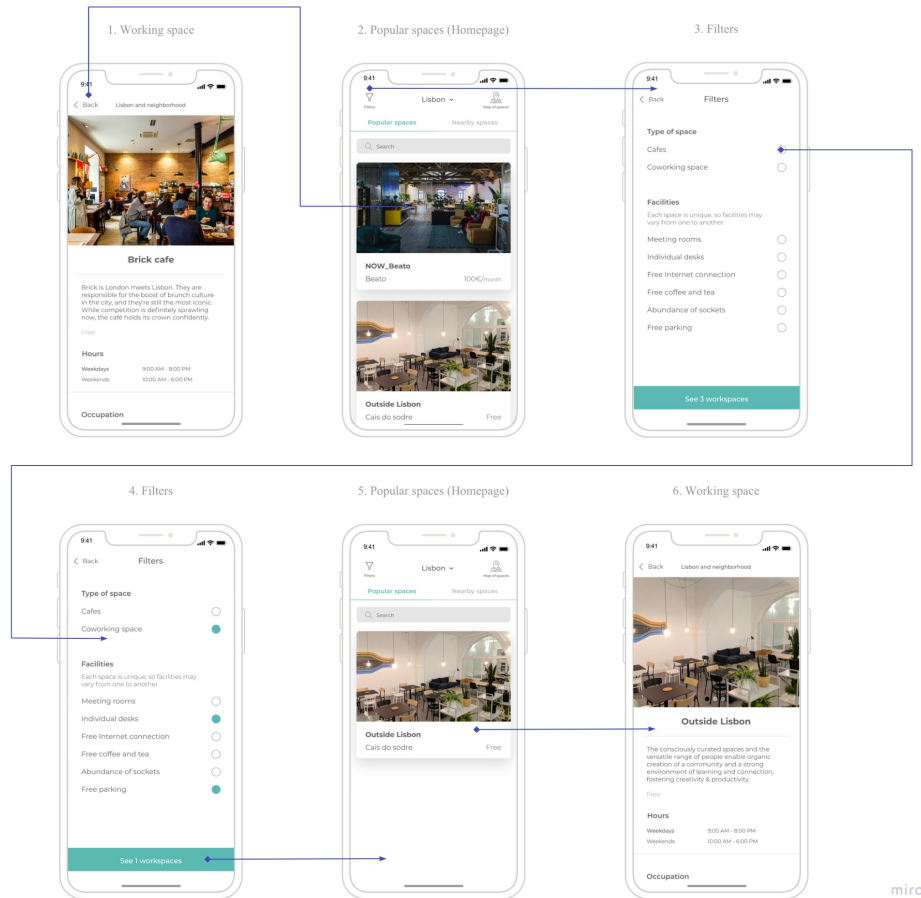


Figure 38. User flow of Task III: You want to use your car to go to the workplace due to the rain and also you need individual desks to spread your paperwork. Find a coworking space with individual desks and free parking lots. A higher resolution version of the figure is available at: <https://bit.ly/3pcASFQ>

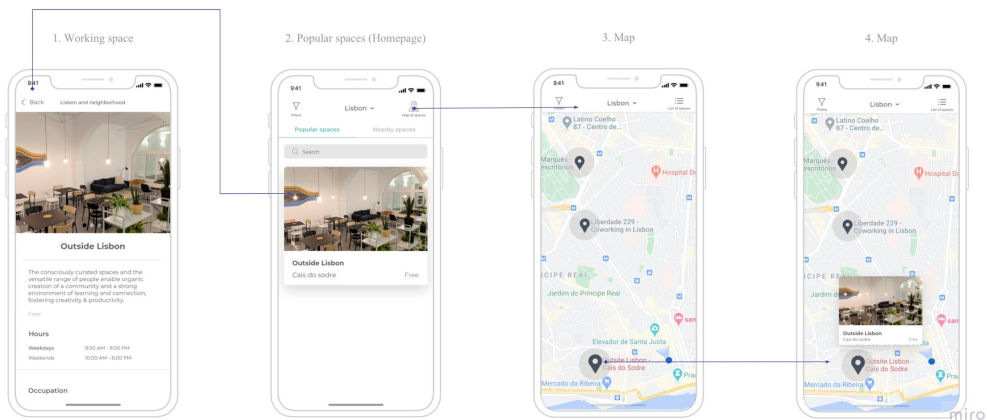


Figure 39. User flow of Task IV: Locate the perfect place to work. See the location of the place called "Outside Lisbon". A higher resolution version of the figure is available at: <https://bit.ly/3a5puaC>

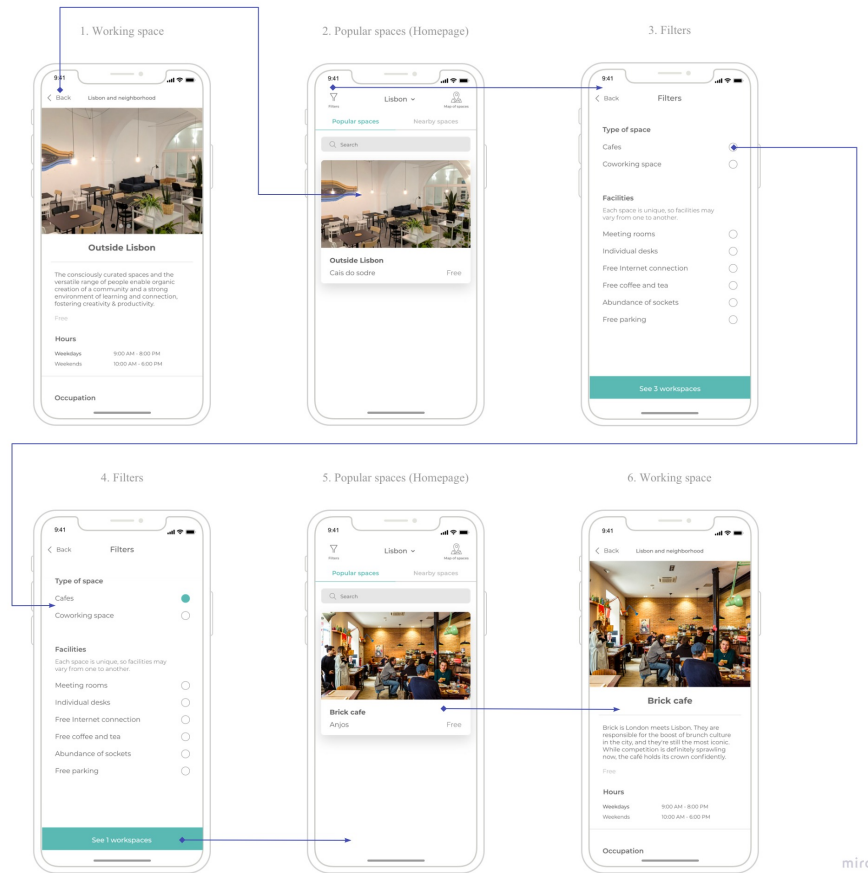


Figure 40. User flow of Task V: You want to work in a cafe today while eating and drinking along the day. Find the most popular cafe to work. A higher resolution version of the figure is available at: <https://bit.ly/3a5GfCk>

Results and discussion

A task analysis was performed to identify usability problems. During the evaluation, usability problems were described, categorized, and analyzed according to Nielsen's heuristics (Nielsen, 2005).

i) Analysis and heuristic evaluation

In total, 6 usability problems were found and 2 out of 10 heuristics were violated. The heuristics violated were “Visibility of the system” (H1) and “Match between system and the real world” (H2). The missing heuristics had no violations identified. The problems were sorted into 3 categories: visual consistency, terminology, and Interaction. The usability problems found in the

task analysis are reported in Table 4. At the screen related to the user preferences, the visual of the header was considered affordable, even though it is not. This problem can confuse and frustrate the user. Another problem, related to visual consistency, was identified in the homepage screen where the menu buttons were considered disabled due to their color and contrast. At the filters screen, the term “sockets” was not recognized, leading to the problem of missing representation icons in this screen. Having icons representing the labels can help users recognize terms faster. The last 2 problems were identified in the working space screen. The wrong use of the term “full” when the place was not at its full capacity confused the user. Another problem found was the lack of comparison between everyday sounds and the decibel scale that was presented to the user. Being the user unfamiliar with the decibel scale, it is important that he understands the meaning of the scale without having to look up for a possible comparison outside the application.

Table 4. Usability problems identified.

Place of occurrence	Problem category	Problem description	Heuristics violated
Screen 6. User preferences	Visual consistency	Header visual looks like it is affordable.	H1
Screen 22. Popular spaces (homepage)	Visual consistency	Buttons (filters, map of spaces) look disabled.	H1
Screen 30. Filters	Visual consistency	Missing representation icons.	H2
Screen 30. Filters	Terminology	Term is not recognized: “Abundance of sockets”	H2
Screen 36. Working space	Terminology	Wrong use of the word “full” when place is not at full capacity.	H1
Screen 36. Working space	Interaction	No comparison between everyday sounds and decibel scale (dB).	H2

ii) SUS results

After receiving the SUS results, to calculate each item's score contribution the range would scale from 0 to 4 (Brooke, 2013). For each of the odd numbered questions (1, 3, 5, 7 and 9), the score contribution is the scale position minus 1. For each of the even numbered questions (2, 4, 6, 8 and 10), it is 5 minus the scale position. To reach the overall SUS score, multiply the sum of the item score contributions by 2.5. Then, SUS scores scale from 0 to 100 (Brooke, 2013). The average SUS score is 68. If the score is under 68, then, there are some problems with the system usability, if the score is above 68, then, the experience of a system should be good (Brooke, 2013).

All participants scored over 80 points. 4 participants scored over 90 points while 2 scored the maximum of 100 points. 4 participants had lower scores between 80 and 87,5 (Figure 41). Although, on the final SUS score the total average score was 91. According to Bangor et al. (2009) the score 91 can be considered as “acceptable” on acceptability ranges, which represents an A score, as it is shown on Figure 42.

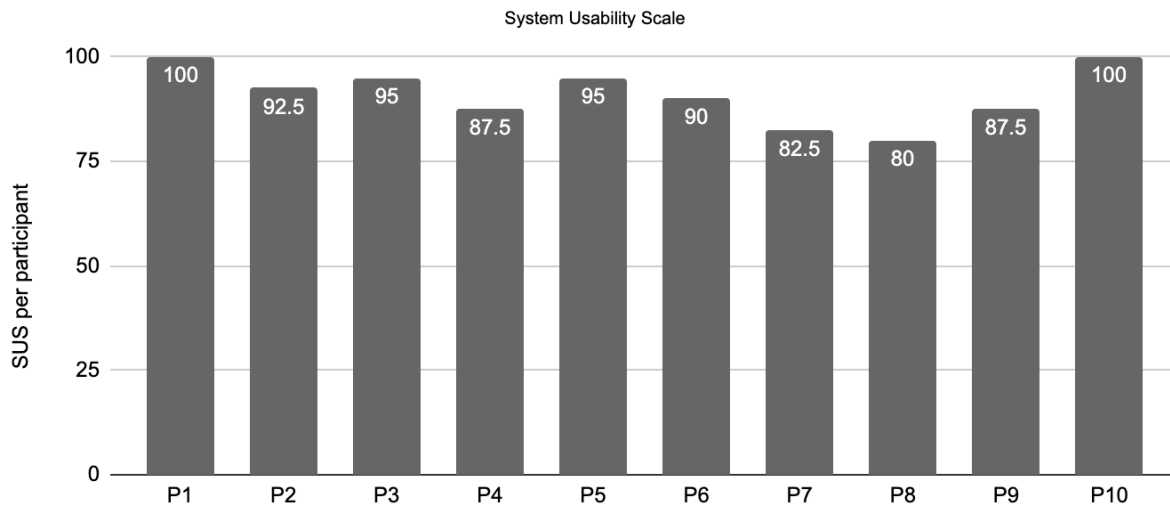


Figure 41. SUS individual results.

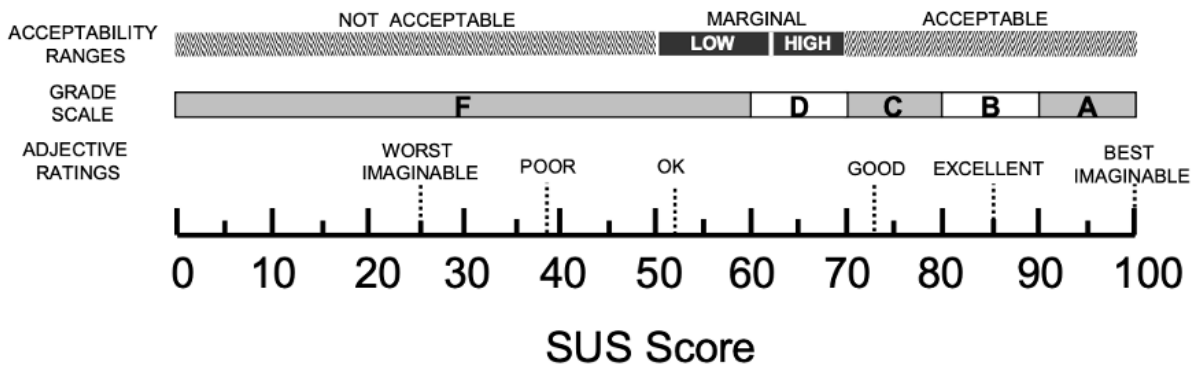


Figure 42. SUS acceptability range by Bangor et al., 2009.

On the open-ended follow-up questions, participants gave their feedback about their experience during the user testing:

P5: *“Easy to learn, intuitive and explicit.”*

P6: *“Excellent design and new interesting concept. App is well developed and simple to use.”*

P9: *“It is a very intuitive app, very easy to use, which ends up helping people who need to study, do schoolwork or even just to “relax”.*

According to participants’ feedback, the system was identified as an intuitive, simple, and useful tool for remote workers and, also, students. Additionally, the majority gave a positive feedback about the real-time features (noise levels and WIFI connection). Two participants refer the system as “revolutionary” since they never saw something like this in the market.

Results and discussion

Ten participants between 19 and 32 years of age participated voluntarily on the moderated user testing study. According to the System Usability Scale (SUS) model it was possible to measure the experience and level of satisfaction related to proposed system. The SUS results identified that the system’s usability was considered acceptable with a score above 80 points and the final score reaching 91 points.

On the open-end questions, participants mentioned ease of use, usefulness and a new but interesting system that could help workers with their daily search for a space to work. Additionally, it was also perceived as a revolutionary system.

5. Conclusions and Future work

Recent technologies allow new ways of communication between persons, places, and things. The daily use of these technologies is becoming more evident as communications devices, such as smartphones and personal computers, started to become part of our daily lives. The wide range of digital devices (i.e., notebooks, tablets, smartphones), along with the birth of the internet, allows workers to perform their tasks and activities from various physical locations. It was found that these digital advancements led to the creation of new ways of working, where a high number of remote independent workers and the increasing use of public spaces as a workspace, led to the decreased and changed the need for office space (Weijts-Perrée et al., 2019). Coffee shops, community centers, and general stores sparked interest among independent workers due to different advantages, such as fast WIFI and space to work for a cheap price of a cup of coffee (Lee, 2018).

It was found that the increasing number of independent workers contributed for the rise of new third places, such as coworking spaces. These spaces offer “control, autonomy, and scheduling flexibility of remote work, combined with optional access to the structure and community of an office if and when the worker wants it” (Mulcahy, 2017). CWS gain popularity over the years owing to the increasing search from self-employees and other remote workers that try to fight feelings of loneliness. CWS can offer ideal conditions to perform work with the highest performance with the lowest prove possible (Laing, 2014). In addition, these spaces can offer a social network, knowledge sharing, and professional relations (Deskmag, 2015).

In this sense, the main objective of this thesis was to identify and evaluate remote workers’ preferences of working spaces characteristics, in the capital area of Portugal. In addition, this thesis takes part of an ongoing project that aims to design and evaluate a real time system that can help remote workers find third places to work in, increasing its efficiency. Findings of this study can be useful when designing or developing a related mobile application or even a coworking space.

To reach the main goal of the thesis, the following secondary objectives were established:

- Investigate the literature review on remote work, current working spaces’ mobile applications and real time technologies.
- Analyze and evaluate remote workers’ preferences and needs when looking for a space to work in.

- Design of the proposed system's interface, according to findings on remote workers preferences.
- Conduct remote moderated user tests with target users to identify and map possible usability problems regarding the proposed system design.

Following Vijay Kumar's methodology (2013), the first phase of this project 'development (online questionnaire and interviews) showed that the majority of remote workers chose to work at home as their first option, however, when working outside their home, remote workers go for coworking spaces and cafes. The main motives of most remote workers when choosing a workplace outside their home are comfort, affordable accommodation, and the opportunity for social interactions with other remote workers. Remote workers' preferred workspaces amenities/attributes are the WIFI quality, the space location, and a silent environment.

Through the remote moderated usability testing, as a second phase, it was possible to evaluate the proposed system' interfaces with the help of the Think Aloud protocol. This phase consisted in two different iteration moments (pilot test and main test), where a low and high-fidelity prototype were tested. In the main study, ten participants between 19 and 32 years of age participated voluntarily on the user testing study. The initial intention on user testing was to conduct individual and physical moderated sessions, to measure tasks performing in a mobile smartphone, provided by the researcher. However, due to COVID-19 pandemic, these moderated sessions were performed as online individual remote sessions through the application *Zoom*, where participants shared their computer screen while performing the given tasks.

SUS technique was applied to quantify the users experience on product satisfaction and to measure user's level of satisfaction. Results identified the system as acceptable on acceptability ranges, with an average score of 91 points. Considering the open-ended questions, users considered the system intuitive, simple and useful. The majority gave a positive feedback about the real-time features. Also, it was perceived as a "revolutionary" system.

A paper presenting the results of this study was accepted for publication in the International Conference Human Computer Interaction 2021: Carvalho, C., Lima, E. S., Ayanoglu, H., "An Evaluation of Remote Workers' Preferences for the Design of a Mobile App on Workspace Search", in International Conference Human Computer Interaction 2021 (HCII 2021), to be held virtually, July 2021.

This study had some limitations and constraints that are relevant to be mentioned. Small sample size can be considered the first limitation in this study, making it difficult to assume that a particular outcome is a true finding, and it may not have statistical power.

Due to time constraints and the current COVID-19 pandemic situation, it was not possible to implement the entire solution, being impossible to collect, use or validate real-time data, limiting the study to the evaluation and validation of the prototype's interface. Also, the current pandemic situation may possibly influence remote workers' choices of the coworking space's characteristics and their personal needs, that should be included as a control variable in future studies.

Furthermore, the pandemic situation also affected the usability tests sessions, and the main study was performed in remote sessions, which brought different disadvantages, such as:

- Several technical problems: Some participants were unfamiliar with the software where the sessions happened. Other problems included outdated or inexistent camera or microphone.
- Limited visual feedback: difficulty capturing body language and emotions during remote testing, due to poor internet connection.
- Prototype limitations: The prototype was built to run in a specific device (iPhone XS). Since participants did not own this same device, the tasks were performed through *Google Chrome* browser, affecting the quality and performance of the prototype.

As a future work, the implementation of a system to use sensors to get real time data will be prioritized. The objective is to implement environment sensors, such as occupancy, noise, and temperature detection sensors in a workspace environment. Additionally, internet speed sensors will also be implemented. These sensors will send information to a data server that will send information to the users' device (e.g., smartphone) through a mobile application, as shown in Figure 43.

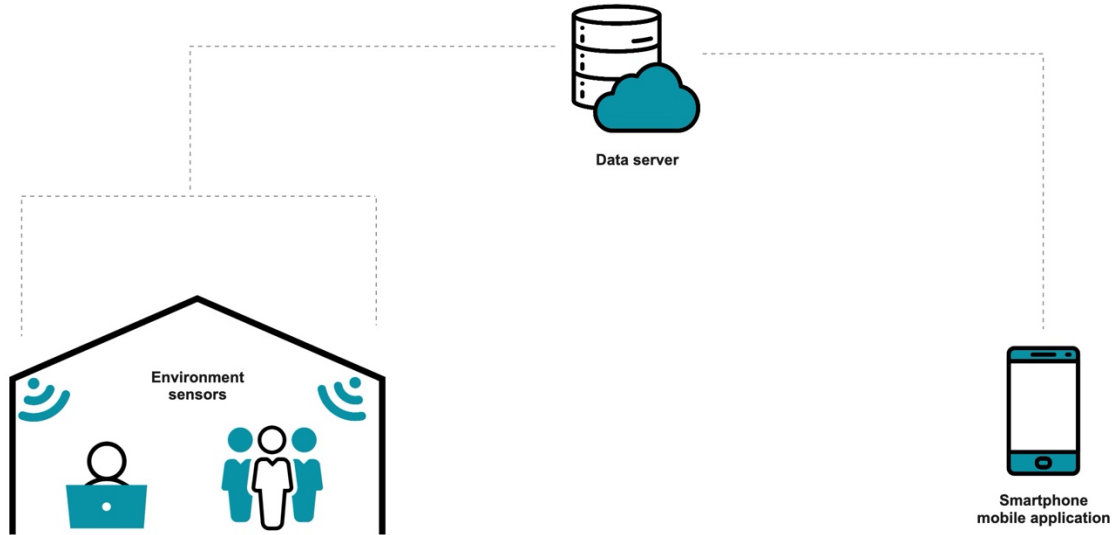


Figure 43. Data model of the proposed environment sensors implementation. Source (The Authors, 2021).

This implementation will be followed by individual moderated usability tests in order to obtain more feedback. The same methodology will be applied to the same target users. Therefore, it is interesting for future research to analyze which (other) preferred aspects of working spaces can be applied into this system.

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Appendix A – Literature review

Title	Type	Authors	Keywords	Abstracts	References
The Physical Elements Affecting Student's Concentration in Libraries	Scientific paper	Dang, T. & Chen, W.	Concentration; Library; Physical Elements.	This study aims to investigate the impact of physical elements in a library's interior design on the concentration of students using the library for their work. The research question is as follows: which physical factors have, from their perspective, an impact on the concentration of students using the library for work? Also, this study compares the importance of the effect of the physical factors on the concentration of different users and activity profiles. There were 24 participants from 3 different Universities located in Guishan, Taoyuan, Taiwan answering the questionnaires and interview questions. Results showed that there were 11 factors rated as the most important factors affecting concentration ability namely: "Cleanliness"; "Aesthetic appearance"; "Noise level"; "Air movement"; "Amount of light"; "Air quality"; "Amount of space"; "Accessibility to facilities"; "Visual comfort"; "Crowdedness"; "Temperature"; and "Comfort of furnishing".	Dang, T. H., & Chen, W. (2016). The Physical Elements Affecting Student's Concentration in Libraries. In <i>Advances in Ergonomics in Design</i> (pp. 299-310). Springer, Cham.
Detection of the crowdedness of a place sensing the devices in the area	Scientific paper	Ozaita, A.	IoT; Crowd management	Nowadays, more and more people start to live in cities. This change involves the apparition of new problems that could be solved using ICTs, which would lead to "Smart Cities". In said cities, all kinds of data is gathered thanks to the sensors all around them, and different applications can be developed, such as the detection of crowded places. The detection of these places can be used, for example, for the prevention of human stampedes, for traffic redirection or for reporting the status of a place remotely. The motivation for this research of the detection of crowded places is caused by the small amount of literature that specifies what was considered a crowded place and that most of the existing methods for their detection distinguished between "crowded" and "not crowded" areas arbitrarily.	Ozaita Araico, A. (2017). <i>Detection of the crowdedness of a place sensing the devices in the area</i> (Master's thesis, University of Twente).
Avoiding the Crowds: Understanding Tube Station Congestion Patterns from Trip Data	Scientific paper	Ceapa, I., Smith, C & Capra, L.	Mobility, Public Transport, Predictions	For people travelling using public transport, overcrowding is one of the major causes of discomfort. However, most Advanced Traveller Information Systems (ATIS) do not take crowdedness into account, suggesting routes either based on number of interchanges or overall travel time, regardless of	Ceapa, I., Smith, C., & Capra, L. (2012, August). <i>Avoiding the crowds: understanding</i>

				<p>how comfortable (in terms of crowdedness) the trip might be. Identifying times when public transport is overcrowded could help travellers change their travel patterns, by either travelling slightly earlier or later, or by travelling from/to a different but geographically close station. In this paper, we illustrate how historical automated fare collection systems data can be mined in order to reveal station crowding patterns. In particular, we study one such dataset of travel history on the London underground (known colloquially as the “Tube”). Our spatio-temporal analysis demonstrates that crowdedness is a highly regular phenomenon during the working week, with large spikes occurring in short time intervals. We then illustrate how crowding levels can be accurately predicted, even with simple techniques based on historic averages. These results demonstrate that information regarding crowding levels can be incorporated within ATIS, so as to provide travellers with more personalised travel plans.</p>	<p>tube station congestion patterns from trip data. In <i>Proceedings of the ACM SIGKDD international workshop on urban computing</i> (pp. 134-141).</p>
A low cost IoT based crowd management system for Public Transportation	Scientific paper	Vidyasagan, S., et al.	<p>IoT; Crowd management; Raspberry Pi; IEEE 802.15.4; Public Transport.</p>	<p>With the evergrowing global population, crowding in public transport is becoming an increasing menace. Public transport systems around the world have remained largely the same over the past several decades although the population they serve has burgeoned. This paper aims to demonstrate a low cost IoT based solution to the crowding problem by using smart seats that can detect and display the seat occupancy status in real time over an internet or mobile application. The feasibility of the project was assessed and simulated using the NETSIM simulation software. The results of the software simulation showed promise and hence a hardware prototype was built using the IEEE 802.15.4 standard on the Arduino - Raspberry Pi – nRF platform. The prototype results are positive and show a fully functional IoT system that can be implemented in buses and trains.</p>	<p>Vidyasagan, S., Devi, S. R., Varma, A., Rajesh, A., & Charan, H. (2017, November). A low cost IoT based crowd management system for public transport. In <i>2017 International Conference on Inventive Computing and Informatics (ICICI)</i> (pp. 222-225). IEEE.</p>
Home Office, Coffee Shop, or Coworking Space? A comparison.	Article	DeGuzman, G.		<p>Why should someone choose a coworking space, instead of just staying at home? New workspace writer Genevieve DeGuzman looked at the pros and cons of working at home, being a latte entrepreneur, and joining a coworking space. Some unexpected findings: noise in a coffee shop helps some people focus better; and some entrepreneurs report 30% of their business comes through their coworking</p>	<p>DeGuzman, G. (2011). Home Office, Coffee Shop, or Coworking Space? A comparison. Retrieved 21 January 2021, from</p>

				network. Here's an in-depth comparison of the various options open to individuals.	https://www.de-skmag.com/en/coworking-spaces/home-office-coffee-shop-or-coworking-space-a-comparison-167
101 Design Methods: a structured approach for driving innovation in your organization	Book	Kumar, V.	Methodology	A step-by-step guidebook for successful innovation planning. Strategists, managers, designers, and researchers who undertake the challenge of innovation, despite a lack of established procedures and a high risk of failure, will find this an invaluable resource.	Kumar, V. (2013). 101 design methods : a structured approach for driving innovation in your organization. Wiley.
Typologies for co-working spaces in Finland – What and how?	Scientific paper	Kojo, I. & Nenonen, S.		<p>Purpose This paper aims to categorize the typologies of co-working spaces and describe their main characteristics. Design/methodology/approach. The aim is reached by means of analysing 15 co-working spaces located in the capital area of Finland. The data used consist of interviews, websites, event presentations and brochures. Findings As a result, six co-working space typologies were identified: public offices, third places, collaboration hubs, co-working hotels, incubators and shared studios. The categorization was made by using two axes: business model (for profit and non-profit) and level of user access (public, semi-private and private). Research limitations/implications. The results provide a viewpoint on how co-working spaces can be categorized. Practical implications. In practise, the results can be applied by all stakeholders who are working with alternative workplace solutions to respond to the needs of new ways of working, especially via workplace services for multi-locational and flexible working, including facilities managers, corporate real estate executives and designers. Originality/value This research builds on the previous academic literature on co-working spaces by making the phenomena more explicit for researchers and practitioners who are facing the challenges of developing new alternative workplace offerings.</p>	Kojo, I., & Nenonen, S. (2016). Typologies for co-working spaces in Finland–what and how?. <i>Facilities</i> .

Appendix B - Online Questionnaire

Remote work questionnaire

As part of a research work, we ask you to answer this questionnaire, whose objective is to collect information about the preferences and habits of a remote worker.

Completion of this questionnaire takes approximately 5 minutes, participation is anonymous, so we ask you to complete all the questions to be able to have an expression in the statistical analysis of the answers.

Thank you for your time.

Cátia Carvalho,
Master in Interaction Design at IADE *Required

1. Age *

2. Gender *

Mark only one oval.

Female

Male

Other:

3. Nationality *

4. Education *

Mark only one oval.

- High school graduate
- Bachelor's degree
- Master's degree
- Doctorate degree Other:
- _____

5. What is your current employment status? * *Mark only one oval.*

- Employed for wages
- Self-employed
- Out of work and looking for a job
- Out of work but currently not looking for a job
- A freelancer
- A student
- Retired
- Unable to work
- Other:
- _____

6. Are you currently working and/or living in Portugal? * *Mark only one oval.*

- Yes
- No

7. What is your company's stance on remote work? *

Remote work is a working style that allows professionals to work outside of a traditional office environment. It is based on the concept that work does not need to be done in a specific place to be executed successfully.

Mark only one oval.

- Everyone works remotely
- We can work remotely a certain number of days per week/month
- We can work remotely as needed
- We can't work remotely Other:
- _____

8. Do you work remotely? *

Mark only one oval.

- Yes
- No

9. What location do you primarily work from? *

Mark only one oval.

- Coffee shop and cafes
- Coworking spaces
- Home
- Libraries
- Park
- Other:

10. What are your main reasons to primarily choose this place to work in? *

11. What is the second most common location that you work from? *

Mark only one oval.

- Coffee shop and cafes
- Coworking spaces
- Home
- Libraries
- Park
- Other:

12. What are your main reasons to choose this place to work in, as a second option? *

13. What are your biggest struggles when working remotely? *

Tick all that apply.

- Feelings of loneliness/Lack of interaction with others
- Distractions/Interruptions
- Finding a good place to work in
- Finding reliable wifi
- Noise
- Privacy
- Vibe/Atmosphere

Other: _____

14. How easy is it for you to find information related to working spaces (location, price, space dimensions, etc)? *

Mark only one oval.

	1	2	3	4	5	
Not easy at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

15. How easy is it for you to find a place to work in besides home? *

Mark only one oval.

	1	2	3	4	5	
Not easy at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

16. When looking for a space to work in, what sources do you use? *

Tick all that apply.

- Internet search
- Mobile apps
- Asking people
- Social media (LinkedIn, Facebook, Instagram, etc)

Other: _____

17. What websites or apps do you use when looking for a space to work in? *

18. Which of the following do you value the most in a working space? (Choose one or more)

*

Tick all that apply.

- Location
- Silence
- Fast Wifi
- Price
- Plenty of space/chair
- Supporting Equipment (sockets, cables, etc)

Other: _____

19. How likely would you be to use one app that could show you information about working spaces around you? * *Mark only one oval.*

- Extremely likely
- Very likely
- Moderately likely
- Slightly likely
- Not at all likely

20. What kind of information (about working spaces) would you like to see inside an app? *

21. Would you like to be contacted with further questions regarding working spaces? *

Mark only one oval.

- Yes
- No

22. Your email address: *

Appendix C - Interviews Script



**Faculdade de Design,
Tecnologia e Comunicação**
Universidade Europeia

Interviews Script

Interaction Design Masters

IADE - Creative University

2020

Introduction

Following your answer to the questionnaire regarding the thesis “AN EVALUATION OF REMOTE WORKERS’ PREFERENCES FOR THE PROPOSAL OF A SYSTEM ON WORKSPACE SEARCH”, I would like to ask you some follow-up questions on the topic.

Questions

Work related

Q1. What is your occupation?

Q2. Are you currently working on your occupation?

Q3. What is your main reason for exercising your occupation remotely? What influenced you to choose this lifestyle?

Working spaces related

Q1. In your experience, after searching the Internet and finding a place to work, how easily do you find information about it? What kind of information is easier to find?

Q2. What need would make you use an application related to workspaces?

(Ex: Price information; Information on the number of people / companies; Be quick and practical, etc.).

Q3. Do you currently know any application that provides you with some type of information regarding Workspaces? If so, which one/which ones?

Q4. Have you worked or currently work in a Cowork Space? If so, what do you like best when using these spaces?

Thank you for your time.

Appendix D - Usability Test Script



Faculdade de Design,
Tecnologia e Comunicação
Universidade Europeia

Usability Test Script

Interaction Design Masters

IADE - Creative University

2020

Introduction

You have been invited to participate in a usability test for a master's study related to working spaces. You will have the opportunity to play the role of a remote worker who wants to find a place to work that meets his/her needs. The goal is to operate a mobile application and evaluate the usability, so **please be aware that there are no wrong answers**. In fact, this is probably the one place today where you do not have to worry about making mistakes. As you go about using the application, I will ask you to think aloud as much as possible: to describe out loud what you are looking at and what you are trying to do. This will be a big help.

Also, please do not worry that you are going to hurt our feelings. We are doing this to improve the system, so we need your honest feedback.

The sessions will be video recorded. The recording will only be used to evaluate the data coming from you, and it will not be shared except those with a need-to-know.

Finally, this test is completely anonymous. Feel free to ask all the questions you need to see answered and be aware that you can discontinue your participation at any time. Once you have finished, you must answer a final questionnaire.

I have read and understood the information on this form and had all of my questions answered. I willingly agree to participate. I consent the recording of this test and the use of the data gathered during the course of this study and I understand I may discontinue my participation at any time.

Scenario

Imagine you are working remotely for a company. You have a home office; however, you get too distracted and there is too much noise so you cannot focus on your work. There are a few working spaces from your knowledge, but you do not want to waste your time going there and turning back if they do not meet your expectations. Luckily, you know a mobile app that can help.

Having this scenario in mind, you are invited to operate with the mobile application and verbalize your feedback and critics and describe what you are looking and/or trying to do.

Note: **Please be aware that there are no wrong answers.**

Task 1

<https://projects.invisionapp.com/prototype/where2work-ckipu0u4c002ktk012pvva4fh/play/5788cfc2>

You need to work in a quiet space and also make video calls. Find a coworking space with individual desks and meeting rooms.

Task 2

<https://projects.invisionapp.com/prototype/where2work-visual-V5-ckih9z66u0045dr01lpe33yrm/play/1c325c46>

You do not take public or private transportation but walk to the workplace. Choose a place that is closest to you.

Task 3

<https://projects.invisionapp.com/prototype/where2work-visual-V5-ckih9z66u0045dr01lpe33yrm/play/26c215aa>

You want to use your car to go to the workplace due to the rain and also you need individual desks to spread your paperwork. Find a coworking space with individual desks and free parking lots.

Task 4

<https://projects.invisionapp.com/prototype/where2work-visual-V5-ckih9z66u0045dr01lpe33yrm/play/15ea4eae>

Locate the perfect place to work. See the location of the place called “Outside Lisbon”.

Task 5

<https://projects.invisionapp.com/prototype/where2work-visual-V5-ckih9z66u0045dr01lpe33yrm/play/ef8c1ca5>

You want to work in a cafe today while eating and drinking along the day. Find the most popular cafe to work.

Final questionnaire

To finish this usability test, please answer this online questionnaire related to the application you just experienced.

<https://forms.gle/RDVmLRFCVNgm9ttS9>

Thank you for your time.

References

- [Steve Krug’s Usability Test Script](#)

Appendix E - SUS - User Testing Post Questionnaire

Where2Work - SUS

You were invited, as a volunteer, to participate in a questionnaire regarding the development of a mobile application for remote workers, inserted in the scope of the master's degree in Interaction Design at IADE.

The questionnaire consists of 17 questions and will take a maximum of 5 minutes to complete. Participation is anonymous, so we ask you to complete all the questions to be able to have an expression in the statistical analysis of the answers.

Thank you for your time.

Cátia Carvalho,
Master in Interaction Design at IADE

Warning: This questionnaire is intended for users who have participated in the usability test for the smartphone application with the name "Where2Work". *Required

On a scale of 1 to 5, 1 being strongly disagree and 5 strongly agree, answer the following questions about the application you just evaluated.

1. I think I would use this application frequently. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

2. I found the application unnecessarily complex. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

3. I thought the application was easy to use. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

4. I think that I would need the support of a technical person to be able to use this application. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

5. I found the various functions in this application were well integrated. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

6. I thought there was too much inconsistency in this application. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

7. I would imagine that most people would learn to use this application very quickly. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

8. I found the application very cumbersome to use. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

9. I felt very confident using the application. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

10. I need to learn a lot of things before I could get going with this application. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

11. It was easy to find the information I needed. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

12. I had a hard time performing the tasks proposed. *

Mark only one oval.

- 1. Strongly disagree
- 2. Disagree
- 3. Neither agree nor disagree
- 4. Agree
- 5. Strongly agree

13. What did you like most about using this application? *

14. Is there anything you did not like? If so, what was it? *

15. What would you change/add in the application you just tested? *

16. In a scale of 1 to 5, being 0 unlikely and 5 extremely likely, how likely is it to recommend this application to a friend or family member? *

Mark only one oval.

	1	2	3	4	5	
Unlikely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely likely

17. Describe, in few words, what motivated your answer to the previous question. *
