The role of IT and space in community driven Coworking Spaces

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Abstract

Coworking Spaces represent a global fast-growing trend which was able to gain momentum in research and academia, yet until now the fundamental role of IT within the coworking space ecosystem proves to be a rather unexplored topic for researchers and academia. Therefore, this research is about the role of space and information technologies (such as software, hardware, and more IT-related services) within CWSs; hence about the relation and interplay among those technologies, the involved actors and the physical environment in which the act of coworking takes place.
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List of abbreviations

IT: Information Technology
CWS: Coworking Space
P2P: Peer to peer
UX: User Experience
ID: Interaction Design
IA: Information Architecture
1. Introduction

1.1 Background

Whereas several definitions and conceptual constructs can be found in literature and on the web, this thesis is developed upon the understanding of the coworking space ecosystem, making it necessary to provide the reader from the very beginning with a precise definition of coworking space, so to facilitate the overall comprehension of the research.

Accordingly, as McGrath states (McGrath, 2018), a coworking space is an office complex with shared infrastructure, this might include basic elements such as desks, power supply, internet connection and computer networking - as well as more advanced IT infrastructure (Müller, 2018). These workspaces generally include common amenities like catering, meeting rooms and rest areas. Also, a coworking space implies the existence of a social environment of likeminded workers who share both infrastructure and, usually, a group culture making it a physical space that hosts a community whose members network, collaborate, and help each other. The adoption of this definition will be further discussed in the literature review.

Since their birth 15 years ago, Coworking Spaces proofed to be more than a temporary trend, currently becoming a widely spread mode of work and workspace model (Allwork.Space, 2019; Gandini, 2015a; McGrath, 2018). Statistics from 2017-18 report a 200% growth rate in number of CWSs during the previous five years, with a total of 14.411 verified CWSs worldwide; a more recent report published in 2019 refers to the existence of over 35.000 generic “flexible workspaces” in the entire world (Allwork.Space, 2019).

According to its relatively recent semantical emergence, the coworking phenomenon does not count with a long history behind itself. Academically speaking, it is generally agreed that the contemporary concept of “coworking space”, from now on CWS, emerged in San Francisco (USA) somewhen in-between the years 2005 and 2007, when the computer engineer Brad Neuberg founded the “Hat Factory” CWS (Parrino, 2015). Nonetheless, similar workspace concepts have been reported to exist already before that date even if under different names; also, several CWSs seem to have appeared almost simultaneously around the globe just around the same time span, making it hard to define a precise and absolute timeline in their birth and development (Parrino, 2015; McGrath, 2018).

Modelled after various open-source and internet freedom movements, coworking soon became a global movement and philosophy with a shared set of values and even a common manifesto firstly promulgated in 2007, declaring coworking to be “the future of work”. In this sense, CWSs place themselves in a specific time context characterized in one side by the rise of ubiquitous internet technology which exponentially accelerated telecommuting practices, and on the other by the 2008 global economic crisis that resulted in inexpensive office space and millions of workers unemployed (McGrath, 2018). As a matter of fact, technology was finally mature enough to allow many knowledge workers to work from wherever convenient, pushing them to not go back to corporates’ life and become freelancers or independent -contractors who will flexibly work for different clients from project to project. Coherently, both technology and emerging business practices made those types of workers free from conventional office, but not from the need to be surrounded by colleagues (Gandini, 2015; McGrath, 2018; Müller, 2018.).

Not surprisingly, early CWSs were inspired by some of the biggest high-tech Silicon Valley corporates such as Google and Apple which nurtured and facilitated serendipitous collaboration among their employees by offering open-plan workspaces, informal working atmosphere and generous amenities (McGrath, 2018). For instance, conventional offices offer not only technical infrastructure but also social support, conviviality, and a sense of identity as part of a group of collaborators, all elements that would most likely be missing in traditional home-office work (Gandini, 2015b; McGrath, 2018). Accordingly, the “Hat Factory” founder states that coworking represent a remedy for the risk of isolation that concerns those professionals who should otherwise choose between working home for themselves or working at the office for a company, renouncing to sociality in the first case, or to economic and professional independence in the latter (Parrino, 2015).

Therefore, and accordingly with what has been discussed, CWSs are enabled by technology but not determined by it as it is the existence of a surrounding community to distinguish them from other working modes such as home-working and conventional corporates’ offices (McGrath, 2018). Yet it should be noticed that whereas community and social dynamics gained their deserved attention from academia and practitioners, in spite of its role of “enabler”, technology in CWSs remains a rather unexplored topic,
leaving a significant gap in CWS-related literature. As to this, up till now no answers have been provided to simple questions like “what technology can be found in a CWS?”, or “how is technology being used by coworkers?”, or again, “what’s the role of technology in CWS?”.

With the research problem in the following chapter the author will try to address these issues.

1.2 Research problem

As mentioned in the introduction, besides their factual worldwide spread and development during the last twenty years coworking and CWSs found their way throughout publications and academic research within a number of disciplines. For instance, social and behavioural sciences’ topics like coworkers satisfaction, productivity, peer collaboration modes, and motivational factors (Akhavan, Mariotti, Astolfi, & Canevari, 2018; Iulia Constantinescu & Devisch, 2018; Orel & Alonso Almeida, 2019), or again management & business administration and economics-related topics such as business model analysis, financial feasibility, impact on coworkers revenue (Bouncken, Clauß, & Reuschl, 2016; Waters-Lynch & Potts, 2017) have all been subject of research, providing community with a good understanding of the hereabove mentioned aspects.

On the other side, until now the fundamental role of IT within the coworking space ecosystem proves to be a rather unexplored topic for researchers and academia. Therefore, this research is about the use and deployment of information technologies (such as software, hardware, and more IT-related services) within CWSs; hence about the relation and interplay among those technologies, the involved actors and the physical environment in which the act of coworking takes place.

Investigating the research problem presented in the previous paragraph might provide the research community with a tool to build on the conceptual understanding of the CWS ecosystem, while taking into account its information architecture and the role and influence of IT on the same.

Moreover, achieving a better understanding about the role of technology in the context of a CWS might be of use to practitioners such as coworking space operators, CWS community managers, architects and interior designers in order to shape environments in a way that physical and digital layers are deliberately and correctly overlaid for the sake of maximizing coworkers benefits and utility.

1.3 Purpose of the research

The purpose of the research can be summarized under the following points:

- Investigating which digital technologies can be identified within a coworking space.
- Understanding the role of technology in the context of a Coworking Space

1.4 Research questions

The purpose of the research will be pursued throughout the following research questions:

- What ITs might be identified within a coworking space and how can these be classified?
- What is the role of technology in a coworking space?

1.5 Disciplinary delimitations

This thesis is developed within the field of informatics and philosophy, ant it mainly builds on existing theories coming from sub-disciplines such as information architecture (IA), information systems (IS), user experience (UX), interaction design (ID) and human-computer interaction (HCI). Additionally, in relation to the concept of “space” readers will be presented with a set of cross-disciplinary interpretations deriving from philosophy and architecture.

As opposed to what discussed in the previous paragraph, the research will not cover business administration-related aspects, nor will it deal with the peculiarities emerging from different coworking space business models. Even more importantly, this study will not draw from behavioural sciences, thus without involving empirical investigation about user satisfaction, productivity, motivational and deterrent factors for coworking.
2. Literature review

2.1 Defining coworking

The following chart reports the interest over time of Google research queries for the terms “coworking” in blue, and “coworking space” in orange.

![Google Trends Chart](image)

**Figure 1: Google Trends: interest over time of the terms "coworking" and "coworking space"** (Google, 2020a)

By looking at this chart, a few observations can be made. Firstly, the number of research queries for both terms has been constantly increasing since the 2008/2009 world financial crisis until the outbreak of the COVID-19 epidemic in March 2020. Secondly, although the number of research queries for the term “coworking space” is significantly lower than the one for “coworking”, the positive correlation between their trend lines appears to be evident.

This correlation in the trend development for both terms also suggests that the rising interest in the practice of coworking led to an apparent fusion in meaning of the terms “coworking” and “coworking space”, letting them become interchangeable synonyms but also outlining how, probably for a matter of simplicity, after starting their path together the single word “coworking” became widely more used. Furthermore, this consideration finds additional confirmation in the consulted literature, where the same terms are mostly used indiscriminately.

Yet it should not be ignored that whereas the term “coworking space” presents a clear reference to the physical space in which two or more professionals co-work, the term “coworking”, or also “co-working”, might be merely intended as the act of working together on something, which also includes collaborating on a common project by means of online digital tools, without necessarily implying physical proximity among the coworkers or any other relation to a physical workplace. Accordingly, Lexico.com, an Oxford University-powered online dictionary refers to coworking as:

> “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.” (Lexico.com, 2020)

Arguably, this definition embraces both the notion of a strictly physical space such as the office, as well as a more generic one to which they refer as “other working environment”, coming closer to Dekoven’s point of view which sees coworking as “working together as equals”, with specific reference to the constantly increasing ease of connection and collaboration among workers through technology (Dekoven, 2013 as cited in Klaas, 2014). Could therefore a working environment be represented by a digital space such as the Google Suite (Google, 2020b) or Office365 (Microsoft, 2020), or again any other collaboration online platform made to share tools, ideas and knowledge? Possibly yes if we literally embrace this last definition, which is the reason why a more specific and precise definition of “coworking space” has been adopted in order to fit the research purpose.

Now, by going back to figure number one it appears to be evident that the coworking space concept presents a strong relationship to physicality. For instance, this is made visible by the exponential decrease in Google research queries registered since the beginning of the global pandemic, which, as we know, made it impossible for coworkers to reach physical facilities due to governmental lockdown policies and temporary
shutdown of non-essential commercial activities all around the world. Although it might be precocious to assume direct causality between the impossibility to access coworking spaces, and the strong drop in related google research queries, it also seems to be logical that people will mostly look for coworking spaces – or any other type of physical working space - only as long as they will be able to actually go out from their homes and access one.

This consideration, as mentioned in the introduction, brings us to a more precise definition of coworking space which makes the physical factor more explicit, leaving no margin for different interpretation:

A coworking space is an office complex with shared infrastructure, including desks, power, and computer networking. The workspace generally includes some common amenities, including catering, meeting rooms and rest areas. A coworking space is also a social environment of likeminded workers who share both infrastructure and, usually, a group culture. The physical space hosts a community whose members network, collaborate, and help each other (McGrath, 2018).

Coherently with this definition, and accordingly with what reported in the previous chapter, community and therefore the social component of a coworking space finds room in this last definition which has been adopted throughout the development of this thesis.

Lastly, it is important to note that different types of CWSs attribute less or more relevance to the community component. Concerning this, several classifications might be found both in literature and throughout web research, yet one main categorization appears to be generally agreed: community based CWSs vs. commercial/real estate based ones (McGrath, 2018; Müller, 2018). As to its name, a community based CWS is a workspace that pivots around the community of coworkers by which it is inhabited, a model in which community wellness has often priority over profit maximization independently from the adopted business model. As opposed to these, on the other side, a commercial CWS often attributes less attention to community building, focusing instead on providing access to facilities and amenities, with the aim of maximizing desks’ occupation rates and therefore its profit too (Müller, 2018). Further on, in her work, Müller identifies and describes four more precise categories of CWS, these being the following:

- Flexible office community
- Specialized educational office
- Cultural network office
- Alternative business center

Here, flexible office community CWSs are described as small-sized workspaces for 8 to 25 people, usually independent freelancers who subscribed a flexible reservation plan. Typically, in this type of CWSs formal events like periodical lessons and workshops, or informal ones like afterwork drinking on a Friday evening, are organized by and for the community. Also, as to preserve and foster stability, trust, security, and sense of safety within the community itself, it is rare to have occasional or daily workers as most of these CWSs stopped offering hour and daily access tickets.

For the purpose of this thesis, particular attention will be payed to community based CWSs, with further reference to the Müller’s “Flexible office community” CWS category.

2.2 Interaction Design

As already mentioned in the introduction, interaction design is one of the disciplines in which this thesis has put its roots. For instance, based on what discussed until now and in reference to the adopted definition, a CWS can be seen as an interaction-rich environment made of people and technology within a given space, making it therefore relevant to provide the reader with a basic conceptual understanding of how interactions relate to the research being conducted.

Under an academic point of view, interaction design is considered to be a part or a sub-discipline of user experience, and closely related to human-computer interaction (Interaction Design Foundation, 2020). In order to further develop the discussion, it is essential to define the object of study of interaction design, which is simply an interaction. Although when talking about interactions we are mostly used to think of interactions among people in our daily life, such context might not be representative enough of its broader conception. Correspondingly, a generic definition of interaction proposed by the Cambridge DICTIONARY
does a great job at embracing its wider meaning: “interaction is an occasion when two or more people or things communicate with or react to each other”. For instance, as we will see in the following paragraphs, the term interaction suites a variety of contexts that go well beyond the human-to-human one, many of which could easily be applied to a CWS ecosystem.

Kolko defines interaction design as “the creation of a dialogue between a person and a product, service, or system” arguing that such “dialogue is both physical and emotional in nature and is manifested in the interplay between form, function, and technology as experienced over time” (Kolko, 2010). Similarly, Benyon states that Interaction design is about designing interactive systems, products, spaces and services for people (Benyon, 2014); he then refers to interactive system as the set of technologies that interaction designers work with, including components, devices, products and software systems mainly used to process digital content such as audio tracks, images and text etc., which also includes functionalities such as editing images or interacting with other devices. Yet the principles of interaction design might find a valid application in addressing more traditional interactive systems, being these intended as systems that dynamically generate a reaction or a response prompted by the user’s actions (Benyon, 2014); for example, re-arranging and reshaping your garden by moving bushes and planting new flowers will produce a response after some time. This time, or also pace, is also the substantial difference among such systems and digital ones which thanks to electricity and computational power are able to provide rapid or seemingly real-time response.

Accordingly, the always increasing integration of digital interactive components into every day’s products and locations which once used to be electronics-free (for example clothing, cars, houses, public spaces etc.) is also increasing the system complexity, hence requiring interaction designers to opt for a holistic approach that involves the study of both physical and social settings in which interactions will take place, how these will mutate over time and location, and how content is experienced through different devices and technologies (Benyon, 2014).

A factor making interaction designers’ work even more complex is the different nature of humans and interactive systems, bringing the discussion at the core of human-computer interaction (HCI). For instance, interactive systems need to deduct exact mathematical instructions from people’s flexible and unprecise – or even unconscious – input to enable the achievement of a specific goal while generating a positive user experience (Benyon, 2014). Interactive systems gather inputs through user interfaces (UI) which include the physical, perceptual, and conceptual touchpoints existing between users and the content accessible by the same system.

Benyon and Resmini describe touchpoints as the loci within a given ecosystem where information is made available to actors, these might be represented by digital and electronic interfaces such as websites and mobile apps, but also by more traditional ones such as kiosks and staff members (Resmini & Benyon, 2016). By building on their work, Kronqvist and Leinonen provide a taxonomy of touchpoints, dividing them into social, physical and digital touchpoints (Kronqvist & Leinonen, 2019). Their model with related examples can be consulted in the following figure.

![Figure 2, a taxonomy of touchpoints with examples](Kronqvist & Leinonen, 2019)
Getting back to CWSs, a touchpoint might be represented by a receptionist, or even by the access management system. By accessing these touchpoints, actors can interact with the given interactive system by consulting and modifying existing information or creating new information to be injected into the ecosystem (Benyon, 2014). For example, signing in for a workshop at the CWS, booking a meeting room or setting their “digital status” to busy in order for other coworkers to know that they are temporarily not available for discussion.

According to Saffer and to his attempt to categorize interactions, these can happen at different systemic levels. Beginning from their smallest scale he refers to them as “microinteractions”, intended as “tiny pieces of functionality that do one thing only” (Saffer, 2013). A microinteraction can constitute a product, for example a simple bread toaster or a desk lamp, but also a whole mobile application based on one single function, for example a clock widget which only function is to show you the time.

At a broader level, microinteractions might be grouped into macrointeractions, or features (Saffer, 2013), or again system features as defined by Benyon (2014), for example a music player resulting from the sum of all microinteractions such as adjusting volume, pausing/starting the music, skipping to the next song and so on. Arguably, it can be deducted that a feature can be as simple as the one just described, or extremely complex when it involves hundreds – or even thousands – of microinteractions, for example an airplane cockpit.

As to this, zooming out a bit further will allow to capture the big picture of an interactive system which encompasses all features and therefore all microinteractions.

Although this categorization might be of great utility when analysing and designing interactive systems, interactions might also be analysed more in depth by looking at their structure. In regard to this, Benyon came up with what he defines a “construct for understanding interaction” called Pact. Through this, he conceptualizes interaction as the relationship among four element which are people, activities, context and technologies (see figure 3), defining it as a way for interaction designers to focus on the wide range of issues of their concern (Benyon, 2014). Finally, he refers to “multiple Pact’s” (see figure 4) to describe the complexity of real-life situations, as for instance it would be very hard to isolate a single Pact, or a specific relation within it, in a situation which involves multiple people, performing different interconnected activities with the support of several technologies within different individual contexts (Benyon, 2014).

While anticipating some of the philosophical notions that will be introduced later on in the physical space chapter, among the other objectives, the Pact construct wants to outline the almost impossibility of isolating people from their environment, and the need to understand them within the modern world which consists
of many things, with interactive technologies and digital content being two of those (Benyon, 2014). Finally, it should be noticed that this comes close to what we referred to with the term “complex socio-technical system”, hence to represent a system which as to its nature, is rich of interactions.

2.3 Embodiment and types of space

2.3.1 The sense of embodiment

Before describing the different types of space which are relevant to this study it is fundamental to understand the essence of “being somewhere” in the first place.

Embodiment is understood as an intrinsic and emergent quality of interaction (Dourish, 2001 as cited in McCullough, 2005; Benyon, 2014). Furthermore, when using the term “embodied” we refer to the fact that cognition depends on the set of experiences deriving from having a body with specific sensorimotor capabilities, and that those capabilities are embedded in a wider context which includes biological, psychological and cultural factors (Resmini & Rosati, 2011; Benyon, 2014; Varela, Thompson, Rosch, & Kabat-Zinn, 2016). Accordingly, in their book Pervasive Information Architecture, Resmini and Rosati summarize these thoughts by pointing out how the embodiment of space constitutes the basis through which we, as human, perceive and interpret reality. Furthermore, as an example of cognitive embodiment, Resmini and Rosati mention the common terminology used for browsing the web, which includes expressions like “meeting online” and “going to the website”, thereafter underlining how such metaphors are unconsciously used to understand the abstract and deduct meaning from it (Resmini & Rosati, 2011a).

Finally, this discourse migrates from academia towards practitioners when McCullough states that:

“For interaction designers seeking to know more about context, space, and place, and conversely for architects wishing to understand the roots of interactivity, the principles of embodied predispositions provide increasingly common ground.”

(McCullough, 2005)

Thus, remarking the importance of understanding embodiment for the application of design interaction practices and, making the embodiment concept potentially relevant for a CWS ecosystem in which both physical and digital presence might come together. Further clearance about the sense of being in place and space will be provided in the next chapters.

2.3.2 Physical space

Although nowadays major efforts are put into designing interactions in the context of software development and digital experiences, the physical environment is becoming increasingly important within ID and UX (Benyon, 2014). For instance, what Benyon defines as “locative media” (2014) corresponds to any application running on our digital devices and relying on Global Positioning System (GPS) coordinates, or proximity sensors’ data in order to gain a deeper understanding of a given physical environment and finally provide a well suited UX. Moreover, it should be considered that the almost ubiquitous integration of digital technologies within our homes, cities and workplaces brought by the advent and rapid growth of the Internet of Things (IoT) and pervasive computing could represent an additional force pushing ID towards the physical space during the next decades. In light of these considerations it is essential to lay down a solid foundation for building a deep conceptual understanding of the physical space.

Instead of referring to physical space, Arango uses the term physical environment to indicate the surroundings of a system or organism and the aspects of those surroundings that influence the system’s or organism behaviour (2018), implying therefore that the environment in which people find themselves influences the way they behave in it, that brings us to the next point.

Physical space is often subject of study within architecture and interior design, but also, designing physical space requires an understanding of social psychology and behavioural sciences. As outlined by Benyon, a physical space acts both actively by inducing people towards desired behaviours, and passively by generating social expectations about how people should ideally behave in a given space (Benyon, 2014). As a matter of fact, although most of the world’s surface is still wild and untouched at least in its appearance, the vast majority of our time is spent in environments that have been reshaped by other people to allow specific targets to carry out determined activities and achieve specific objectives (Arango, 2018). Consequently, it follows that just as any other context or environment, for example language as discussed
by Resmini (2014), even physical environments convey meaning and information (Arango, 2018). Just for the sake of making this more concrete, a representation of a physical space/place’s ability to convey information would be a door separating two rooms, is telling that most likely one can go through the wall.

Further comprehension surrounding the concept of space might be found in philosophy. This being said, for how appealing it might appear, developing a wide discourse on the multitude of philosophical conceptions of space would lead this research out of its own scope, shifting the discussion onto relevant but yet unnecessary definitions. Nonetheless, it is worth mentioning that Newton’s conception of “Absolute Space” and Descartes’ conception of “Relational Spaces” were analysed as presented by Tally (2013) and considered not to be suitable nor applicable to the scope of this thesis.

When talking about being in space and place, Benyon recalls – and shortly after questions – Heidegger’s concept represented by the German word “Dasein” which in English can be literally translated into “being there” as equivalent to “being-in-the-world”. This involves the thought that people are always in space, and that no meaning can be derived by talking about those people without referring to the place they are in, or to what they are doing there (Benyon, 2014); hence encompassing not only the sense of “being there in the world” but rather being, as conscious human beings, directly involved in it, and “existing against a contextual background upon which all behaviours, cognitions, interactions, etc. are contingent” (Resmini, 2014).

On the other side, another philosophical conception of space comes closer to the research path when Immanuel Kant refers to space as a mental construction:

*Space is not something objective and real, nor is it a substance, nor an accident, nor a relation; it is, rather, subjective and ideal; it issues from the nature of the mind in accordance with a stable law as a scheme, as it were, for coordinating everything sensed externally.* (Kant, 1963, as cited by Tally, 2013)

Made simple, Kant refers to space – and also to time – as mere categories or concepts containing any other existing concept, meaning that whatever we perceive as humans, is perceived within space and time, and that time and space are not additional concepts to be perceived. Accordingly, Kant neglects the existence of a real and absolute world, embracing the concept of a subjective reality as experienced by each of us (Tally, 2013), conceptually reconnecting to the sense of embodiment, hence to the fact that the only way we have got to perceive the world, is throughout our body.

Arguably, Kant’s concept of space together with the previously introduced concepts of embodiment should be kept into consideration throughout this whole research as they constitute two fundamental keys for understanding and “digesting” the underlying pillars sustaining the adopted theoretical frameworks.

To bring the discussion to the next step, it is now important to denote the thin but yet substantial line which separates the concepts of space and place. As to our perception and accordingly with Kant’s interpretation, space tends to be a more abstract concept than place, often connected to our geometrical interpretation of the environment which involves areas and volumes (Cresswell, 2004). For instance, whereas an architect or a designer might be responsible for shaping a space, only people’s interactions with and within it will create the “sense of place and being” (Benyon 2014).

The sense of place was firstly defined by John Agnew as: “the subjective and emotional attachment people have to place.” (1987). This notion appears to build on Cullen’s description of place, where he states that the concept of place:

“...is concerned with one’s emotional reaction to the position of their body in its environment” (1964, as cited in Benyon, 2014)

Accordingly, the philosopher Tuan asserts that in adulthood, place can acquire deep meaning through the steady accretion of sentiment over the years, implying the instauration of emotional attachment even towards object, furniture and architectural elements (Tuan, 1977).

To conclude, in addition to the conceptual definitions of space and place reported in the previous paragraphs, one last point is worth being presented. For instance, Cresswell points out the semantical difference between the terms place and location, asserting that whereas a location indicates a static geographical point, a place can also be mobile – for example a boat or a camper (Cresswell, 2004), both places towards which we, as human, are able to create emotional attachment. The direct implication of this is that not only a place is situated inside a space, but it can also move through it.
2.3.3 Digital space

In relation to the previously introduced “Dasein” concept, Benyon outlines how Heidegger’s examples are difficult to extend to those places that mix digital and physical experiences, legitimately nourishing doubts about the ability of his definition to represent more modern conceptions of places (Benyon, 2014).

When examining the language patterns in the context of the web, Resmini and Rosati outline that expressions such as ‘he or she goes online’, ‘we meet online’ or ‘go up the page’ build on deep embedded conceptional models. Hereby, they wonder if people really move to places in digital space or if these places, if they can be so called, come to the people (Resmini & Rosati, 2011b).

Accordingly, another conception of place by Tim Cresswell also includes “imaginary places” (2004). Here, by taking into example Harry Potter novels he explains how the author’s narrative and description of the Hogwarts School – with its rooms, stones, tunnels and animated stairs – is able to generate “imaginary materiality” in the readers’ mind, and therefore a sense of place. Arguably, this represents an analogy to the imaginary materiality that people experience through gaming and immersive digital technologies such as virtual (VR) and augmented reality (AR) (Cresswell, 2004), hence suggesting that the sense of place and the concept of space itself might be both rightfully applied to digital contexts too.

To sum up, with the following definition Benyon makes explicit the deep relation between digital space and digital technologies:

*Digital space concerns digital technologies and how people interact with them and through them. It is about communication with other people. It is about how digital devices communicate and interact, and about the digital infrastructures that facilitate that.* (Benyon, 2014).

and again:

*Digital space is the space of bits rather than atoms.* (Benyon, 2014);

In light of this, given a specific environment, Benyon remarks the importance of understanding all involved technologies and their characteristics, hence how they interact with each other and with people, labelling such understanding as “the beginning of digital space design” (Benyon, 2014). Also, Benyon refers to the fact that some of these technologies are carried by people, whereas some other will be integrated in the physical environment they inhabit. With this, he comes closer to what Resmini and Rosati refer to with the terms “pervasive information architecture” and “ubiquitous computing” (Resmini & Rosati, 2011a).

Coherently with this, the process of deliberately designing the digital space appears to be essential in relation to modern and technology-rich workspace design, and therefore for the design of a CWS too.

2.3.4 Blended Space

To complete the journey through the types of space, there is still one last concept to be introduced, the one of blended space.

Blended spaces are spaces where the physical world and the digital world are closely integrated and designed to provide a different sense of presence (Benyon, 2012). Again, in blended spaces, physical space is deliberately integrated in a close-knit way with a digital space, they go beyond mixed reality as they are conceptually much closer to tangible interactions where the physical and digital are completely coupled. Also, the aim of blended space design is to enable individuals, or group of people - that don’t necessarily share physical proximity - to feel present in a blended space, acting directly on the content of the blended space (Benyon, 2014).

Some typical examples that create blended space are the use of augmented reality devices such as Microsoft Hololens or gaming apps like Pokemon GO, or even smart meeting rooms in which screens, sits and tables are placed in a way so to simulate physical proximity among participants. Yet it should be noticed that digital and physical space rarely co-exist, as for instance, as soon as sight is turned away from the device screen, or someone outside the blended space talks to us, we can no longer be present in the blended space (Benyon, 2012).
As we can see in figure number four, correspondences are an element of blended spaces that represent a link between physical and digital space. Thanks to correspondences users are able to experience the blend of digital and physical and sense the presence in a space of its own, the blended space. In other words, correspondences can be used by designers to bring digital and physical spaces together in a way that the experience feels natural and intuitive (Benyon, 2012).

In regard to the blended space model, primary research will look at its actual relevance in the context of CWS and CWS design, with particular attention to the implied technologies.

### 2.4 Coworking Spaces and IT

Both at the practical and academic level it is generally agreed that technology and more specifically IT played an essential role in the birth and development of the coworking space phenomenon (Ivaldi, Pais, & Scaratti, 2018; McGrath, 2018; Parrino, 2015). Even more importantly, as McGrath affirms, the same act of coworking from within a coworking space is enabled by technology - as one could not work from there without a stable internet connection and a laptop - but not technologically determined – as most coworkers could simply chose to work at home exactly in the same way they do at a Coworking Space (McGrath, 2018).

Although different CWS models might offer a variety of technological assets to their coworkers, at the most basic level CWSs provide just power supply and high-speed internet connection, similarly to conventional offices (Gianquitto & Battocchi, 2018; McGrath, 2018; Uda, 2017). This being said, non-informatics related literature which refers to the use and deployment of several types of ITs is abundant. Among these we find office equipment such as PCs, screens, projectors, TVs, printing & copying facilities and building access systems (J. M. Waters-Lynch, Potts, Butcher, Dodson, & Hurley, 2016), as well as more specific and advanced infrastructure such as hardware like 3D printers and 3D scanners for makers and industrial engineering, or again software for designers and digital services for software developers like VPN and cloud servers (Andrews, 2021; Müller, 2018; Rus & Orel, 2015). Additionally, as Rus & Orel state, within the context of a community-based CWS the type of infrastructure and facilities to be found is likely to reflect the field of specialization of its coworkers (Rus & Orel, 2015), meaning that a CWS mainly inhabited by architects will be more likely to offer architecture-related IT, whereas one inhabited by a strong community of software developers will most likely provide software development-related IT and services.

Furthermore, despite their absence in academic research, several CWS-specific management software are currently available to CWS operators as SAAS (Software as a service) under the shape of web platforms and mobile applications; among theme we find names like Cobot, Nexudus, Coworkify and Optix (Bages, 2021; Lukjanska, 2016) not to mention a whole list of CWS software which can easily be found with a simple web research (coworkingresources.org, 2021).

If on one side such software are helping operators to run their CWS smoothly by managing billing and resources, on the other, most of these applications include features for coworkers to exploit the CWS resources, access services and take part to the community’s life and activities. Nexudus, for example, as of today offers seven different mobile applications with well distinct functions, just to mention some, NexEvans for coworkers to subscribe to events and workshops, NexKiosk for selling items and additional
services to coworkers, and Passport to book meeting rooms, access discussion boards, update personal profile and consult/edit their membership plans (nexudus.com, 2021b). Also, on top of their internal functionalities several of these software count with a high level of third parties’ service integration, hence offering both operators and coworkers the possibility to connect the CWS application to other external applications, for example Stripe and PayPal for payments, Trello and Slack for project management & productivity, Kisi & Salto KS for building and room access management, Ezeep and Papercut for printers usage, and many more (andcards.com, 2021; cobot.me, 2021; nexudus.com, 2021a).

Finally, in relation to the previously described concepts of digital and blended spaces McGrath states how, based on real life examples, “a coworking space may be augmented with digital networking and social media, mirroring digital and physical communities in the space”. For instance, he points out, this is the case for WeWork or Seat2Meet where coworkers can create digital profiles in which they can provide their contacts, receive invitations or collaboration requests, list their skills and make public their availability to work and collaborate on new projects (McGrath, 2018).

Unfortunately, as described in the research problem, as to now there is a gap in the academic discourse about the use and deployment of digital technologies within CWSs, which is also the reason why it falls under the scope of this study to seek clarity and generate additional information about this topic through primary data collection and analysis.

3. Research methods

3.1 Semi-structured interviews

Semi-structured interviews represent a qualitative research method that combines predefined questions, like the ones used in structured interviews, with the open-ended exploration of an unstructured interview. The overall objective of semi-structured interviews is to systematically collect information about a set of researched topics, while leaving enough freedom to interviewees so that new issues and topics might emerge organically from discussion. Also, this research method is suited to those contexts in which the researchers already counts with some knowledge about the topic being investigated but additional information is required (Wilson, 2014).

Within the field of user experience, semi-structured interviews are often conducted in those situations in which behavioural observation is not possible because of timing, safety risks, privacy or other factors. In this contexts, this type of research can be used to understand user needs and goals, or to gather information about opinions, tasks, practices and work artefacts such as documents, equipment, photographs etc. (Wilson, 2014).

Semi-structured interviews provide the interviewer with a set of advantages such as the possibility to discover unknown issues, addressing complex topics through probe and clarifications, while also requiring less training and skills than the ones needed to conduct unstructured interviews thanks to the availability of a set of questions as starting point (Wilson, 2014). On the other side, the weaknesses of this research method should also be acknowledged in order to prevent avoidable biases and to enhance the research reliability. Among these we find the interviewer’s need for training and experience so that interviewees are not unconsciously driven towards specific answers; furthermore, the so-called “interviewer effect” determines the respondent’s will to answer the posed questions based on the demographic and psychographic gap existing between interviewers and interviewees, for example, a woman might not feel comfortable when discussing specific issues with a man (Denscombe, 2010 as cited in Wilson, 2014). Finally, semi-structured interviews present the difficulty to generalize the findings and compare the answers as different questions might be posed to different participants (Wilson, 2014).

3.1.1 Sampling method

As to the research purpose, the potential interviewee is represented by either a CWS operator (owner, community manager or similar role), or a coworker intended as any type of professional, independent or part of a company, inhabiting a coworking space and carrying out his/her professional duties from its premises.

Interviewees were sought throughout two different channels: open invitation shared on the author’s social media pages, and direct requests via email or LinkedIn messages.
Concerning the open invitation on social media, the author posted a brief introduction and request on his wall, with a PDF attached containing all relevant information about the study (context and purpose) and the interview questions which would allow interested professionals to better evaluate whether their contribution could be relevant to the research.

On the other side, direct interview requests were sent to coworking spaces’ email addresses as reported on their websites; coworking spaces to be contacted were retrieved among the ones listed and presented throughout the literature review, and the ones found by searching “coworking space + city” on Google, where city was equal to the following European cities: Rome, Milan, Turin, Berlin, Hamburg, Munich, Paris, Nice, Lion, Jönköping, Stockholm, Gothenburg, Lisbon, Porto, Madrid, Barcelona, London, Dublin. Among the given results, only the ones corresponding to the adopted CWS definition and listed within the first page of results were selected.

Moreover, additional interview requests were sent out via LinkedIn messages to the author’s contacts who were known to work in coworking spaces. Just as the open invitation, also direct requests included a brief introduction and the interview PDF attached (see appendix number 1).

For what concerns the previously scheduled interviews to be conducted in person with the coworking space operators in Porto, communication ceased as no more answers were received after the outbreak of the pandemic. For instance, a minimum total of twelve interviews had been planned originally, with more than 120 direct requests being sent, of which only nine received an answer and just five resulted in successfully carried out interviews: one CWS operator and four coworkers. Notably, three of the four interviewed coworkers, as well as the coworking operator were found within the author’s professional network, constituting therefore a non-stratified convenience sample.

3.1.2 Conducting interviews

Semi-structured interviews were carried out online by means of a video communication tool called Zoom, a computer software which allows users to make audio and video calls, screen sharing, audio and video recording, and other secondary features. After receiving a confirmation of interest from potential interviewees, the call was scheduled, and a Zoom Meeting invitation was sent via email.

Interviews lasted an average of 40 minutes, being these distributed among a first phase of mutual personal introduction, a second phase for contextual understanding of the interviewee role within the coworking ecosystem, and a third and last phase for asking the questions listed in the interview guideline document and eventually building on the received answers with more questions – see the interview questions in the appendix.

3.2 Web research

Considered the previously discussed research limitations, with particular reference to the ones emerged from the COVID-19 pandemic, further data collection techniques might be needed on top of the ones introduced before.

Accordingly, based on the information gathered throughout the literature review first, and the semi-structured interviews afterwards, additional data will be sought by means of web research, hence mainly by browsing emerged keywords on Google and reporting them in the results whenever relevant. Unavoidably, these data will be based on texts and media content such as images and videos, therefore without relying on user confirmation about the veracity of such information.

3.3 Research limitations

Although it is unconventional to start discussing the research methods by exposing the limitations, the strong impact of the events on the research strongly shaped the development of the research methodology, making it necessary to provide a contextual background before discussing the methods themselves.

This study was carried out in parallel to the authors entrepreneurial and professional activities, hence determining reduced time resources to be dedicated to the research. Not less importantly, it should be noticed that the research was conducted during a global pandemic, limiting the range of actions at the author’s disposal and causing further limitations.

For instance, the heavy restrictions to personal freedom imposed by Italy’s lockdown legal policies activated in response to the COVID-19 pandemic might have influenced the author’s ability to focus on the research,
hindering, among the others, his ability to overcome bias and probably, to provide the work with the needed conceptual linearity.

Further pandemic-related limitations such as travel restrictions and flight and accommodation cancellations affected the foreplanned field research which consisted of a travel to Porto (Portugal) from the 16th of February to the 10th of April 2020, travel in which the researchers should have conducted the already scheduled interviews of coworking space users and operators.

The main consequences of such developments have been the reduced ability of the author to reach out to potential interviewees, and the consequent need for a more extensive literature review which would make up for the scarcity of primary data - also forcing the deployment of additional research techniques as reported in the next chapters.

Finally, one last limitation refers to the scarce extendibility of the findings to other geographical regions which substantially differ from the ones to which the interviewees belong.

3.4 From interviews to literature review first approach

As a main consequence of the COVID-19 pandemic the author had to adapt the research plan, hence shifting from semi-structured interviews as main data gathering method, to have a literature review-based study instead; as to this, more space was given to theoretical background and frameworks.

Furthermore, the extended literature review was backed up by a modest quantity of primary data retrieved throughout semi-structured interviews and web research as exposed in the next chapters.

3.5 Ethical considerations

3.5.1 Privacy and confidentiality

In terms of privacy and information confidentiality concerning the interviews, all respondents were guaranteed anonymity, meaning that any reference to their words were made anonymous to the reading public through the use of name initials, fictitious names or interviewee number. All audio and video recordings were stored in private file storage devices that are accessible exclusively to the researcher, no documents containing the interviewees name were printed.

3.5.2 Informed consent

Interview respondents were informed about the purpose of the research and voluntarily participated to the interview after being provided with the interview information document by the author, with no monetary compensation – nor of any other type - being offered to them. All interviewees were given the possibility to check and correct their interview transcript, their consent was recorded firstly via email and then verbally at the beginning of each video-audio calls.

3.5.3 Dual role, involvement, and conflict of interest

It is important to consider that based on his personal experience within CWSs, as well as on his entrepreneurial projects to start a coworking space business activity in summer 2021, the author might unconsciously be affected by emotional and confirmation biases while investigating the topics falling under the research umbrella.

In light of these considerations, the author’s personal experience within the context of coworking spaces was used as a basis to develop the study and the interview structure, but at the same time any opinion deriving from his direct experience was excluded from the research findings in order to produce a more reliable and objective result.

Finally, it should be noticed that no direct economic benefits for the author depend on the outcomes of this research.

4. Results
4.1 The interviews

As result of the primary research five semi-structured interviews were carried out between June 2020 and January 2021 when none of the respondents was able to reach the CWS physical locations due to COVID-19 restrictions. The sample is composed of four coworkers and one CWS owner and operator, coming and working from three different countries which are Italy, Germany, and Sweden. Furthermore, all the interviewees fall under a tight age cluster which goes from 27 to 33 years, and concerning the fields of specialization, all coworkers operate in the IT industry, three of them as freelancers and one as part of small enterprise. A summarized table of respondents can be found here below.

**Table 1: Table of respondents**

<table>
<thead>
<tr>
<th>n.</th>
<th>Role of respondent</th>
<th>Coworking Space</th>
<th>Job</th>
<th>Location</th>
<th>Gender</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coworking owner</td>
<td>Treballu Rural Community Hub</td>
<td>CWS Owner &amp; Manager</td>
<td>Laconi - Italy</td>
<td>M</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Coworker</td>
<td>Gro36</td>
<td>Graphic designer - Freelancer</td>
<td>Jönköping - Sweden</td>
<td>M</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Coworker</td>
<td>Betahaus</td>
<td>IT Project manager – Small company</td>
<td>Hamburg - Germany</td>
<td>F</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>Coworker</td>
<td>Hub&amp;Spoke</td>
<td>Software developer - Freelancer</td>
<td>Cagliari - Italy</td>
<td>M</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>Coworker</td>
<td>Tribò</td>
<td>Software developer - Freelancer</td>
<td>Milan - Italy</td>
<td>M</td>
<td>33</td>
</tr>
</tbody>
</table>

Three interviews received consent for audio-recording, while two respondents felt more comfortable with no audio being recorded, comporting answers to be directly noted down in order to be summarized later on together with the audio interviews. Interviews’ summaries were then coded into the emerged topics which appeared to be relevant to the research purpose, these were then analyzed, and the results presented.

As result of the interviews coding, three categories of relevant information were identified:

1. ITs used in CWSs
2. Coworkers’ User Experience with IT at the CWS
3. Coworkers’ opinion about IT in their CWS

These are presented in the following chapters.

4.1.1 IT in Coworking Spaces

For what concerns the use of ITs in the CWSs inhabited by the respondents, a wide list of technologies and services was mentioned in the interviews with the majority of them being already emerged in the literature review. Moreover, respondents number 2 and 5 reported that more technological items are available at their CWSs than the ones directly provided by the CWS operator as these are often provided by coworkers throughout P2P lending, or, in the case of software, provided by third parties with no direct decisional power exercised by the CWS operator. As to this, a list of the technologies mentioned in the interviews is presented in the following table, grouped by respondent and by provider (CWS or Coworker).

**Table 2, table of ITs available to-for coworkers**

<table>
<thead>
<tr>
<th>Resp. n°</th>
<th>IT provided by the CWS</th>
<th>IT available through P2P lending</th>
<th>IT provided by third parties (not determined by the CWS operator)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Internet wifi, printer, screen, projectors, TVs, IT closet (tablet, digital camera, photographic equipment)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In relation to basic IT infrastructure, all respondents reported the availability of power supply and wi-fi internet connection, yet respondent number one reports that no wired internet connection is provided, and
two of the respondents (4 and 5) reported that cabled network outlets are available just in few spots and often used to connect permanent IT infrastructure such as printers, wi-fi routers, TVs and desktop working stations, and respondent number two reported that internet connection is available only through WiFi. At the same time, all coworkers stated that they never had the need of connecting to the internet via cable, and two of them (2 and 5) report that they don’t even have an ethernet port in their new laptops. On top of the just mentioned IT infrastructure, all the respondents referred to office equipment such as screens, projectors, TVs and printers/scanners, with two interviewees (2 and 5) who referred to them with the terms “basic facilities” and “essential devices”, also, respondent number two reports the presence of the Apple TV for screensharing and content streaming on all TVs.

For what concerns the provision of professional equipment the situation varies significantly from respondent to respondent. Respondent number one reports that in his CWS a “technology closet” is made available to coworkers, here coworkers can find items like a smartphone, a tablet and a digital camera with photographic equipment, but also minor items like a mouse, keyboards, webcams, cables, chargers, adapters, power banks, pen-drives, SD cards and external hard disks; these can be borrowed for free and put back in the closet once no longer needed. Furthermore, the CWS operator reports his intention to enrich the closet with additional technologies in the near future. Respondent number two reports that the CWS operator only makes available a photography studio with lights, flashes, camera mounts and green screen, yet much more equipment is available as coworkers (both freelancers and companies) often practice P2P lending, among these we find professional photo and video cameras, 3D printers, a drone and portable projectors; even in this case, the coworker reported the CWS’ operator will to widen its technological offer with 3D printers and a podcast station already in the following months. Respondent number 3 reported that she had at her disposal a variety of devices such as a graphic tablet, professional cameras, action cams, full equipped PC working stations and a digital library, yet she assumed that these items were not provided by the CWS but rather by her firm. Finally, respondent number five answered that no additional equipment was made available by the CWS, and respondent number four reported that in his CWS there is a makers’ prototyping working station equipped with 3D printer, electronics welders, digital microscope, sensors and components; moreover, he had borrowed an “emergency laptop” from the CWS and photographic equipment from another freelancer coworker.

In relation to the building/room access system, respondent number one reported the absence of an automated system for automatic access in his CWS, hence making it accessible only during regular opening hours or, occasionally, managing extraordinary access time by handling keys to coworkers; on the other side, room booking would happen through an external web application called “Calendly”. Respondent number two reported the existence of an automatic building-rooms access system that works throughout personal RFID tag, which is also connected to the room booking system on a private section of the CWS website which can be used both from desktop and mobile devices; on the website he can also monitor how much he is using the bookable rooms to ensure that other coworkers can benefit from them too. He also reported that outside regular opening hours he should turn off the security alarm after coming in to prevent it from accidentally activating it. Also respondent number three reports the existence of automatic building/room access system, here the doors can be opened with an RFID tag but also with the personal smartphone thanks to Near Field Communication (NFC) sensor; also, in her coworking a third party web and mobile application is used to book rooms – and exploit other features, yet she could not recall the name and would not know how it works as she never used it since they mostly use the rooms dedicated to her company. Similarly, also respondents 4 and 5 described an automatic building access system which works with RFID badges, with the difference that rooms booking would happen with the mediation of the CWS community manager and/or receptionist, in person or via email.

Concerning the billing system, respondents one, four and five send – in the first case – and receive – in the others - monthly invoices via regular email communication. Respondent number two receives an email notification and can then consult and download the invoice from his personal panel in the CWS web application. Finally, respondent number three reports that as part of a company she does not receive an invoice from the CWS, nor has a way to consult one.

When it comes to communication and collaboration tools, respondents reported the use of generic channels created, managed, and promoted by the CWS operator, these include WhatsApp groups (1) and Slack Channels (2 and 4). Here, operators would mostly hold informal conversations (1) or even coordinate CWS-wide projects that require coworkers’ professional services, or events planning (2 and 4). Furthermore, all interviewed coworkers referred to the existence of additional communication-collaboration tools in which the CWS operator would not be present. These include informal messaging apps like WhatsApp (3, 4 and 5), a Facebook private group (2), Google Drive private folders (2 and 4), Slack channels (2, 3 and 4), Trello
boards (2 and 4), Microsoft Teams and Azure DevOps, a software developer dedicated software for collaboration and project management (4).

In addition to this, respondents (2, 3 and 5) reported the existence of a newsletter service that they would receive on a weekly or monthly basis on their professional email inbox from the CWS operator, to be informed about new coworkers and coworkers who leave the space, events, workshops and community happenings, but also about scheduled maintenance activities, security measures and extraordinary opening-closure times. On top of the email newsletter, respondents one, two, four and five reported the use of email for ordinary communications such as support and information requests handling, troubleshooting, lost and found and guest invitation besides minor personal communication. To conclude, two coworkers (2 and 3) reported the presence of informational screens in common areas, this would introduce new coworkers and present information concerning weather forecast, events and news from the digital world.

Again within a digital context, respondent number three reported how some months after the outbreak of the pandemic, the Betahaus (respondent 3) made available to its coworkers a “skills’ bank” web platform on which they could upload information about their skills and availability, and then offer or request collaborations to other coworkers. Also, she reported that she had not yet tried the platform and that most likely she will not need it as she is an employee and not a freelancer who would look for services and collaborations.

Concerning the use of CWS management software, the only interviewed operator states that due to the recent opening, and shortly after the forced closure, still no subscription plan to a management software was made, and that most likely this would happen ones the pandemic will end and the business will run as normal. When asked which software he would opt for and why, the CWS operator stated that he had not yet researched nor made a choice about this. On the other side, three coworkers-interviewees (3, 4 and 5) reported the use of a CWS management software by their CWS operators, yet without being able to provide more information about this as no shared UIs nor functionalities were involved.

4.1.2 Coworkers’ User Experience with IT at the CWS

Generally speaking, all coworkers report satisfactory experience in relation to the usage of IT infrastructure available at their CWS, yet only one of the respondents (2) reports about the ease of use of an integrated system which aggregates multiple functionalities, (room booking, space usage monitoring and invoice consultation); this is made explicit by his statement: “it’s nice to be able to book a room or download my invoice from the same application, even on the go”. Even so, the same coworker states that still many functionalities are not available in the customized web application, and that basic interactions such as manually turning off the security alarm outside regular opening hours could be avoided with a higher degree of technological integration - for example, when you access the CWS with your card and the alarm gets automatically turned off, or being able to book a room when you schedule a meeting with someone and the invitation get accepted.

Accordingly, respondents number four and five reported a sense of stress due to effort demanding and slow procedures to “reach functionalities that could be at reach of your fingertips” (4). For example, respondent number five reports that inviting a client or any external guest into the space would require him to send an email request to the community manager or receptionist, and then wait for a confirmation which sometimes would arrive the day after. Also, coworkers three, four and five reported reduced service accessibility on the go, meaning that more functionalities are usually available on desktop web applications than on coworkers’ smartphones. This is different for respondent number two who reported that the all functionalities available on the CWS desktop web application are actually available on the mobile website too as this is a device-responsive web application.

Coming to digital presence and collaboration, three respondents (2, 4 and 5) reported to maintain frequent or constant contact with other coworkers at the CWS by means of digital tools such as Zoom, Teams, Trello and Slack even while working from home or other premises. Respondent number four reported that he often communicates/collaborates via Slack with a coworkers which is sitting just next to him; when asked why he would not turn to the peer to talk instead, he answered “I don’t know exactly why, but probably to keep focused on what I’m doing on my screen”. Similarly, respondent number five reported that several times he held video calls with other CWS members which were sitting in adjacent rooms, when asked why he would not walk to him instead, he answered that “physical presence was not needed, we often need to share our screens and this can be done online, probably better than in person”. Coherently with this statement, respondent number two reports that most of his work – 80 to 90 percent he states – is done without meeting clients or other stakeholders in person, but rather through digital communication and collaboration tools,
whereas physical presence is mostly required for manual and creative work such as brainstorming, photography, video recording, and painting. Furthermore, when asked whether any IT that simulates physical proximity, or physical-digital overlay is available in their CWSs – for example augmented reality devices or functionalities, all respondents reported the absence of such systems.

Finally, when asked what digital tools make their experience as coworker better, two coworkers (2 and 4) referred to informal communication channels such as WhatsApp and Facebook Messenger; respondent number two stated “most of my communication with other coworkers takes place on WhatsApp” and again “when I should meet up with someone at the CWS I usually write on WhatsApp to arrange the meeting” and when asked about the use of other tools such as Calendly or Google Calendar to arrange meetings he stated “I do use Google Calendar or email invitations to schedule meetings, mostly for online meetings I believe, but also for meetings in person that are scheduled at least a couple of days in advance”. In relation to this, respondent four stated “I always send invitations for important meetings that I should not forget” and “with Google Calendar I also set a reminder on my smartphone 30 minutes before the meeting to make sure I don’t forget it”.

4.1.3 Coworkers’ opinion about IT in their CWS

When asked an opinion about IT in the context of their CWSs all respondents agreed, even if to a different extent, that technology plays an important role within their experience at the CWS. More specifically, three respondents stated that IT plays an essential (1 and 4) and fundamental (2) role in their experience at the CWS.

Accordingly, coworker number four stated that if broadband internet connection makes it possible for him to work therefrom, benefiting from bigger and high-quality monitors to be coupled to his laptop screen enables him to be more productive; again, the same coworker stated that as software developer more IT would be needed to enable optimal experience and maximal productivity, for example working stations with two monitors or digital services like cloud servers.

On the other side, two coworkers (3 and 5) stated that their CWSs provided enough IT, with one of them (5) reporting that he does not expect his CWS to fulfil all technological needs of a software developer. Also, when asked about the presence of any video gaming console, a coworker (3) stated that as “serial gamer” she would love to play video games at her CWS during breaks or afterwork, yet none of these is provided.

Finally, respondent number two stated that he is looking forward to have new technologies at his disposal at the CWS, especially in light of the already announced purchase of 3D printers and a podcast station at his CWS.

4.2 Web-research

Web research became particularly helpful for the retrieval of information concerned with the CWS management software, their features and their integration with third parties’ software and hardware. Regarding this, a website called coworkingresources.org provides free informational resources for CWS operators. Here among the other resources, a complete list of CWS management software with functional comparison and ratings is provided (coworkingresources.org, 2021), the names of these software are reported here below:

- OfficeRnD
- Archie
- Nexudus
- Andcards
- Cobot
- Optix
- Satellite Deskworks
- Coworks
- Coworkify
- Essensys
- Habu
- Yardi Kube
Additional CWS management software was searched on Google first five results pages through the following keywords: Coworking software, coworking space management software, coworking space management application. The only software which was found in addition to the ones mentioned in the previous list is called Zora (Zora Systems, 2021) which based on the information presented on its website is an early-stage generic facilities management software for the Mexican market.

Although a functional analysis for each individual software would fall outside the scope of the research, providing an overview of what these tools can do for both CWS operators and coworkers might add informational value to the analysis, partially covering the lack of primary data caused by the reduced sample size. Therefore, the websites of the previously listed software were then accessed and browsed to learn how these systems work, how they deliver functionalities, and what functionalities they deliver to their users; whereas this will be further discussed in the analysis, it is essential to outline already now that functionalities are provided in two ways: with internal features and by connecting to it external software and hardware, the so called “integrations”.

Starting with the internal features, these are generally made available to CWS operators throughout a web back-office panel, and to coworkers throughout dedicated web and mobile applications; such panels and applications often include multiple features all accessible through the same software (see figure number 6). Nonetheless, as it is the case for Nexudus, features might be made available to CWS operators and/or coworkers by means of feature-specific applications. For example, one app to create events and selling tickets to coworkers – and for coworkers to buy them, or one for selling items to community members – and for community members to purchase them.

![Figure 6. Home screen member experience App OfficeRnD (Officernd.com, 2021a)](image)

Common internal features identified after browsing the CWS software websites are the following:

- Rooms booking
- Desk booking
- Membership management
- Multi-location management
- Communication and messaging
- Occupancy management
- Reporting and analytics
- CRM
- Issue reporting and support
- Invoicing and payments
- Community feed and newsletter
- Facilities and amenities management
- Guest/visitor management
- Mail delivery management
- Marketplaces for internal and external stores (Coffee shops, restaurants etc.)

Jumping now to integrations with external software, all browsed CWS management software websites dedicate a web page or a page section to list and describe the integration of external digital services, these integrations add functionality to the management software by connecting it to other systems used in the CWS, for example the building access control hardware. Based on the retrieved information, these integrations are concerned with the functionalities listed and described in the following table:

Table 3, Table of Integrations for CWS management systems

<table>
<thead>
<tr>
<th>N°</th>
<th>Functionality</th>
<th>Systems</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Payments</td>
<td>Stripe, GoCardless, Authorize.net, Paypal, Square Point of Sale, Braintree, Forte, Placepay, Omise, Ezidebit, bottomline, WorldPay, CardConnect, Moneris, PayDock, Adyen</td>
<td>These integrations are used to process and collect payments - single or recurrent - from coworkers, for their membership and/or for additional services</td>
</tr>
<tr>
<td>2</td>
<td>Accounting</td>
<td>Xero, Quickbooks Online</td>
<td>CWS sales-related data are sent automatically to the accounting systems</td>
</tr>
<tr>
<td>3</td>
<td>Single Sign-On Authentication</td>
<td>Okta, Azure SSO</td>
<td>CWS staff and members get automatically logged in to all available platforms while logged into the WiFi or wired to the network</td>
</tr>
<tr>
<td>4</td>
<td>Visitor Management</td>
<td>Envoy</td>
<td>Allow CWS operators to monitor and manage the access of non-members, coworkers can use it to invite visitors and offer them access to facilities and services</td>
</tr>
<tr>
<td>5</td>
<td>Marketplaces</td>
<td>Coworker</td>
<td>CWS operator can insert their CWS onto a marketplace which aggregates many CWSs</td>
</tr>
<tr>
<td>6</td>
<td>Meeting booking and scheduling</td>
<td>Zoom, Jitsi, Google Calendar, Hymly, Tapirix, Liquidspace</td>
<td>These integrations are used to schedule and book meetings</td>
</tr>
<tr>
<td>7</td>
<td>Reporting and analytics</td>
<td>Google BigQuery, Google Data Studio</td>
<td>Used by the CWS operator to gain insight into occupancy, facilities and amenities usage and sales analytics</td>
</tr>
<tr>
<td></td>
<td>Service Description</td>
<td>Software/Platforms</td>
<td>Notes</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>8</td>
<td>Printing and copying</td>
<td>Ezeep, Papercut</td>
<td>Used by staff and member to manage the access and billing of the printing and copying services</td>
</tr>
<tr>
<td>9</td>
<td>Newsketter &amp; Marketing Campaign</td>
<td>Mailchimp</td>
<td>Used to reach staff and coworkers to communicate news and events</td>
</tr>
<tr>
<td>10</td>
<td>WiFi Ticketing</td>
<td>Mikrotik, Cisco Meraki, Radius, Isopy, Aruba, IronWiFi</td>
<td>Used to manage internet access for staff and members</td>
</tr>
<tr>
<td>11</td>
<td>CRM</td>
<td>Hubspot CRM, MS Dynamics, Capsule</td>
<td>Use to connect and exchange data between CWS management software and Customer Relationship Management software</td>
</tr>
<tr>
<td>12</td>
<td>Collaboration and productivity</td>
<td>Slack, Trello, Google Drive, Dropbox, Office365</td>
<td>Use to connect the CWS management software and related Coworkers’ Apps to collaboration and productivity applications</td>
</tr>
<tr>
<td>13</td>
<td>Electronic signature</td>
<td>HelloSign, DocuSign, SignNow</td>
<td>Used by CWS operators to let coworkers sign membership contracts and services purchase</td>
</tr>
<tr>
<td>14</td>
<td>Community</td>
<td>Recomazing, included.co, Syncaroo</td>
<td>These category includes integrations which should bring benefits to the community; for example, Recomazing suggests tools to be used by the community of coworkers</td>
</tr>
<tr>
<td>15</td>
<td>Building and rooms access control</td>
<td>Brivo, Kisi, Salto KS, Salto ProAccess, Doorflow, Gallagher, Avigilon, ACT365, Tapkey, Sensorberg, Dormakaba Exivo, Welcomr</td>
<td>Are used by the CWS operators to enable staff and members to effortlessly access premises and rooms based on their membership plans and in correspondence or room bookings</td>
</tr>
<tr>
<td>16</td>
<td>Integrations’ management</td>
<td>Zapier</td>
<td>Zapier makes it possible to connect many more services to the CWS management software.</td>
</tr>
</tbody>
</table>

In addition to the integrations listed in the table here above, CWS management software like Cobot, OfficeRnD and Nexudus offer a developers-dedicated section for CWS operators to develop fully customized integrations and applications through the use of API services (Cobot.me, 2021b; Nexudus.com, 2021; Officernd.com, 2021b).

Finally, another fact emerged thanks to web research is that the Hamburg Betahaus CWS frequented by respondent number three uses the Cobot management software as observable in the clients section of the Cobot.me website (Cobot.me, 2021a); hence meaning that other coworkers at the same CWS might benefit from all Cobot features and integrations.

Figure 7, Cobot.me website - clients section screenshot (cobot.me, 2021)
5. Discussion

5.1 Coworking and IT

Based on the results and accordingly to what emerged in the literature review, technology does not determine coworkers’ will to work from a CWS, hence confirming that CWSs are technologically enabled but not technologically determined (McGrath, 2018) and that once basic IT has been provided (power supply and internet connection), community and wellbeing play a greater role than technology (Garrett, Spreitzer, & Bacevice, 2017; Müller, 2018). Nonetheless, IT was generally agreed by all respondent to play an important role within the CWS ecosystem as it enables remote working and affects coworkers’ efficiency and productivity.

At the same time demand for technological infrastructure appears to be growing and therefore, CWSs technological standards are getting higher in order to meet coworkers’ needs and expectations. Accordingly, three out of five respondents reported that their CWSs were planning to expand their technological offer in the near future. It is then important to mention that, as emerged in the interviews, often also coworkers play an important role in the provision of IT; for instance, the practice of P2P lending turned out to be common among coworkers, making available more IT than the one provided by the CWS operator, and potentially turning this practice into an integral part of the CWS ecosystem. In addition, especially for what concerns communication and collaboration tools, CWS operators try to address coworkers onto internal channels, yet the adoption of these channels appears to be driven and determined by coworkers who often create, promote and use alternative channels.

Coming to the identified technologies and related functionalities, comprehensive lists of these can be found in the results chapter. After discussing about how and by whom these technologies can be provided to a CWS community it is now important to discuss the role of these technologies within the CWS ecosystem. As to this, the author was able to classify the identified technologies into four categories:

- **Functional IT**: Functional IT comprehend devices such as computers, smartphones, graphic tablets and design software through which the coworker execute his work till completion and delivery;
- **Subsidiary IT**: Subsidiary IT mainly refers to office equipment that helps coworkers execute their tasks more efficiently, these technologies are mostly used together with functional IT such as computer and other computing units in order to extend their functionalities.
- **Information exchange IT**: include all software and features which are used by CWS operators and coworkers to communicate and collaborate, for example Emails, Slack, Trello and Teams;
- **Space Access and reservation**: for example room and desk booking systems, smart door locks and alarm systems, these include both software and hardware and allow coworkers to reserve and access premises independently without – or with few – help by the CWS operator.

It should be noticed that the listed categories do not include Wi-Fi and Lan connection, being this an IT minimum requirement to enable the deploy and use of all other IT.

Moreover, the information retrieved throughout web research let emerge the existence of a wide set of CWS dedicated software and hardware delivering functionalities to both CWS operators and coworkers.
Nonetheless, as outlined by the interviews result, only one of the respondents reported the adoption of such a highly integrated solution, adoption which is believed to be correlated to the magnitude of the CWS, being this a nation-wide multi-location CWS. For instance, as reported by all other respondents, their smaller community driven CWSs spaces relied on less integrated solutions, often composed of several independent software and hardware which would not communicate any data to each other, for example meaning that the room booking system would not be connected to the rooms door lock, and therefore actual access to the rooms should be managed manually. Although no data that would explain this gap was retrieved, financial reasons and lack of resources for implementation are likely to hide behind it.

5.2 Space, IT and sense of presence

As discussed in the chapter “defining coworking” it is evident that physical space and coworkers’ sense of presence in the CWS itself play an essential role within the CWS ecosystem. In this sense, being community the key component of a community-based CWS (McGrath, 2018; Müller, 2018; J. Waters-Lynch & Potts, 2017), it can be assumed that physical space is determined, among the other factors, by the community which inhabits it. Even more importantly, this finds factual confirmation in those interviews’ statements that refer to the adoption/purchase of new IT by the CWS operators in response to coworkers’ technological needs, hence once again, that physical space and its relation to IT are shaped by the community. To make it more tangible, if the members of a CWS community start to have more and more calls, both physical space and IT infrastructure will have to adapt in order to enable all coworkers to hold calls in silent environments. This might imply the design and creation of new spaces – for example small soundproof phone booths and adjusting the lan/Wi-Fi connection so that internet can be accessed inside the booths too.

With the growing importance and adoption of IT in community-based CWSs as discussed in the previous chapter, digital space as defined by Benyon (Benyon, 2014) proves to play a relevant role within the CWS ecosystem, hence confirming the need for a design approach which coordinates and harmonizes the creation of co-existing physical and digital spaces. Moreover, the relevance of digital space design appears to be confirmed by the coworkers who, based on their statements, often chose to act, work, and collaborate in the digital space even when physically close to each other. Arguably, based on the statements of respondent number four and five, the choice of acting exclusively in the digital space even while physical proximity exists might be due to the attention-cost to be paid when switching from physical to digital space – and vice versa, and therefore, to the higher degree of efficiency of collaborations happening within the digital space. Also, in spite of these consideration, physical presence might be seen an intrinsic factor which fosters coworkers’ motivation and productivity, yet further clarifications about this are to be found in social and behavioral sciences.

Finally, in relation to Benyon’s blended space concept (Benyon, 2012), the author found weak application in literature (McGrath, 2018) and no application at all in primary data as reported by all interviewees, hence meaning that at the moment, precisely overlying digital space onto physical space so that a new type of space is perceived, does not represent a trend nor a priority within the CWS ecosystem.

5.3 CWS, UX and interaction design

As observed in the results, coworkers, and therefore CWS users report fragmented user journeys due to the low level of IT integration and automation. For instance, although web research revealed great potential for IT integration, interviews let emerge how actual coworkers’ experience present a number of tasks which could be easily automated with help of CWS management software and connectable third parties’ IT services.

Based on the touchpoints taxonomy model (Kronqvist & Leinonen, 2019), the author assumes that UX fragmentation and consequent difficulties experienced by the user to access the system features might be related to:

- the distance among touchpoints (functionalities are too far from each other to be reached quickly);
- the high quantity of touchpoints due to low IT integration and automation;

Arguably, such issue could be better understood by mapping the user journey in order to understand where the UX loses its linearity.
Furthermore, by referring at Benyon’s Pact and Multiple Pact models (Benyon, 2014) it is clear that CWS present highly complex interaction contexts in which multiple individuals might interact with each other throughout the use of multiple technologies while being present in digital and physical space at the same time. Unavoidably, such complexity and the impossibility to isolate people from space and technologies should be taken into account when designing both interactions and presence in space.

Finally, it is worth to mention that more interviews would be needed to find out information about how CWS management software influence coworkers’ UX, as the small sample size hardly allowed the author to generate assumptions.

6. Conclusion & recommendations

In conclusion, by getting back to the research questions the answers are provided in the following paragraphs.

First of all, concerning the role of IT in CWS, both literature and primary data appear to confirm IT as an enabling factor for coworking, yet placing it in a lower position in the priority scale when compared to factors such as community and wellbeing. Nonetheless, primary data attribute an essential role to IT, again as coworking enabler, but also as a mean for achieving better results more efficiently.

Concerning the identified ITs in the context of CWS, four categories have been identified on top of basic IT infrastructure which include Lan and Wi-Fi internet connection. These categories are the following:

- **Functional IT**: Functional IT comprehend devices such as computers, smartphones, graphic tablets and design software through which the coworker executes his work till completion and delivery;
- **Subsidiary IT**: Subsidiary IT mainly refers to office equipment that helps coworkers execute their tasks more efficiently, these technologies are mostly used together with functional IT such as computer and other computing units in order to extend their functionalities.
- **Information exchange IT**: include all software and features which are used by CWS operators and coworkers to communicate and collaborate, for example Emails, Slack, Trello and Teams;
- **Space Access and reservation**: for example room and desk booking systems, smart door locks and alarm systems, these include both software and hardware and allow coworkers to reserve and access premises independently without – or with few – help by the CWS operator

This being said, a list which includes all technologies reported to be present in CWS can be consulted in table number 2. As observable in the same table, it is important to mention that IT is not only provided by CWS operators but also by the same coworkers through the practice of P2P lending, in fact, such practice has been reported by multiple interviewees, suggesting that this might be taken into consideration when evaluating which ITs should be provided by the CWS operator.

In relation to user experience and interaction design models introduced in the literature review, these have shown to be appliable to the context of CWSs and therefore useful for the design and modelling of CWSs that consider the relation and interplay among technologies, people and physical environment in which the act of coworking takes place. More specifically, the PACT model (figure 3 and 4) might be used to design and analyse the context in which coworkers activities take place, and the taxonomy of touchpoints (figure 2) can be used to design touchpoints for both coworkers and CWS operator to communicate and modify data in the CWS information system. Also, the “blended space” concept as defined and introduced by Benyon, a finds weak application in literature and no application at all (Benyon, 2012). Finally, for what concerns physical and digital space, both concepts as discussed in the literature review turned out to be relevant for the design of linear user experience in which coworkers might switch from the first to the second – and vice versa – with minimal switching costs in terms of attention and focus.

Coming to recommendations, further research could focus on user experience by mapping and analysing user journey. Also, parallel studies with a wider and better clustered sample could be carried out once the
COVID-19 pandemic is over and CWS become accessible again; this could reveal potentially useful information about the influence that the pandemic had on respondents as well as new information about how CWS adapted their IT to manage and minimize pandemic and health safety risks.

Furthermore, empirical studies about the use of technology within CWS might add informational value to the discourse, providing a more representative image of what technology is to be found in community driven CWSs – and other types of CWSs too. To conclude, this research does not investigate how coworkers’ gain access to technology in relation to CWS business model, hence providing no information about different degrees of access to IT based on pricing and membership plans.
7. References


Appendix 1 – Interview Information and questions

COWORKING SPACES AND THE ROLE OF IT
(a master thesis interview)

TO WHOM
This interview is addressed to coworking space operators or to any professional who works in a coworking space.

WHAT
A semi-structured online interview on Zoom or Skype. This research is about the use and deployment of digital infrastructure such as software and devices within coworking spaces, being these intended as complex socio-technical systems. Therefore, the study investigates the relation and interplay among that infrastructure, the involved actors and the physical environment in which the act of coworking takes place.

WHY
This study is carried out within the frame of my master thesis and it wants to provide the research community with a tool to build on the conceptual understanding of the coworking spaces ecosystem, while taking into account the role and influence of information and communication technologies (ICT) on the same. Also, achieving a better understanding at the ecosystemic level might also be of use to practitioners such as coworking space operators, coworking community managers, architects and interior designers in order to shape environments so that physical and digital layers are deliberately and correctly overlaid for the sake of maximizing co-workers benefits and utility.

QUESTIONS
1. What digital infrastructures are available at your CWS? Services, software, devices, IoT....
2. What is your overall experience with digital infrastructure at your CWS?
3. Are you using any CWS-related services, tools and devices while you are not at the CWS?
4. How could your CWS improve its digital infrastructure to better serve coworkers?
5. What is the role of technology and digital infrastructures in a CWS?

Please note that this research is not sponsored by any institution or private organization, as interviewee you will be granted access to the final research and your name won’t be published without your permission.

Not confident with your English skills? No problem, you can answer in Spanish, Italian and German.
Thanks in advance for helping me achieving my goals, the outcomes of my research depend on your experience and expertise – a wish you a sunny day.

Best regards, Enrico Porceddu