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Aspects of developing digital tools that would strengthen pedestrian mental connection between outdoor urban spaces.

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ABSTRACT

The urbanisation as a global trend (The Open University, 2016) encourage city transformation processes related to its urban form, mobility and perception of urban landscape. During the past decades most wayfinding has put stress on traffic by focusing on drivers, not so much on walkers (Herbes, 2018). My thesis will focus on combining socio-cultural, historical and built form city elements in a digital tool that would aim to help pedestrians with building a better understanding of a city while they are navigating through it. Scholars argue that pedestrian wayfinding concepts introduced by Kevin Lynch in 1960 cannot be fully applicable for the urban living of 21st century (Damayanti, 2019; Wesselman, 2015; Al-ghamdi & Al-Harigi, 2015). To navigate oneself more successfully in a city environment, the pedestrian needs to acknowledge the space not only by its built form, but also conisdering anthropological aspects related to it. As the theoretical groundwork for my thesis Kevin Lynch's (1960) "Image of the City" are used and Rully Damayanti's Phd thesis (2019) on extending Lynch's urban element meaning. Layers with socio-cultural information are created as a digital extension to an existing navigation app platform that aims to encourage pedestrian navigation and city exploration by feet. With usability tests of real life navigation experiment I will try to empirically prove if the layers enrich the wayfinding process experience and promote the effectiveness of it. The historical centre of Ålesund, a coastal town in Norway, and its surrounding areas are used as the base location for representing the prototyped digital layers. The results of the thesis present design strategies and methods that can improve digital map systems, thus improving the experience for the users. This study can be used as a groundwork for further development of guidelines that improve the digital map systems, particularly in the context of getting a better understanding of the explored area in Ålesund.

Keywords: pedestrian wayfinding, urban navigation, identity of place, social historical space

SAMMENDRAG

Urbanisering er en global trend (The Open University, 2016) som oppmuntre til by transformasjons prosesserer, relatert til dens urbane form, mobilitet og oppfatning av det urbane landskapet. De siste tiårene har veifinning lagt mest fokus på trafikken ved å fokusere på sjåfører, og ikke så mye på de gående (Herbes, 2018). Oppgaven min vil fokusere på å kombinere sosiokulturell, historisk og by aspekter samtidig som by elementer i et digitalt verktøy. Som skal ha som mål å hjelpe fotgjengere med å bygge en bedre forståelse av en by, mens de navigerer seg gjennom den. Forskere argumenterer at konsepter om veifinning for fotgjenger introdusert av Kevin Lynch i 1960 ikke kan være fullt anvendelige for de urbane levende fra det 21. århundre (Damayanti, 2019; Wesselman, 2015; Al-ghamdi & Al-Harigi, 2015). For å navigere seg mer vellykket i et bymiljø, må fotgjengeren erkjenne stedet ikke bare av sin bygde form, men også de forgjørende antropologiske aspektene knyttet til det. Som det teoretiske grunnlaget for min avhandling har jeg brukt, Kevin Lynch (1960) "Image of the City" og Rully Damayantis doktorgradsavhandling (2019) på å utvide Lynchs urbane element betydning. Lagene med sosiokulturell informasjon opprettes som en digital utvidelse til en eksisterende navigasjonsapp plattform. Som har som mål å oppmuntre til fotgjenger navigering og utforskning av byen til fots. Med brukervennlighetstester av virkelighets navigasjons eksperiment, vil jeg prøve å bevise empirisk om lagene beriker opplevelsen av veifinning prosessen og fremmer effektiviteten av den. Det historiske sentrum av Ålesund, en kystby i Norge, og områdene rundt er brukt som utgangspunkt for å representere prototypen av de digitale lagene. Resultatene fra oppgaven presenterer design strategier og metoder som kan forbedre digitale kartsystemer, og dermed forbedre opplevelsen for brukerne. Denne studien kan brukes som et grunnlag for videreutvikling av retningslinjer som forbedrer de digitale kartsystemene, spesielt i sammenheng med å få en bedre forståelse av det utforskede området i Ålesund.

Nøkkelord: veifinning for fotgjengere, urban navigasjon, stedets identitet, sosial historiske sted

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1. INTRODUCTION

1.1. Background and motivation

During the past decades most wayfinding studies have put stress on mobility that focus on drivers, not so much on walkers (Herbes, 2018). In past research about "walking" and "walkability" in city environment there has been a lack of emphasis on the importance of wayfinding, which is defined as "the interactive, problem-solving process by which people use environmental information to locate themselves and navigate from place to place" (Vandenberg et al., 2016). To see the places as "walkable" is a very important experience for the pedestrian to build a mental map of the city landscape, that can be influenced by physical accessibility, visibility, prior knowledge and even intuitive cultural expectations.

James Holston's analysis on Brasilia is an example that shows how due to a large-scale reconstruction and re-organization works, the capital became so unfamiliar to the habitants, that one may argue it intervened with citizen' wayfinding. The visual impact of constructing new architectural volumes in juxtaposition to cultural and historical landmarks defamiliarized the place and increased confusing reactions in habitants (Holston, 1989). The social aspects, as traditions and history form cultural expectations of a city that can serve as a natural wayfinding guide. Reconstructing the landmarks and main avenues in such a way may lead to disorientation and distortion of an overall image of the city. It is important to preserve the historical values also in the urban patterns by not changing the setting in a deconstructive manner.

A central church, square or a park, surrounded by commerce, finance and light manufacturing were the features that Brazilians liked most about their narrow streets and the walkable city environment (Holston 1989). People from ancient times have lived in communes that gradually have developed as cities that we know today. While preserving the historical image of the city, its vision of the culture and traditions are still alive in the contemporary society. The cultural familiarity with the historical city centre is still present in inhabitants mind, providing them with sub-conscious hints about the ancient urban structure – that, for example, the main church might be located in the very centre of the city.

This sub-conscious cultural familiarity of a city makes it easier to recall wayfinding elements and navigate oneself. Nowadays the usage of the classical paper map can be substituted with a digital wayfinding device that allows the user to follow a pre-constructed route without much thinking. The technology era that started at the 20th century has made digital maps more accessible, allowing Global Position System (GPS) to track the user's location and the variety of services that are available around him. Digital maps are ego-centric, placing the user in the center of view, whereas on an analog map the users first task will be to find out "where am I on the map". The study will look into the topicality of not only digital way-finding tool usage, but also physical map usage in everyday life of a pedestrian. There are successful outdoor signage systems as Legible London and WalkNYC that take a form of thoughtfully designed info stands, and are put in strategically accessible locations within a city. Nevertheless, digital wayfinding tools can also provide the user with some advantages as building the route for him and displaying the surrounding services. Google Maps could be considered as a key player amongst digital navigation apps on smartphones and tablets, but also Apple produced maps are widely used (Panko, 2018).

A sense of place and recognition in wayfinding increases the confidence in habitant, because of understanding the proximity of desired locations. This encourage the habitant to walk more and decreases the dependence on transit (Pearce, 2018). Digital tools now are made to simply show the route to our desired destination and the services that surround us, but what if they could show the real "essence" of place? Marc Augé in his work on Non Places (1995) describes that every place has an anthropological side, a social meaning "formed by individual identities, through complicities of language, local references, the unformulated rules of living know-how" (Augé, 1995). It is a rich supplement to the urban form and raising awareness about it would increase the legibility for the inhabitants of the city.

1.2. Methodology

A mix of qualitative and quantitative research methods will be used for this study. The main focus is put on qualitative data analysis, but in the user study section surveys are performed as a quantitative data collection method with results analysed in both descriptive and content analysis form.

The theoretical groundwork is based on Kevin Lynch's concepts on city elements that he describes in his book "Image of the City" (1960). The descried elements that form the urban environment (path, edge, district, landmark and node) will be extended with more recent scholar critiques on the relevance of their recognition nowadays. A traditional or narrative literature review will be carried out, which summarize relevant articles and projects on cognitive and practical aspects of pedestrian urban wayfinding. The review will look at how during the past decades pedestrian wayfinding has been developing along with the IT devices and how digitalization of information has changed the perception of building a mental map of a city. The literature review aims to conclude on the correlation between the awareness of social identity of a place and mental connections between different urban locations. It also aims to support the hypothesis that (H) if the digital device provides information about urban form, social, cultural and historical aspects of a city, pedestrian's awareness of social identity of place is increasing thus improving the mental connections between outdoor urban locations.

The practical part of the research requires urban study methods where the environment of Ålesund, a coastal town in Norway, is chosen. The discussed urban design concepts and examples are referred to a large scale city context, which in this case is not present in Ålesund town setting. By choosing a smaller scale environment, it is possible to get a more thorough understanding of the urban structure in a shorter time period. Although Ålesund is a vibrant town that features historical area and residential surroundings, the application of the urban design concepts (discussed further in literature review) cannot provide fully reliable results, because of its town-scale environment. This will lead to the possibility to generalise results not further than the surroundings of Ålesund.

In order to implement the findings in a digital tool it is necessary to develop preliminary habitant mental map of the area in aim to understand the existing urban environment. As

previously mentioned, this approach is practiced by urban planner Kevin Lynch. The methods described in his book “The Image of The City” will be used to explore how the urban elements are recognized by the city habitants. The methods include various forms of mental mapping and will identify the elements of the city constructed from habitant experiences. Parallelly a user research must be carried out to understand the main issues of pedestrian navigation in the specific urban environment.

According to the urban study and user research results, user centred design methods are applied. Personas with scenarios are developed describing the everyday pedestrian navigation issues within the city. In order to successfully integrate the solution in an existing digital navigation tool, task analysis are performed, based on which personas and scenarios are refined. Physical and digital prototyping methods, as sketching, wireframing, different visualizing and modelling software are used to create a prototype, which is being tested, evaluated and refined to a high fidelity prototype.

The gathered information would be transferred to an interface based design that is possible to be viewed as a digital map application via smart phone. The participants then are gathered and different locations are given for them to find by using the map prototype as a navigation tool. After they have navigated through the city environment, a post-experiment discussion would take place where after their feedback it would be possible to analyse the data and conclude weather research hypothesis can or cannot be supported. A content analysis method would be used to analyse the data from interviewees as one of the commonly used methods for qualitative data analysis.

1.3. Research Limitations

As this research has a master thesis framework, the scope of the study is being limited. Factors as limited time and recourse are taken into account and focus is put on following actions that narrow down the research field:

a. the design proposal involves only one segment of target audience and features that are discussed and chosen from the user study section and are developed further;

b. the research does not look into other types of navigation, as indoor way-finding and vehicle mobility (car, public transport, bicycle), but the focus is specifically put on pedestrians;

b. the navigation experience in the prototype is limited and does not involve the whole application usage, but only the specific design feature.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

A traditional type of literature review is conducted in order to obtain knowledge and collect data related to the research questions. The gathered information, concepts, critiques, descriptions and suggestions were found in scientific journal articles and books that are primarily written by experienced professionals, professors and other scholars. Although some concepts are taken from sources of the last century, the aim is to look at them through the lens of scholar critiques and ideas from the time frame of the past 5-10 years. The necessary information was gathered from both primary and secondary sources. Primary sources as Kevin Lynch's book "Image of the City" (1960) gave theoretical background about the previously discussed research problem on mental connectivity between outdoor urban spaces. Marc Augé "Non-Places" (1995) provides more thorough explanation for the social meaning of places and Rully Damayanti's critique on the relevance of Kevin Lynch's elements nowadays (2015) creates a groundwork for further research that re-defines the elements adding a socio-cultural meaning to them. Secondary sources of other scholars helped to get a general understanding about the topic and specific issues related to it. In order to empirically test the hypothesis later on, literature review looks into topics that cover the potentials and downsides of digital wayfinding tools.

2.1. Elements of the city – extended

Building the navigation system in one's mind involves the process of mental map making. A mental map is a cognitive representation of space, which, according to Lynch (1960), is based on natural and man-made elements of the surrounded environment. In a city these are architectural and urban components which create patterns and guide the person through the city. American urban planner Kevin Lynch is best known for his work on urban form and mental mapping. In his book "The Image of the City" he describes that in environmental perception process the city elements are recognized both, physically and psychologically. He describes 5 important elements that are the core qualities for building up the mental image of the city. These qualities are used to guide and recognize specific places within the urban landscape (Lynch, 1960):

- Pathways – streets, sidewalks, trails, canals, railroads and other channels along which person moves;
- Edges – boundaries that form breaks in continuity, such as waterfronts, large walls, railway cuts;
- Districts – areas that have the same character (style, colours, texture, urban fabric, etc.) and person can enter and be "inside" of them;
- Nodes – strategic points in the city where all the flows meet and person can be directed to other places (central stations, gathering places, large junctions);
- Landmarks – points of reference that person cannot enter into, a defined physical object, usually a special building, sign, monument, mountain.

As Lynch describes *"districts are structured with nodes, defined by edges, penetrated by paths, and sprinkled with landmarks."* (Lynch, 1960, p.48-49). Some elements can be recognized to have multifunctional character as a street can also define an edge of a neighbourhood or a node that leads to other paths. All elements are interrelated according to the city context and together create the city image as a "whole". Lynch defines the visual quality of a city according to (1) *legibility*, when elements are clearly recognizable and can be arranged in a logical pattern; (2) *image*, when the result of human-environment interaction forms a subjective image; (3) *identity*, when the created image has a specific structure and meaning, and (4) *imageability*, when the qualities of an object evokes strong images in any given observer. Later in his work Lynch writes more about the meaning of a place and how it can be defined; as the relation between person's social class and spatial behaviour and the influence of it throughout the time (Lynch, 1972). Also in "A Theory of Good City Form" (1981) he mentions factors that affect the development of meaning for a place, such as accessibility and adaptability and diversity of the spatial urban elements (Lynch, 1981).

The mental map is not necessarily geographic, but rather represents the relationship of the locations and routes that are memorable and relevant to the user's needs. According to the Legible London project (2006) the key for building mental maps lies in this relationship that describes how the areas are being connected using routes in one's mind. The journey starts at the node, when a person arrives to a specific location and enters the wayfinding system. From there the knowledge of the nearby area around the node (the locality) is built up. The locality

clusters are then used to represent bigger scale information about the neighbourhoods. These steps are used to build up mental maps for the pedestrians applying the concepts to the "Legible London" wayfinding system (Fendley et al., 2006).

Sam Wesselman in his online collection of architecture and urban planning articles raises the question of relevance for the Lynch elements in contemporary society of 21st century. He writes that "*the issue is that this vocabulary has become somewhat obsolete in describing all but the most historic and innermost cores of cities, places that people have come to recognize as important, but generally do not access them on a daily basis*". The post-war cities do not resemble the dense urban structures that were common before, instead they have expanded creating single-purpose suburbs with vague, undefined areas and intersections so large that they cannot anymore be classified as nodes or other elements from Lynch's theory. He argues that the city planning and understanding is more complex than a "*simple addition of a path here, a node there,*" and that by introducing the "*somewhat naked elements*" that lack the cultural meaning, the built environment has developed in a faceless and meaningless way.

> "*Why the highway has failed as an aesthetic element for the city is exactly because it has no other use except for transportation and considered as a necessary evil for the modern city at best*." (Wesselman, 2015)

For acknowledging a more complex definition of a place, it is possible to look at it through the lens of anthropological concepts. The social meaning of space is discussed in Henri Lefebvre's book "The Production of Space" (1974), where he introduces the concept of space as a social production considering not only the spatial character but also time and society. Marc Augé in his theory on Supermodernity in "Non-places" (1995) distinguishes a place from more abstract spaces explaining that "anthropological place" is "*formed by individual identities, through complicities of language, local references, the unformulated rules of living know-how*", but "*spaces which [..] are listed, classified, promoted to the status of 'places of memory', and assigned to a circumscribed and specific position*" (Augé, 1995, p.101, p.78) he introduces as "non-places". Augé's social meaning of place includes three aspects: identity, relations and history, which consist of both, spatial and social content. These aspects are interrelated in a sense that individual identities can coexist and have a common occupancy of place thus having relations as shared identities. The historical aspect accommodates the shared identity in a

continuum of time, creating places of memory and "*what we see in them is essentially how we have changed, the image of what we are no longer.*" (Augé, 1995, p.55) As an example Augé describes a feast that is still annually celebrated in front of a renovated chapel to keep the tradition alive, strangely enough for those who inhabited the place from the very beginning it is an invitation to a spectacle of a fragment from their history, that they once perceived as ordinary life. These are the monuments of social space (the chapel in this case) that can be represented as *"[..] a set of breaks and discontinuities in space that expresses continuity in time."* (Augé, 1995, p.60).

There are spatial arrangements that can express the identity of place, similarly as there are contours of an island and facades enclosing a historical square. Rully Damayanti has based her PhD work (2015) on re-evaluating Lynch's five spatial urban elements and reformulating them by adding a social context. The extension of these elements is defined as "spatial recognition" and its aim is to provide better understanding of society in addition to the urban form:

1. *Historical value* – meaning of the places in relation to the broader scale of the areas;
2. *Social spaces creation* – paths and nods that create meeting places for people;
3. *Territoriality creation* – edges and district areas of social activities that can also affect the identity of society;
4. *Point of references* – landmarks that refer to social life.

Because of misinterpreting Lynch's elements, architects and urban planners have used them in terms of evaluating visual quality and legibility of the elements, but often forgetting the recognition of identity and social meaning. Damayanti echoing Lefebvre's concepts underlines that space creation is a process of social construction undertaken by a society and developed over time. Space, society and time are the three main factors in understanding space as a product of social construction. Contemporary Asian cities are an example, where Lynch's elements cannot be applied, because the issues of spatial segregation based on ethnicity and social class dictate the pattern of the city (Damayanti, 2015).

2.2. Walkability of a place

Walking is considered a form of an exercise that is recommended for improving not only physical health but also mental wellbeing ("WHO | Physical Activity and Adults", 2020). By making walking more accessible and desirable people will walk more rebuilding a healthier and safer community. The businesses of the local community also benefit from pedestrian mobility, as more people do window shopping and the chances of entering the ground floor shops are higher (Arquati, 2008).

In order to support pedestrian mobility in the city, their needs and behaviours must be taken into consideration. Every walker wants to know where to look for the information he needs, how to communicate it, and how to get around quickly and intuitively. One of the goals for influencing people's choices between walking and driving is to encourage people to reach their destination on foot rather than using a car or public transport. This can be done to demonstrate sufficiently that the route is much shorter than expected, can be reached more convenient and faster than using a car. This can be achieved by the means of using a variety of information, including walking maps, local area maps and route signage (Fendley et al., 2006).

In research that was carried out by Richa Singh (2016) the results showed that the perception of walkability was influenced by factors as the built envelope on both sides of the street and other urban form related conditions, as block length, feeling of enclosure and edge conditions. The creating the perception of walkable neighbourhood these aspects are the most crucial (Singh, 2016).

2.3 Urban wayfinding styles

According to a recent study in Netherlands by Zomer et al. (2019), there can be determined two urban wayfinding styles according to behaviour of travel and preferred navigation method. There are several components that influence and explain urban wayfinding behaviour described in experimental studies, such as:

- “socio-demographic and motility (e.g. gender, age, mode availability, and financial compensation);
- urban environment (e.g. urban density and perceived accessibility levels);
- navigational preferences (e.g. minimize number of turns and active navigation ratio);
- daily travel behaviour and patterns (e.g. mobility portfolio, mobility cluster pattern).” (Zomer et al., 2019).

After the participants completed a three day diary along with a cross-sectional survey, it was concluded that wayfinding behaviour can be categorised into two urban wayfinding styles that are based on attitudes towards spatial knowledge and orientation intents. *Orientation Ability* - basic knowledge, skills and actions for orienting in the surrounding environment – bands together self-to-object (egocentric), object-to-object (allocentric) and map-based orientation. *Knowledge Gathering & Processing Ability* – preference to extend the basic knowledge, by exploring and taking new routes – combines the potential knowledge of landmarks, planned route and map knowledge (Zomer et al., 2019).

2.4. Legibility and connectivity

The city environment works as “an enormous communication device”, that is interpreted by its inhabitants in many different ways. The ways of reading the city are influenced by both temporal and spatial legibility. For a city layout that has preserved its identity and historical traces recognition and legibility “is better than one that is chaotic or has destroyed its past” (Lynch, Banerjee & Southworth, 1990, p. 518). For city planning and developing it is indeed important to keep in mind that not only spatial form builds the image but also the historical link to it.

Different sociological and cultural aspects influence individual’s urban perception. A case study in 2019 about GPS-based navigation effects on perception and image formation shows that “the numbers and content of the perceived images varied depending on a person's educational level, the residential area where they lived” and this also influenced their mobility in the city by foot and by vehicle (Erçevik Sönmez & Erinsel Önder, 2019). This means that the principles

of Lynch's "legibility", where … cannot be completely generalizable. Scholars write that both mental and physical connectedness between places is highly dependent on the legibility of the built urban form. The geometrical and topological relations between the different parts of the space influence the wayfinding performance and "the misalignment of local, cognitive reference frames suggested by architectural features leads to way-finding problems" (Werner and Schindler, 2004). Urban form influences not only the flow and ability of people to orient themselves, but also their interactions and networks in the living and working environment (Wentz et al., 2018). Elizabeth Wentz and her colleagues define materials, configuration and time as three main components of urban form, that are explained accordingly:

"Materials, or the physical elements of the urban landscape, consists of three aspects (1) human constructed elements, (2) the soil-plant continuum, and (3) water elements. The second component is configuration, which includes the (4) two- and three-dimensional space and (5) spatial pattern of urban areas. Lastly, because of the dynamics of human activities and biophysical processes, an important final component is the change of urban form over (6) time." (Wentz et al., 2018)

2.5. Map based signage: Legible London

There is a certain behavioural pattern common for a pedestrian in a wayfinding process and it is to answer four basic questions: Where am I? Where is it? How do I get there? What else is around here? These questions set certain conditions and activities that follow, as knowing where you are, knowing the desired destination, following the best route, recognizing the desired destination and successfully finding the way back (Dziuban, Moskal, Cassisi & Fawcett, 2016). It can be argued that visualized answers are more helpful to perform the actions that lead to the set goals (as recognizing the destination and finding the way back). Fendley et al. (2006) clearly lists certain advantages of a map based signage over other types of signage design. He argues that map signage encourages walking, because of the ease for showing many more routes and destinations (compared to a other types of signage, as fingerpost, for example), also by adding simple "5-minute walking circle". In a map it is possible to combine different graphical approaches as text, 3D illustration, directional lines or arrows, colour coding

and other elements for more universally understandable design. He also mentions street clutter as a big issue in Bristol and London, where map based signage can more efficiently substitute fingerposts and be integrated in lights, litter bins, etc., reducing 40% of street furniture, thus absorbing enormous amounts of street clutter (Fendley et al., 2006).

Legible London is a pedestrian wayfinding system, that developed from early study in 2007 and now is a part of UK's transport policy in its capital city. It consists of unified signage design in public transport nodes, on-street elements and paper-based products, as well as supportive digital mapping information, that all aim to help people plan their journeys on foot and give the confidence to explore (Spinney, Reimer & Pinch, 2017). The Legible London project emphasize the importance of landmark recognition and walkability, therefor the landmarks are highlighted as 3D illustrations accompanied with walking distance circles. The schemes for Legible London were built on the knowledge from Bristol project, where city audit identified "strider and stroller" as two behavioural types for the pedestrians who navigate (Jeffrey, 2017). Colette Jeffrey explains in her work, "A *stroller* seeks memorable experiences by drifting and wandering through a new city focusing on the environment, not on the information. A *strider* wants to get to their destination as quickly and efficiently as possible and their strategy is often to get near, then use information and the environmental cues to find their destination." (Jeffrey, 2017, p. 517-517). The Legible London aims to cover information for both, striders and strollers, by providing digital and static information.

2.6. Urban interaction design

There are three separate terms that make up the title of this field. Urban interaction design (UIxD) plans the interaction of people within the urban environment that involves technology. "Urban" refers to the spatial aspects of human relations, based on a social science approach. "Interaction" refers to technologies ranging from city-wide solutions to the local level. "Design" builds on interdisciplinary art traditions, combining criticism and creativity, emphasizing both theory and practice (Suran et al., 2014; Suran et al., 2015; Brynskov et al., 2014).

In the 21st century a concept of “digital city” can be applied to spatial planning. A digital city is characterized by three aspects: a flow of information space, where space is a “social information infrastructure for urban life”; space as platforms that support community networking; spatial structure between urban built forms and digital interactions (Chang, 2003). Location Based Services (LBS) enable the production of information and knowledge sharing using social platforms that creates the digital space around the users (Li, 2006). The built form has a layer of information generated by social media as well as interaction via smart devices. Urban interaction design is a field which explores both, physical and digital interactive aspects of space (Suran et al., 2015; Brynskov et al., 2014).

More and more devices are being developed to be connected to internet (Morgan, 2014), this can be observed not only for everyday products, but also for architectural and urban components. For example, “Intelligent Façades” that can be adjusted according to outdoor environment and indoor thermal comfort (Ahmed, Abel-Rahman & Ali, 2015) or interactive wayfinding signs that point to the desired locations (BREAKFAST LLC, 2019). As described in UrbanIxD (Suran et al., 2014) Manifesto, city has changed from “life between buildings to life between systems”. In order to understand the urban interaction processes in the Digital Age (n.d., 2018), professionals from different fields - information technologists, urban anthropologists, philosophers, artists and sociologists, architects, etc. – are working interdisciplinary to make the “smart city” more liveable for its citizens (Suran et al., 2015).

2.7. Public involvement and participation in planning

Urban interaction designer’s role is also to engage the public in the city-building process, because users' point of view often may differ from the planner's perspective. User habits and specific travel routes are the daily experiences, which form the important information for the urban interaction designer. Such collaboration with the public will facilitate the city-building process and improve project solutions (Brynskov et al., 2014). David Harvey (2008) in his work on The Right to the City echoing Lefebvre (1991), argues that society needs to think about right to the city as a human right. People have the right to change the city as they change themselves, because city is not static, it is dynamic. The community and public groups should

make decision on how the processes should take place. The development and re-arrangement of the city should be a transparent process, and public voices should not be muted accordingly (Harvey, 2008).

In the field of spatial planning the participation of the public for whom the planning is carried out, is increasingly important. To bring the practices of GIS and mapping to a local level, PPGIS (public participation geographic information systems) can be used to generate knowledge about the surrounding environment (Rall, Hansen & Pauleit, 2019). An alternative to public meetings and discussions in an online mapping tool that support PPGIS. This is how people can participate anonymously with comfort from any place. This option offers a potential for significant amount of data being collected more efficiently, allowing the participants to add comments and photos of the specific areas (Rzeszewski & Kotus, 2019). Although PPGIS as an online mapping tool could help in spatial planning, Michal Rzeszewski and Jacek Kotus points out the downsides related to the complicated usage of it and the need of constant internet connection. Also a presence of such a complex digital device can provoke a digital exclusion within the local communities, as difficulty for elderly people to use it and the question of trust-worthy information providing from the younger generations.

Couple of years ago Google launched the Local Guides feature for Google Maps in aim to achieve higher human participatory in providing geographic information by allowing them to add reviews, photos and in other ways express their personal opinion in a gamified way. The reason why it has been a failure, Google My Business Product Expert Steady Demand's Ben Fisher explains, that it is "too easy to manipulate" (Pitman, 2019). The system gives user a point each time he writes a review, answers in the Q&A section or posts a photo, which results in a false "power" status and confidence with no real rewards. SearchLab's Greg Gifford understands the purpose behind gamification, but in his opinion, the result is completely opposite to the intentional outcome. The system provides points for any action that is not properly verified and "Ironically, the more fake reviews and spam a user submits, the more likely they are to become a Local Guide" (Pitman, 2019). Greg expresses more trust in non-Local Guide users, because their interests go above earning points - they are willing to help society by sharing a true, useful and detailed review. This is what makes OpenStreetMap more useful for user participation – the data are accessible for everyone, the edits are not

verified, therefor immediately visible, and users are willing to contribute for making the map more legible ("About OpensStreetMap", 2019).

2.8. Digital tools and their usage

Along with digitalizing the information, also GIS has become more accessible on smart devices to the local community, but experts say that relying only on the GPS and the displayed map weakens the human-environment interaction, which lead to loss of attention and individual's ability to predict locations and distances (Willis, Hölscher, Wilbertz & Li, 2009). It is important to see the digital tool not as a device of distraction, but rather as a system that feeds the user with the necessary information for him to create mental connections and understandability of the city around him. According to the experiment May et al. (2003) carried out comparing wayfinding with a GPS-based navigation device and without it, the need for interaction with city elements (landmarks, nodes, paths, etc.) was reduced, but the use of device did not prevent of perceiving and remembering them (May et al., 2003). Moreover, the results can draw parallels with Sönmez & Önder's (2019) work, where it is said that "landmarks, buildings with distinctive design features, and crowds of people in front of a building or a function drew strong attention as local landmarks" (Erçevik Sönmez & Erinsel Önder, 2019, p.110).

2.8.1. Active and passive travellers

In literature and experimental studies on urban wayfinding scholars usually define two types of how pedestrians navigate, that are categorised in two simple navigation strategies – *planning* (looking at the map) and *doing* (looking for signs and interacting with outdoor elements) (Spinney, Reimer & Pinch, 2017). Zomer et al. (2019) calls it "*route-based wayfinding*", where a sequence of local views are memorised and pedestrian makes landmark-intersection based turning points along the route; and "*map-based wayfinding*", where decisions are map coordinated and pedestrian's mental map "includes spatial relations and distances between important urban elements" (Zomer et al., 2019).

According to the chapter “Mobilizing the pedestrian” people use to mix both of the previously mentioned strategies. Afrooz, White & Parolin, (2018) carried out an experiment where eye-tracker was used to determine on which visual parts of the coordinated and “free” walking journey pedestrian puts more emphasis. From the heat maps it was concluded that the accuracy of outdoor wayfinding can be increased by creating urban “eye-catchers” and memorable building elements. Here again the experiment defines “active traveller” as a participant who is not using a wayfinding guide and “passive traveller” who is using a GPS. The results suggest that memory performance and cognitive configuration is better or increased for the active traveller, because of the direct involvement in the wayfinding task (Afrooz, White & Parolin, 2018).

2.8.2. Hands-free devices

There is also an increasing interest to improve usability for aging population (Walford, Samarasundera, Phillips, Hockey & Foreman, 2011). To solve the previously mentioned issue and making it more accessible to both able and disabled people, hands-free feature is being introduced in interface devices. The method of providing a hands-free urban wayfinding system for elderly may minimize the struggle of getting familiar with an interface and lower the feeling of exclusion. Hands-free feature also allows more interaction with the surrounding environment, thus decreasing human-interface distractions. Greg Milner’s work (2017) suggest that walking and reading a map are both spatial processes that require similar amount of attention. If the directions are perceived as a sound from a spoken language source, it is a verbal process and therefor makes it easier to multitask the two similar processes (Milner, 2017).

Smartphones are the most compatible for integrating hands-free navigation, because of positioning capabilities and other already built in sensors as acceleration, barometer, gyroscope, etc (Bartie et al., 2018). A device called “SpaceBook” was developed by Bartie et al. to focus on speech interaction and hands-free, eyes-free application. After evaluation it was concluded that more detailed descriptions about the landmark physical features were necessary, as colour or details. The biggest issue was the noisy environment interpretation as the users voice, thus giving wrong push/pull notifications (Bartie et al., 2018). A similar system for blind pedestrians was designed by R. G.Golledge, Klatzky, Loomis, Speigle, and Tietz (1998)

that gave an information about the instant environment around the user. “Vista space” is a concept that represents the visible space and objects from the standing point of the pedestrian. It is widely used in Augmented Reality navigation tool prototypes, but it is hardly possible to make the actions intuitive, as the user has to learn a whole new way how the device provides the information (Bartie et al., 2018).

Hands-free feature gives an advantage that the system recognizes the actual objects, names of the buildings and their functions, rather than naming just the streets. It creates a hierarchy of the visible objects or buildings putting the highest importance on those where the pedestrian comes to a junction and where he has to make a choice. This encourages the pedestrian to explore the space, remember the turning points and build the mental map based on landmarks and “vista space”.

The voice control and augmented reality integration is not the only way for making a device hands-free. There are prototyped solutions that users can wear on themselves thus allowing the device to monitor the action patterns in real time and body movements of the user. Smart watches (e.g. from Apple, Sony and other companies) are widely available already, but less known navigation devices as smart glasses (e.g. Google Glass) and smart shoes (Lechal, 2017) are also being prototyped. A personalized wayfinding information can be provided if the device is synchronized with a map and satellite navigation system, but none of them have been fully adapted for universal use in wayfinding. People still prefer portable devices as phones or vehicle built-in navigation systems over wearable ones (Jeffrey, 2017).

2.8.3. Design features of digital navigation tools

The way how information is represented on an interface highly influence the effectiveness of successful self-localising and further orientation (Ohm, Bienk, Kattenbeck, Ludwig & Müller, 2016). Pedestrians tend to mix the previously discussed two wayfinding strategies “planning” and “doing” (Spinney, Reimer & Pinch, 2017) therefor keeping information as organised and intuitive as possible is necessary for improving the navigation performance. As previously learned that urban wayfinding behaviour is relative to different socio-demographic background and city environment accessibility (Zomer et al., 2019), the opportunity to personalize and filter the information would also benefit the usability. A study by Chao Li (2006)

on user preferences during the wayfinding tasks shows a tendency on route instructions or different types of map information. It was concluded that if Location Based Service applications would integrate multi-mode (multi-layer) information, it would assist individuals in completing wayfinding tasks (Li, 2006).

Dave Arquati in the study about pedestrians in central London (2008) defines key elements for Legible London prototype design. He introduces points that cover graphical representation, as adding 3D landmarks, strategic use of colour and contrast for key buildings and linked appearance of typography for street names. It is pointed out that small details as “locations of pedestrian crossing, steps, station entrances, bus stops and toilets “ are important to include for maximum legibility. To encourage people to walk, they need to be confident about the time and distance to the desired location or locations around. As a solution Arquati describes the concept of adding walking distance circles for 5, 10, 15 and 20 minute walks (Arquati, 2008).

Specifically for an interface design, the outdoor navigation system would require simplicity especially for Augmented Reality and real-time applications to reduce the rendering time on portable smart devices as phones, suggest Christina Ohm et al (2016) in project about mobile interfaces for pedestrians. Compared to existing maps, the user experience should allow users to pick and selected objects thus taking up extra information directly. For future recommendations Christina Ohm et al. suggest looking into information categorising that involves the spatial context of landmarks and motivating users to add the landmarks in different contexts themselves exploring the potentials of gamification and the use of social media (Ohm, Bienk, Kattenbeck, Ludwig & Müller, 2016).

2.9. Conclusive summary

Mental connections are created through the process of exploring an unknown environment. A mental map shows how a person connects certain places in urban setting by creating a sequence of places, objects and feelings that transform into a route between the desired locations in one’s mind. In order to navigate and realize the route, there are cognitive processes happening that lead to seeking answers to the two main questions: Where am I now

(position) and where do I need to go (direction)? (Fendley et al., 2006). The process to reach the goal afterwards involves wayfinding and recognition. The person completes his directional task depending on the different cognitive and physical relationships and factors that influence his mental connectedness between the places.

Literature review shows that all the influential factors for mental image creation can be described using two interrelated groups. Urban form – the geometrical and visual relations between different parts of the space, that Lynch describes as elements of the city. This creates the urban landscape qualities as legibility, imaginability and walkability. The second group covers the cultural and historical aspects that Lynch lacks in his work "Image of the City" - the social identity of the place, which contribute to the previously discussed factors (Sidjanin, 2007; Damayanti, 2015; Wesselman, 2015). The social aspects that transforms a space into place involve collective memory, participation of the community, traditions, even sense of familiarity influenced by different forms of art.

The widely accessible smart devices produced in the "digital city" of 21st century has an impact on the perception of space and thus influence the cognitive navigation processes. The Global Positioning System ensures Location Based Services, that makes the information accessible for anyone who has a smart device and internet. GIS provides the opportunity to edit the geographic information in maps, although it is mainly used by people with prior knowledge. A successful implementation of editing tools in existing pedestrian navigation devices has the potential to more actively involve the habitants of the city in the place-making process. Also the opportunity to synchronize different information platforms with the digital map would enrich the user's knowledge about the surrounding environment. Previously mentioned projects and experiments suggest to implement voice control, so that user would pay more attention to the actual reality and not be distracted by the interface. Augmented reality models using LBS suggest combining smart device cameras with graphical pop-up information where the street names could be linked with the buildings, although the system response time is usually the biggest issue. The Legible London example shows how a physical map signage can successfully help a pedestrian to orient himself and explore the city by implementing three simple design aspects: (1) displaying walking distance circles, (2) adding axonometric landmarks and (3) having a synchronised wayfinding system for different means of transport.

These features have proved to encourage walking and strengthen the cognitive wayfinding process, therefor they also have the potential to be implemented in an existing digital navigation tool.

It can be concluded that in order to create a more comprehensive experience of the city, the pedestrian should be encouraged to have an “explorer” mindset, that promotes the willingness to gather and process the information city provides not only with the built form, but also with the cultural context. A lot of empirical experiments in pedestrian wayfinding categorise them in two bold groups, the ones who use a navigation device (active) and the ones who do not (passive). It can be argued that the information that is displayed on the digital device should not encourage these categories, rather promote mixing them, creating a desire to explore.

According to literature review the first hypothesis “If the digital device can enrich the perception and knowledge of urban form and social identity of a place, then the pedestrian’s mental connection between different urban locations can be strengthened” can be supported by arguing that the following features added to the interface design extrapolates the perception and knowledge of urban form for the pedestrian thus providing more thorough image of the social identity of place:

- implementing simple and intuitive editing tools;
- organising information using layers, “modes”, colours, contrasts and clickable icons;
- implementing voice control (AI) and augmented reality features;
- linking street names with illustrations of the buildings that are on the street;
- displaying more details about walkability, like walking distance circles;
- adding axonometric landmarks and personalizing the digital map;
- synchronising a digital map with other social platforms.

3. RESEARCH PROBLEM, QUESTION AND HYPOTHESIS

3.1. Research problem

There are several methods that can potentially improve outdoor orientation and wayfinding in a city environment making it less frustrating for pedestrians. Nowadays one of the most common solutions is a digitalised map system that is viewed on a smart device using a GPS feature. The research explores the potentials of implementing additional information to an already existing digital map system in aim to improve the orientation performance and enrich the wayfinding experience for a pedestrian. The study examines not only how the built form helps in way-finding but also argues that the anthropological side of urban landscape is useful information for a pedestrian regarding the way-finding process. According to literature review it would be desirable for the pedestrian to discover the identity of place that consists of the built urban form and social condition of it. Culture, traditions and history are the aspects that form a specific social atmosphere providing person with a more thorough image of the city.

3.2. Research questions

Can digital tool usage strengthen the pedestrian mental connections between outdoor urban spaces, if it provides “hints” for social identity for these places (additional information about cultural, sociological and historical aspects)?

- How do mental connections form in pedestrian’s mind and what are “mental maps” according to scholars?
- What are the aspects that strengthen/weaken mental connections between outdoor urban spaces?
- What is social identity of place and how can it be represented in a digital wayfinding tool?
- What are the advantages/disadvantages of using a digital tool for pedestrian navigation?

3.3. Hypothesis and variables

H: If the digital device provides information about urban form, social, cultural and historical aspects of a city, pedestrian's awareness of social identity of place is increasing thus improving the mental connections between outdoor urban locations.

Research variables:

- Independent variable - information about urban form, social, cultural and historical aspects of a city that are given in a digital device
- Dependent variable - Awareness of social identity of place

Operationalisation:

The dependent variable is an abstract form of subjective person thoughts. As discussed in the background literature section, the concept of mental connections between urban locations includes two influential factors:

1) visual perception of the built urban form;
2) understanding of the social, cultural and historical aspects of the built urban form.

According to the literature review social identity of place is an idea that forms from both – the built urban form and the anthropological aspects related to it, for example, a public space in a city can take various physical forms (plazas, squares, parks) and can consist of different services that are subordinated to the specific community needs thus describing the social character of the place. Literature review shows that there is a correlation between awareness of social identity of a place and mental connections between different urban locations. The more aware the person is about the social identity of a place, the stronger mental connections there will be developed between the different urban locations in one's mind.

The research aims to measure if increasing the understanding of the social, cultural and historical aspects of the built urban form (factor (2) - the independent variable), the awareness of social identity of place (the dependent variable) will also increase. In this research it is proposed that if a person is provided with the specific information about the social, cultural

and historical aspects of the city and it is possible to access it via the digital device, the person gets an understanding about the anthropological side of the place.

The tool for measuring pedestrian's awareness of social identity of place will be post-experiment semi-structured interviews where participants will be asked to describe their experience with the prototype that informs them about the social, cultural and historical aspects of the built urban form. The interview will focus on the aspects of social identity of the urban spaces in Ålesund.

4. USER RESEARCH

4.1. Interviews and survey

4.1.1. Method

An online survey and on-place interviews were conducted featuring the same questions. Interviews were held with respondents at Ålesund NTNU campus area and Sentrum, the historical center of Ålesund using the printed version of the survey. For more diverse backgrounds, online survey (see Appendix-1) was distributed via social media platforms, as Facebook, Instagram and Twitter. Questions were grouped according to topics: demographical information, self-report on wayfinding, orientation tool preferences in two different situations, landmarks and streets of Ålesund, neighbourhoods in Ålesund. Likert scale of 5 was used in Self-report on wayfinding statements that respondents had to evaluate from "strongly disagreeing" to "strongly agreeing". The task for evaluating statements and giving a self-report should be an intuitive and fast process, meaning that numbers should correspond the scale. In this case disagreeing was associated with "1" as the lowest "score" value and agreeing with "5" thus giving the most "score" to "5" as strongly agree. To find out orientation tool preferences respondents had to put the listed wayfinding tools in a specific order where 1 would be "the first tool I'd use" and 6 "the last tool I'd use". To discover landmarks, streets and neighbourhoods of Ålesund, respondents had a space for free text writing along with evaluating some statements.

The printed copy of the survey (see Appendix-2) has a QR code which allows people to scan and access the same survey online. In order to save more space and not overload the survey with information, the printed version has a more "compact design". For example, respondent has a possibility to write a paragraph in the online version, but printed version has only a line and the Likert scales are minimized to one blank space where respondent writes the number of the Likert value. In most of the questions respondent had an option to write his/her own answer if the given options are not enough or not understandable.

4.1.2. Risk assessment

The potential risks for user study (R1):

a. Low participatory rate, the sample cannot be considered as fully representative of the target population. Mitigation: reach out for institutions that can spread the survey further, approach people in personal messages.
b. Inaccurate information in on-place questionnaires, because of lack of motivation. Mitigation: Motivate potential participants by offering food or other gift, or lottery.
c. Poorly formulated survey or questionnaire questions can lead to irrelevant responses. Mitigation: do research before formulating the survey questions, improve formulation with existing survey example questions.

The Risk matrix (Table T4.1) shows that it would be necessary to mark R1a and R1b.

Risk	Impact	Likelihood
R1a	Medium	High
R1b	High	Medium
R1c	Low	High

T4.1, Risk matrix

4.1.3. Results

Background of the respondents

From both, online survey and on-place questionnaire 64 responses are collected. From the respondents 56.3% are female and 43.8% are male. Around 33% of the respondents are in the age group of 18-25 years, which is the most amount of people from one age group. The least are in the age groups from 50 to 66+ years. Around 30 % of all occupations are students, then technical, managing, academic and arts industry professions. 62.5% of the respondents are locals of Ålesund.

Respondent mindset

- Most of the respondents (around 70%) have walked 5 times and more during the last 7 days, which means they are more active than passive when it comes to walking
- When it comes to giving directions, the tendency leans towards "being good at giving directions", although 37% of respondents neither agree nor disagree that they are good at giving directions. This might indicate that people are not sure about their ability to give directions, because they haven't received feedback about it.
- For ability to judge distances respondents are quite evenly distributed around "neither good or bad" answer. To the statement "I am good at judging distances" 27% have answered disagreeing, 23.5% neither agrees or disagrees and 34% agrees. The minority have very strong opinions with answering "absolutely" agreeing or disagreeing, which means of some lack in confidence about evaluating how far or long one should walk, for example.
- The respondents are quite confident in saying that they do not easily get lost in a new city, by having 45.3% that agrees to this statement and 18.8% who absolutely agrees.
- It can be said that most of respondents (around 80%) enjoy exploring a city environment.
- For being good at finding and using shortcuts to places, respondent answers lean towards agreeing to the statement, although 28.1% neither agrees or disagrees to it. This might indicate that pedestrian shortcuts are visible and not difficult to find in the city, although after previous research it can be said that shortcuts of Ålesund are usually very steep and in form of stairs, that would make them less accessible and desirable to take.
- The majority (around 70%) have responded that they are good at reading maps. The statement did not identify weather it is a digital or a physical map, so it can be assumed respondents thought about general cartography and recognition of places from both digital and physical map systems.
- Also the majority (again around 70%) have responded that it is important for them to know where they are, which can be explained with the ability of reading a map system.
- For the statement "I easily remember a route after I have travelled it once" respondents tend to agree, although 35.9% neither agrees or disagrees and around 11% disagrees to the statement. This indicates that there is a part of the public present in Ålesund to whom it actually can cause trouble to remember a route when they have travelled it once.

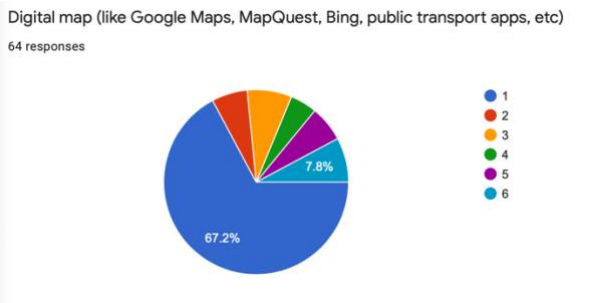
- Respondents clearly do not have a tendency to navigate without using a digital tool, only around 20% try it with not using a digital device. This means that the majority of people would use a guiding system in a form of digital device when it comes to navigation. This also shows that paper based maps are not that popular amongst the inhabitants of Ålesund.

Navigation tools in city environment, pedestrian preferences

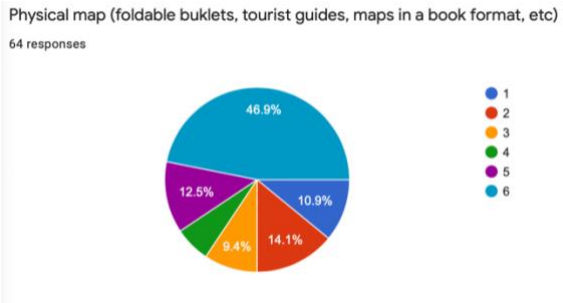
There were given two situations for choosing the most and least preferred wayfinding tools in an order they would be used in 1) getting faster from point A to B, and 2) exploring the city environment. The first situation is characterised by having less time and a specific destination point, while in the second situation the pedestrian would have no time limits and no specific destination points.

Getting faster from point A to B. Sequential order summary – most frequent answers:

1. Digital map (like Google Maps, MapQuest, Bing, public transport apps, etc)
2. Street names and numbers, rarely outdoor signs, info stands
3. Outdoor signs, info stands, again - street names and numbers
4. Landmarks (buildings, statues, outdoor objects, etc Outdoor signs, info stands)
5. Physical map (foldable booklets, tourist guides, maps in a book format, etc)



F4.1, Way-finding tool preference



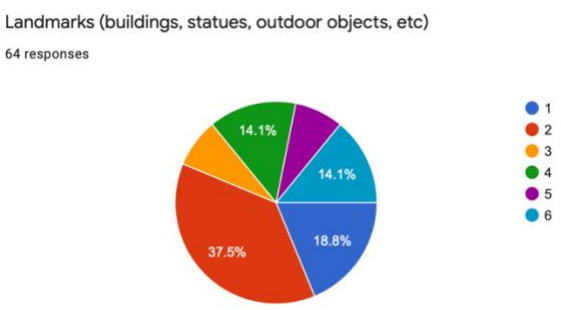
F4.2, Least preferred way-finding tools

It is clearly visible from the survey that the majority of respondents (67.2%, see Figure F4.1) choose to have a digital map as the first guiding tool for faster navigation and physical map as one of the last tools (46.9% would use it as the very last tool, see Figure F4.2). The main reasons behind this may be related to the fast response, GPS availability and frequent information

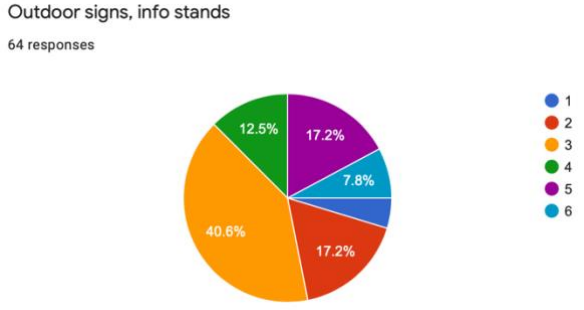
updates that a digital map usually features. Street names and numbers have been mostly picked as the second tool for navigating, as usually a systematic building order observed in cities can be used for determining the distance to the destination as well as street numbering can be collaboratively used with a digital map. Outdoor signs and info stands can be used in various combinations according to respondents (starting from second, ending with one of the last). It may be considered as a flexible tool, which can be conveniently used depending on every person's preference, specific location or other influencing factor. Landmarks are ranked as more frequently chosen tool for faster wayfinding right after digital maps and street names and numbers. Asking people for directions would be a fast solution for finding out where to go and not thinking much, but survey shows that it is one of the last "wayfinding tools" respondents would choose. It could be possible to argue that for wayfinding pedestrians of Ålesund would rather interact with a digital device, then with the surrounding environment and only after that with other inhabitants.

Exploring the surrounding by feet. Sequential order summary – most frequent answers:

1. Digital map (like Google Maps, MapQuest, Bing, public transport apps, etc. Occasionally also landmarks
2. Landmarks (buildings, statues, outdoor objects, etc), sometimes Street names and numbers
3. Outdoor signs, info stands..
4. Street names and numbers
5. Asking people for advice
6. Physical map (foldable booklets, tourist guides, maps in a book format, etc)



F4.3, Sequential order summary for "Landmarks"



F4.4, Sequential order summary for "Outdoor signs, info stands"

The second situation shows similar results where pedestrians prefer to use digital map for exploring the city environment over physical maps. In fact physical maps are again mostly ordered as the last tool to use in this situation. Very confidently landmarks are picked as the second (37.5%) and for some even first (18.8%) tool to use when exploring surroundings (see Figure F4.3) . It can be explained with the fact that landmarks are the natural attention catchers and city explorers are dragged towards a place that seems to pop out from the rest of the surroundings. More than a half of the respondents would use outdoor signs and info stands as the third and sometimes second tool (see Figure F4.4) – this again shows the importance of interaction with surrounding environment when the pedestrian is out to explore it on feet. In this case the street numbering and naming system can be perceived as a flexible method that pedestrians use depending on their individual needs, as the results show a variety of preferences for this specific wayfinding tool. Comparing person interaction preferences in the two given situations, survey shows that in both cases respondents tend to push asking for verbal directions or advice as one of the least preferred options.

Age group preferences

After comparing age groups with individual preferences in choosing a wayfinding tool, 2 most preferable and least preferable were counted (see Table T4.2 and Table T4.3). The age groups from 18 to 49 prioritize digital map when it comes to wayfinding, but age groups from 50 and above prefer asking direction to a person and/or using a physical map. The second most chosen tool varies among the different age groups: 18-25 prefers orientation by outdoor signs and info stands, 26-33 and 42-49 prioritize street names and numbers and 34-41 would choose a physical map (see Table T4.2). The least preferred wayfinding tools (in survey the last and one before the last) for almost all age groups seems to be physical map and asking people for advice (see Table T4.3). On contrary these were the two most preferred orientation tools for the age group 50+. The age group 26-33 has prevalence for not willing to use outdoor signs and info stands, although for 18-25 this is one of the preferred tools (compare Table T4.2 and Table T4.3). The age group 50+ has opposite thoughts on physical map – some prioritize it, but some put it as the least preferred. Interestingly enough landmarks score the 2nd place for being chosen when exploring the surroundings in the general results, but age group preferences shows it as the tool that has been mostly chosen as the 3rd and/or 4th wayfinding tool. This

can indicate that the potential of landmarks as an orientation guide is not used fully and for further research it can be suggested to raise the awareness for landmark as a wayfinding tool by implementing it's whereabouts and "character" to a digital map, which apparently is the most preferred tool. To summarise the specific age group preferences, a list of most and least preferred wayfinding tools is given below:

- Age group 18-25: prefers digital map and outdoor signs and info stands; does not prefer physical map and asking people for advice
- Age group 26-33: prefers digital map and street names and numbers; does not prefer outdoor stands, info signs and physical maps
- Age group 34-41: prefers digital map and physical map; does not prefer asking people for advice
- Age group 42-49: prefers digital map and street names and numbers; does not prefer asking people for advice and physical map
- Age group 50+: prefers asking people for advice and physical map; does not prefer street names and numbers and physical map

	18-25	26-33	34-41	42-49	50+
Digital map[1]	19	11	5	10	3
Physical map[2]	5	3	6	4	6
Outdoor signs, info stands	7	1	2	3	4
Street names and numbers	4	6	1	6	2
Landmarks[3]	4	4	3	4	3
Asking people for advice	3	3	2	3	5

T4.2, Most preferred way-finding tools according to age groups

[1] Google Maps, MapQuest, Bing, public transport apps, etc.
[2] Foldable booklets, tourist guides, maps in a book format, etc.
[3] Buildings, statues, outdoor objects, etc.

	18-25	26-33	34-41	42-49	50+
Digital map[1]	4	1	1	1	2
Physical map[2]	15	8	2	9	4
Outdoor signs, info stands	5	7	3	5	1
Street names and numbers	4	2	4	1	3
Landmarks[3]	1	2	4	2	1
Asking people for advice	12	6	5	8	1

T4.3, Least preferred way-finding tools amongst the age groups

[1] Google Maps, MapQuest, Bing, public transport apps, etc.
[2] Foldable booklets, tourist guides, maps in a book format, etc.
[3] Buildings, statues, outdoor objects, etc.

Issues in neighbourhood

When asked to evaluate the statement "There are many dead-end /private-end streets in my neighbourhood. (Streets, that I cannot include in my journey while walking; streets that make me question if they will lead me somewhere)", people who inhabited more central area of Ålesund tend to disagree with it, but people located further away from the city centre or "Sentrum" area, tend to agree. This shows that the central area of Ålesund would allow more alternative routes for wayfinding, than the areas that are further away from the "Sentrum". It also shows that the typology of housing is usually observed as properties with private roads to the houses, therefore some roads can be misleading if the destination is not visible for the pedestrian. This may influence pedestrian's mindset on choosing only one route, which it is known to not lead in a private property, thus reducing the engagement in exploration. Due to the fact that the area of Ålesund consists of two longitudinally stretched islands, the alternative routes from further residential areas to "Sentrum" may be limited. Also taking into consideration the fact that pedestrian "shortcuts" are consisting mostly of stairs and steep elevations, the inhabitant is discouraged to take the effort.

The question about feeling safe on streets was connected to probability for a lack of light infrastructure (such as street lamps, façade lights, light from windows, etc.). After the survey

results showed that despite the neighbourhood inhabitants are not feeling endangered walking on streets in the dark hours. This answer was also highlighted by doing a face-to-face survey, in fact the lack of light infrastructure is not the issue that would make pedestrians stay away from streets in the dark hours. Most of the respondents explained, that they don't feel any danger weather the streets are lit up or not. Some exceptions were students for whom Ålesund is not their hometown, therefor they may not be that familiar with the surrounding areas thus avoiding walking at night. Because of different backgrounds, hometown settings, culture differences, international inhabitants who live here for a short period of time, may have biased expectations.

4.1.4. Summary

The user study shows that half of the participants are usually not getting lost in a new city environment, but the other half hesitates or are easily getting lost. Although almost all participants enjoy exploring a city environment, meaning that it would necessary to make the wayfinding as enjoyable and easy as possible also for the people who get easily lost. Age group preferences show that digital map is the mostly desirable tool for way-finding until around 50 years age. Participants in 50+ age group prefer physical maps more and human interaction on street. To the age groups below these methods are the least preferred way-finding tool. Street names and numbers, as well as outdoor signs and info stands can be said as more or less equally used amongst the age groups. If a universal design is considered and it aims to cover all the (pedestrian) user age groups, it would certainly be a digital map tool created for as intuitive use as a paper-based map including the other types of considered features as outdoor signs, street names and numbers and landmarks.

There are recognised two main issues in the urban structure that stretches out of the borders of Sentrum and can make the wayfinding more difficult. Study shows that the central area of Ålesund would allow more alternative routes for wayfinding than the areas around it, because in the residential neighbourhoods can be seen a lot of dead-end streets that lead to private properties and are not that easily recognised from afar. The second factor is that the actual pedestrian "shortcuts" are consisting mostly of stairs and steep elevations, and the pedestrian may be discouraged to take the effort.

Comparing the results from the two given situations - faster commute and exploring the surroundings - it can be concluded that there are differences in the choice of wayfinding tools when the wayfinding aim is different. For commuting faster to the desired location, pedestrians would tend to use a more systematic approach that does not require too much thinking nor visual stimulation (like recognising landmarks or looking for informative signage), as the results of survey show digital map as the first tool and street names and numbers as the second. For exploring the surrounding environment the pedestrian has less of a time restriction and not one specifically located place to go to, therefore tools that encourage more interaction with the built setting are prioritized. In both scenarios respondents tend to choose the digital device as the first tool, but here the landmarks and outdoor signage are ordered as the following. All of the given tools have strengths and weaknesses that can be individually adjusted to every person's needs and preferences. As the digital map tool has been prioritized, it can be suggested that it has the potential to strengthen the other tools so that they could be used in a combined setting improving the wayfinding experience for the pedestrian.

4.1.5. Discussion

There can be observed relationship between age and nonresponse bias. The most actively participated people from age groups 18-25 with 21 respondents. The less active seems to be people from age groups 50-66+, where only 2-3 respondents participated from each group, therefor the age group had to be merged as "50+". This can be explained with the high rate of students and their willingness to participate in surveys speculatively because of the academic environment around them. The sample size could have been increased and/or diversified by interviewing people in different locations in Ålesund, not only the NTNU campus and Sentrum.

The structure of the survey covered most important issues, but still could be considered as too long for the participant to complete it with ease. The questions require thinking and remembering, also understanding concepts that could be completely new for some of the participants. In this case the survey could have been restructured and the most important questions that require most time prioritized and located at the beginning of the survey (for example, naming specific character or details that make the neighbourhood unique). This would allow the most precise answers with more details and less "skips". The complexity of questions were avoided by giving examples, but according to some participant feedback, there

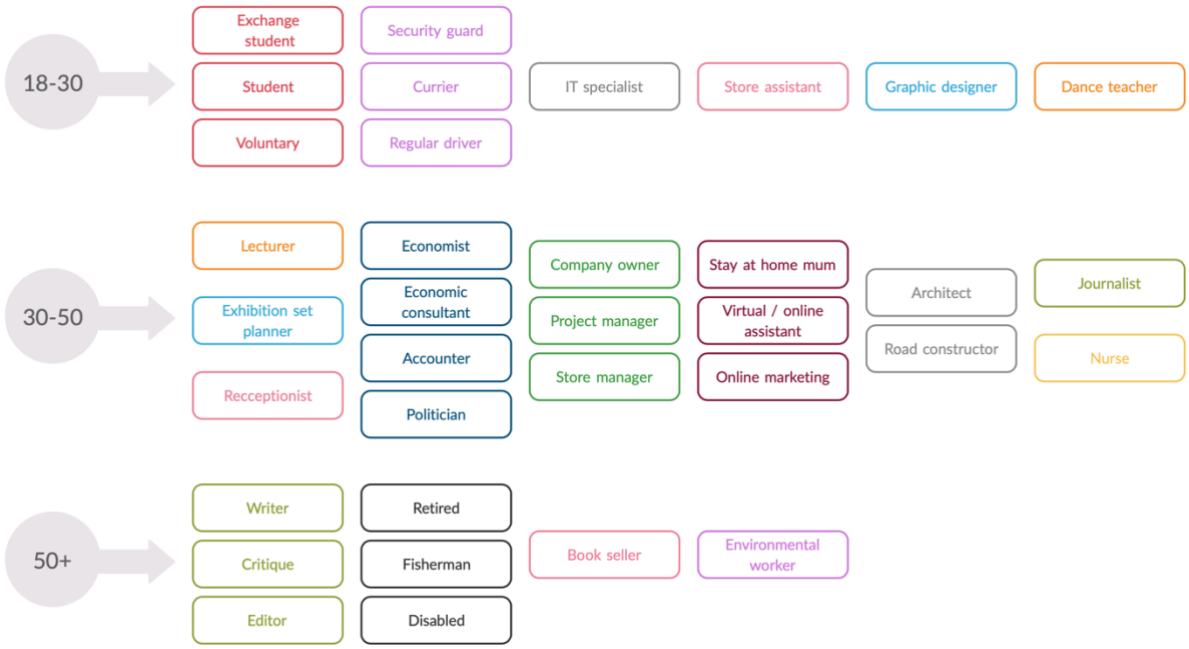
were still misunderstandings of the meaning for statement as: “I am good at reading maps”. This means more restructuring and reformulating needs to be done before the survey is published, especially helpful would have been a pilot survey test.

4.2. User profiles

The user profiles are created based on the gathered information from the survey of the respondent’ occupations. As the survey had 64 respondents the professional field varied, but some job titles overlapped. The occupation was merged under common professional fields in order to create user profiles with different backgrounds: student, economist, writer, retired person, manager, teacher, nurse, stay at home mom, engineer, designer, security guard, customer service, community worker. It is needed to take into consideration that the survey response amount should be increased 6 times in order for the data to be statistically significant and convincingly projected on all inhabitants of Ålesund. In my thesis it will be assumed that this complete list of professions represent the most common job titles in Ålesund. User profile includes demographic characteristics, as the age group, gender and location of inhabitancy; also common job titles, experience usually gained or asked for the specific profession, education gained before starting a professional career (degree or taken courses, qualifications), the average income within the professional field. “Wayfinding tool” indicates the preference for navigating (see Appendix-4).

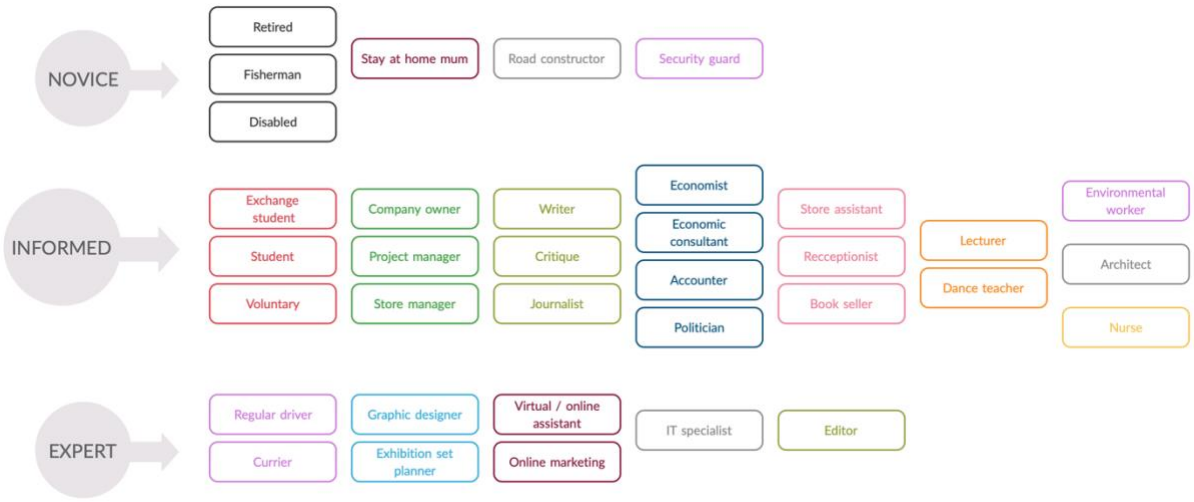
To organise the user profiles into groups of similar characteristics, affinity diagrams (Baxter, Courage & Caine, 2015) were created. The different professional fields consisted of various job titles, which already forms sub-groups under the professions in the user profile list. The job titles were now separated and assumed that they represent different types of users. They were organised in new groups for age (data taken from the survey), experience and adaptability (novice, informed and expert users) and relatedness to more likely exploring the city or more likely moving to get faster to a specific destination.

The data from age group preferences for wayfinding tools can be compared with affinity diagram where different professional field job titles (the ones common in Ålesund) are categorised in three age groups 18-30, 30-50, 50+ (see Figure F4.5). It can be possible to assume that people who have just began their professional job careers, still students, who work part time as assistants, chauffeurs, teachers or have a voluntary job to get experience would prefer to use digital map, outdoor signs, street names and number system, rather than physical maps and asking others for help. Data show that the ones that are in the age group 30-50 are most likely in their professional career, have families, manages their own business or otherwise have a sustainable long-term occupation would prefer to use both, digital and physical maps, but still would hesitate to ask other people's advice in wayfinding. The 50+ group includes life-long learning professions, that can transform into hobbies, as writing, editing, other arts, fishery or community work. The previously gathered data show that this age group on contrary prefers asking people's advice and some using physical maps for orientation (see Table T4.2, Most preferred wayfinding tools according to age groups).



F4.5, Age group categories

The second affinity diagram organises the job titles in 3 digital map usage experience levels: novice user (progress to achieve the goal can be slower, sometimes tutoring required), informed user (familiarity and everyday use of smart devices, fast response) and expert user (experienced users that are familiar with digital map systems and GPS usage and the design or editing of these systems) (see Figure F4.6). The novice users could potentially be retired or

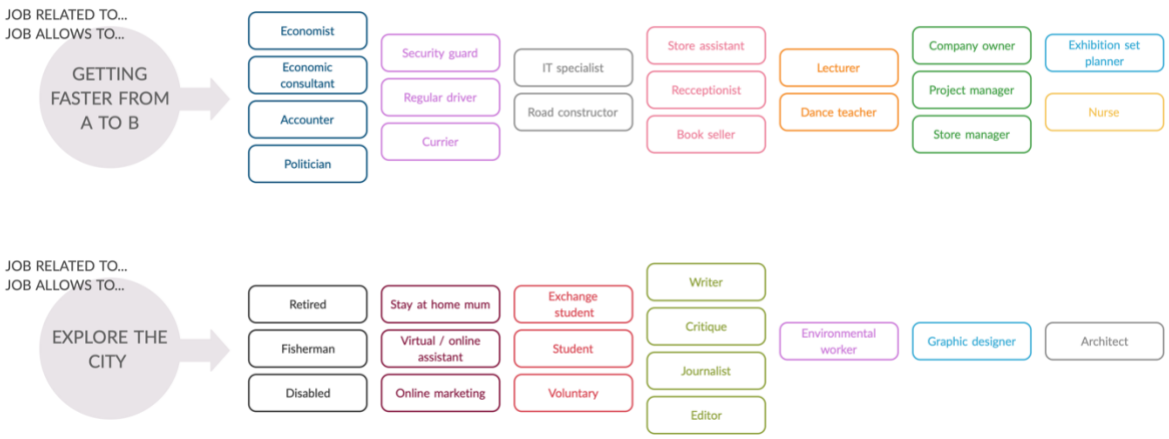


F4.6, Grouping by expected level of adaptability

disabled people who would need additional tutoring, also people who do not have frequent need of digital map usage daily, for example, out-of-office workers, like road constructors, guards, simple fishermen, stay at home moms. Informed users can be all age groups, mostly people who have a smart device and uses the digital map system on regular basis in or outside of work. The expert users have a specific prior knowledge that the other groups lack. The users can be experienced in web, app or digital illustration design, editing, their daily work is related to IT, or they can be curriers using digital map system to navigate while driving daily.

The third affinity diagram is based on assumptions and shows two groups of users: the occupancies that suggest digital map usage mostly for getting faster to their desired location and the occupancies that would allow more flexible time for exploring the city environment (see Figure F4.7). The professional fields that have an average of 8 hours working day from 8:00-16:00 usually are office on-place workers, that would use the digital map to navigate from one work place to another (for example, conferences, meetings, lunch, etc) during their working day. The second group gathers the occupancies who have more flexible planning opportunities and sometimes are connected to arts industry, can possibly be students or

retired elderly people. Some of the creative industry occupancies include architects, graphic designers and writers, whose job can be related to city exploration for professional, educational or inspirational purposes.



F4.7, Grouping by usage purpose

4.3. Personas and scenarios in connection with features

The summary of the interviews and survey gave results on the issues that may interfere with pedestrian outdoor wayfinding in Ålesund. The following issues are linked to new features that could possibly solve them:

- Dead-end and private streets solved with the possibility to see alternative routes to the desired destination on a more detailed map;
- Person cannot judge the walking distance properly, but the map displays minutes by walking, using a bicycle or public transport to the desired location;
- Only the main street is lit up during the dark hours, meaning that person who is not familiar with the place would choose only the main street for walking, but not in the case if a map could show streets with light infrastructure and without;
- Steep shortcuts, stairs that cannot be visible on a two dimensional map can cause trouble if a person plans his route but does not see the elevation gain and drop, there for a more detailed map view can be helpful;

- A person has troubles associating a specific street with the actual location, but if bigger orienteers as landmarks and squares are illustrated in the map, person can possibly recall the location of the street;
- Not being familiar with a city as a tourist or regular visitor is a common issue, therefor the illustrations of important places could help in orientation within the city;
- The current image people see of the city they inhabit has historically changed over the time, for the possibility to explore and see the historical image of the city, person can switch a historical layer in the map system that is used and compare how the urban landscape has changed over time;
- Being a newcomer in a foreign place and not having any network could be solved with synchronising the map platform with social media applications, so that topical events and activities could be displayed in the surrounding environment.

There can be developed four separate branches that can be implemented into an existing map platform. These branches would cover topics as historical and cultural information, personalisation, detailed overview of the map and synchronisation with social media. For each of these branches can follow a list of scenarios:

1. Historical and cultural information as a map layer:
    a. Local grandparent wants to show his/her kid the historical town and have a walkthrough with a story telling.
    b. Artist wants to get inspiration for his paintings from the historical city centre and learn more about the past image of the city.
    c. Tourist who visits Ålesund for the first time, wants to learn more about its history but is not keen on going to museums and reading.
    d. Student has a research project in history subject and needs to trace how the city landscape has changed over time.

2. Personalisation of the map with suggestions for activities, routes and places of interest:
    a. Person has a sports schedule and prefers jogging on roads with less traffic, sometimes changes the difficulty (steepness).

b. Artist who paints landscapes by going out in the nature, needs to find quiet places with great views.
c. Person has to go for a walk with his/her dog and needs to find a remote, forest like area, where he/she could let the dog run.
d. A person enjoys shopping and wants to go for a tour in the city centre, he/she needs a route to cover shops that interest her.
e. A student who has just move to Ålesund is interested in creative activities and meeting new people, participating in drawing events and buying a painting kit.
f. A student is interested in music and wants to go and see the local music pubs/bars, he/she specifically likes jazz and rock music.

3. Detailed or "Explorer" mode, that displays the main orienteers and pedestrian friendly details:
    a. A project manager needs to get faster from one conference to another and grab a hand sanitizer on the way, does not have much time, therefor needs to use shortcuts and would like to avoid steep stairs
    b. Tourist family has arrived by bus to Ålesund and wants to explore the surrounding by having a walk through the city and then back to the bus station.
    c. Mom with her children on baby carriage wants to show her friend around and they would like to avoid stairs or narrow/crowded places.
    d. Elderly people who has difficulty to move through steep areas wants to visit the new shopping center and walk to it.
    e. A person is late on a work meeting and is not so familiar with the city environment, needs to go from terminalen to the harbour place through he city and grab a lunch in the meantime.
    f. A person is coming home very late in the evening when there are no buses going, he is afraid of the dark and wants to walk only on streets that have street light.

4. Synchronisation with social media providing variety of suggestions and extensions combining different functions into a one map platform:
    a. Lectures have been cancelled on short notice and a person wants to see what events are happening in the city centre.

b. A persons family is coming over for a Sunday visit, he/she wants to check out their location, how far they are and does he/she still have time to clean the apartment.
c. A person is feeling lonely and wants to meet one of his/hers friends spontaneously on a coffee in the mall, in order not to ask everyone, he would like to see their location, who of them already is near or in the mall.
d. A person receives invite to a conference he/she has never attended before and wants to find out where exactly the conference is being held and how difficult is to find the correct room.
e. A person receives email with suggested holiday vacation hotel locations, he wants to compare them and choose the one closer to the sea.

Four personas were developed after summarising the different user profiles and the list of possible scenarios. Each persona covers a segment of users within Ålesund's population. Persona 1 "Ingrid" (see Appendix-5) tells about people in age group 40-50, usually locals with families and full time occupation having spare time to use map system for exploration purposes. Ingrid's scenario covers a feature and advantages of having a digitalised historical map that shows a 100 year old urban landscape and gives the option to search the historical landmarks, streets and buildings. Persona 2 "Thomas" (see Appendix-6) represents the age group 30-40, where young adults have started their own career, are financially independent and usually business oriented. Thomas' scenario talks about navigating faster from point A to B, where the map is synchronised with his email invitations and an indoor wayfinding system for more optimised commuting. The Persona 3 "Mari" (see Appendix-7) covers the youngest age group <18-30, where a large part of it are enrolled in education or starting work / their own business. Mari is not familiar with Ålesund, so her scenario shows that if the digital map is personalised and synchronised with social media, it is possible to be up to date with events and activities for meeting new people. Her scenario also emphasize the aspect of personalisation where a user can create their own personal map by filtering the roads. The Persona 4 "Kjetil" (see Appendix-8) represents the age group 60+, where a lot of people are retired, have more free time for their hobbies and exploration activities. Although being a local Kjetil's scenario describes his interest in Ålesund's architecture and his willingness for inspiration from it. The scenario shows that even for a local person a tourist-oriented map with illustrated landmarks, can bring more sense in navigation.

4.4. Card sorting

In order to proceed with the development of functions and features, a card sorting exercise was conducted with a specific group of users. Card sorting is an easy way to create user-intuitive information architecture by letting the users organise and group the given features in their own way. Originally planned card sorting that would have been performed physically being on place had the structure K. Baxter describes in chapter 6 “Preparing for your user research activity” (Baxter, Courage & Caine, 2015). The advantages of physical card sorting are much higher in terms of gathered information, but the process may be more time consuming compared to digital card sorting. Due to unpredicted global events of Covid-19, the time for doing user research has coincided with social distancing amongst people and therefor all exercises that required physical human interaction are digitalised.

4.4.1. Pilot test

A one-to-one physical pilot card sort was performed on a person to observe the reaction of a “non-designer” and improve major user uncertainties that could happen while performing the digital card sort. The pilot test consisted of 60 cards where both functions and features were combined on the same type of cards. The functions were taken from an already existing map system (in this case Google Maps) and covered the main actions user typically performs. The feature cards consisted of the newly added options that the user might not be familiar with. After the pilot test it was concluded that there could have been several scenarios for choosing the cards for the digital card sorting:

- leaving the mixed functions and features as 60 card deck and having a smaller amount of participants, but with higher chances of mental overload, thus having biased results;
- reducing the amount of cards leaving base functions and the same amount of features. That would mean not including some important aspects of the new features, and could result in misunderstood usage and grouping of them;

- reducing the amount of base functions and explaining them in an introductory text before the card sorting exercise. Leaving all the features enables the user to understand them more thoroughly and group accordingly.

The last scenario was used for the preparation of the digital card sorting exercise. The cards were reduced to 30 including all of the new features and few of the base functions providing a small description for each (Appendix-9). As the new features were originally intended to have 4 groups, meaning that it is not only one new option user can try, but 4 different options user can pick to achieve different goals, the last scenario seemed to fit the most. In this case, by including all the new features in the card sorting exercise, the results will indicate how the new features should be grouped not in relation to the base functions of the map but in relation to each other. The reason behind this is that an "extension" for a digital map should be flexible enough to be adopted to different base map system, as there can be several, for example, Google Maps, HERE WeGo or Kommunekart. The functions or function groups in this "extension" should also have a flexible adaptability also as separate entities.

4.4.2. Method

For digitalising the cart sorting Optimal Workshop (optimalworkshop.com) online tool was used. As It is described in "Understanding your users" (Baxter, Courage & Caine, 2015), the digital card sorting exercise is suggested to be carried out in groups that are present in one room and completing the task individually (or in teams) by entering data in the digital device. Group card sorting performance that usually takes place in a common room has the benefits of group discussion and idea generation, although it requires more preparation work beforehand, it usually concludes with richer data. This type of exercise was substituted with completely virtual interaction due to the social isolation obstacles, where participants received instructions in a text form before the task. The benefits of performing a cart sort virtually are that participant has as much time they need, comfort and a more predictable setting. In order to let the user's thoughts flow freely, an open card sort was conducted without any predetermined categories. An open card sorting method allows exploring the mindset and understand the mental model of the user (Juhlin, 2016). As the features are new and have not

been tested before, it is important to explore all the possibilities how they can be sorted and labelled, only after that a validation process that takes form as a closed card sorting can happen.

4.4.3. Structure and process

The structure of the card sorting exercise consisted of 4 parts – invitation, introduction, card sort and comments. The invitation was a targeted process to cover the planned demography of the participants. It consisted of simple explanatory text that highlights the importance of participation in the end:

> "*Hi,*
> *I am doing a study about digital map systems and way-finding. I am developing extensions for digital map platforms and in order to create better user experience, I need to gather data about user performance and mindset. I would appreciate if you did a small exercise about interface design of a digital map that puts focus specifically on pedestrian user experience. It can take up to 30 min to complete it, the instructions will be in the introduction of the card sorting task. Your contribution will extremely help to encourage people walk more on foot and explore the surroundings they inhabit*!"

The user can complete the task in the online platform Optimal Workshop to which a link is provided in the invitation. The introductory text informs that the information will be used for further studies:

> "*Thank you for participating in this study on digital map features for wayfinding and orientation. By participating you accept that any information you provide in this exercise will be analysed and used in a master's thesis on digital wayfinding tools*."

Participant is asked to provide some demographic information, as age group, gender and occupation. Then the system provides the list of the features and in simple 4 step instruction windows explain what is necessary to do. As the exercise was an open card sort, system allows to label the groups. In the finishing stage of card sorting, participant can leave a general

comment before finalising the task. As the closing text follows a “thank you” and an additional comment / suggestion window to encourage the participant to express more personal opinion.

4.4.4. Results

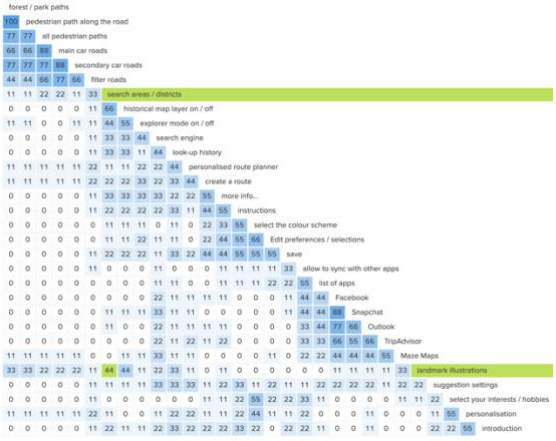
The sample of the group consisted of 9 participants covering different age groups: 18-25; 26-33; 34-41; 42-49; 50-57; 58+. Four of the participants were students from different professional fields (arts, economy and maritime), the rest participants have following occupations - a professor, a manager, an engineer, a designer and a retired chemist.

Possible relationships between the cards (Similarity matrix)

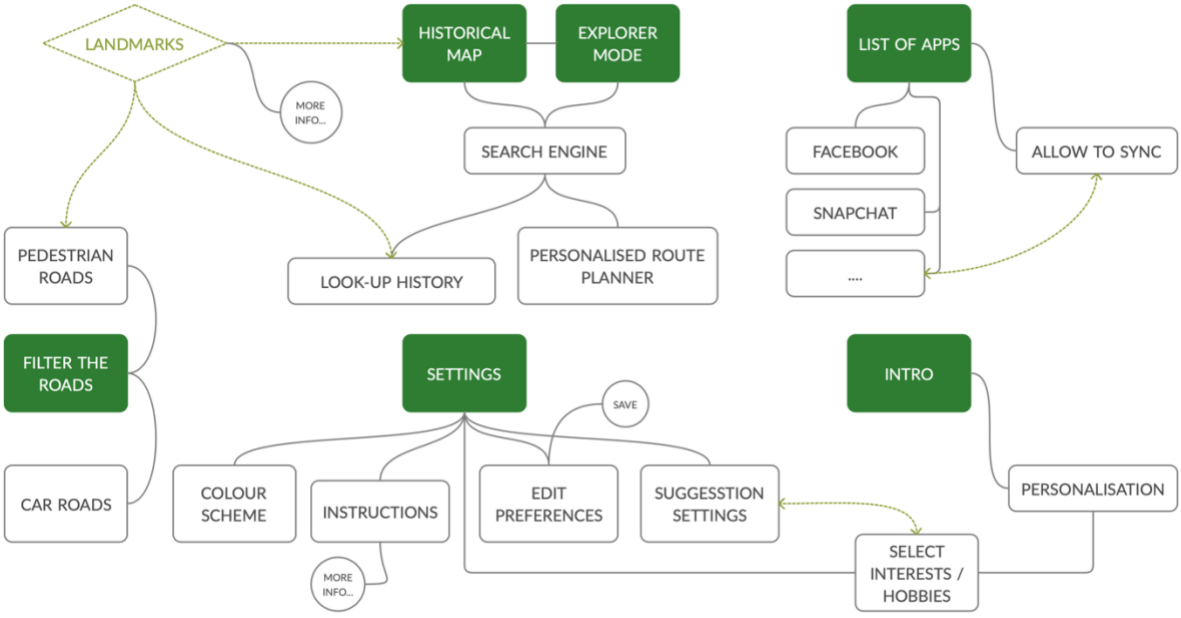
To measure the similarity of the different card groupings, a similarity matrix is analysed (Baxter, Courage & Caine, 2015). The data summary that Optimal Workshop provides displays the related features in pairs indicating the mostly paired features in darker blue colour (see figure 2). It is possible to distinguish 3-5 groups where 2 of them can be combined as a larger group. The group where participants agree the most combines the different types of roads and the option to filter them. The second most agreed group combines the list of applications and the “allow to synch” option. It is also visible that participant’ opinions have split and some of the features have been grouped with different pairs. The similarity matrix shows that the “selection of colour scheme” goes well together with “ edit preferences / settings” and “instructions” but also can be grouped together with selection of hobbies, interests and personalisation that is displayed as the “introduction” (see Figure F4.8). This means that the “introduction” can include some personalisation features, but they should also be accessible in “settings” and “instructions” section. The similarity matrix also shows that 55% of the participants group the “historical map layer” and “explorer mode” together and associate them with a search option. 66% of the participants think that “historical map” should be searched by filtering areas and districts, also that these options can be combined with illustrated landmarks (see Figure F4.9). Schematic analysis are done to visualise the relationship between the groups in a cluster-like manner (see Figure F4.10). It can be concluded that “landmark illustrations” is the feature that can be related to various groups changing its function: 1) historical layer map can display the historical landmark illustrations; 2) filtering and searching option can include “search by landmark”; 3) the same way as it can

be related to search function, the look-up history can display the landmarks using a different icon or illustration.

F4.8, Relationship between selecting colour scheme and selecting interests / hobbies



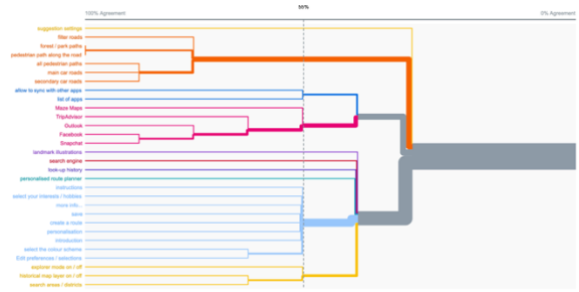
F4.9, Relationship between searching areas / districts and landmark illustrations



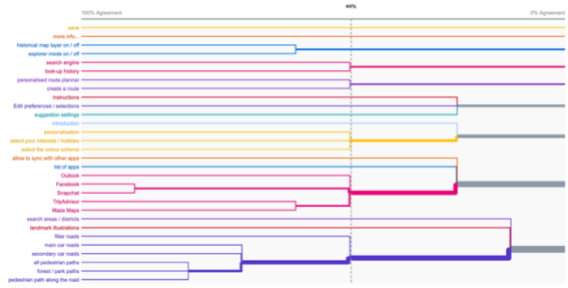
F4.10, Schematic analysis of the similarity matrix

Hierarchical and cluster analysis (dendrograms)

Dendrograms are usually used for organising the data in a hierarchical matter, diagrammatically representing a "tree" (Bock, 2020). Optimal Workshop in data analysing section suggests 2 types of dendrograms, hierarchical and cluster. In this case the hierarchical relationship of the features consists of a "root node" (Healy, 2020) and 3 defined branches with a one-feature branch (see Figure F4.11). As the card sorting was defined as open, the

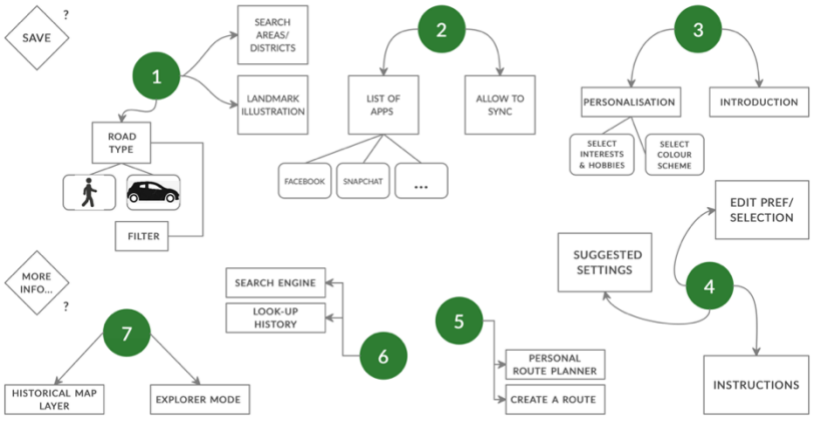


F4.11, Tree type dendrogram



F4.12, Cluster type dendrogram

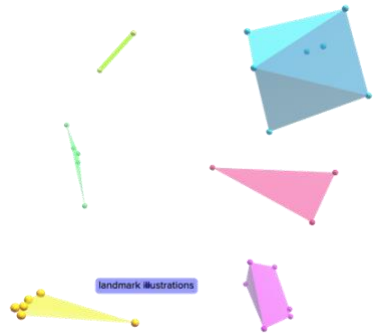
participants were asked to name the groups they have created. The hierarchical type suggests the names for 5 of the branches as following: 1)areas and exploration; 2)action planning and settings; 3)applications and integration; 4)app preferences and settings; 5)commuting options and filters. The cluster type of dendrogram displays separate groups without a common "root node" (see Figure F4.12). It suggests 7 separate groups that are named accordingly: 1) paths and roads, filtering; 2) app synching; 3) intro with personalisation; 4) settings; 5) personalisation; 6) search; 7) maps (see Figure F4.13). The cluster type of data organisation allows to see the separate groups and the possibilities for their usage. In card sorting exercise participants have left comments that some of the options can belong to several groups. The cluster diagram that have more groups but less features in those groups, makes the possible overlaps more visible. For example, group "settings" can appear both, in the "introduction" and later in the "main menu".



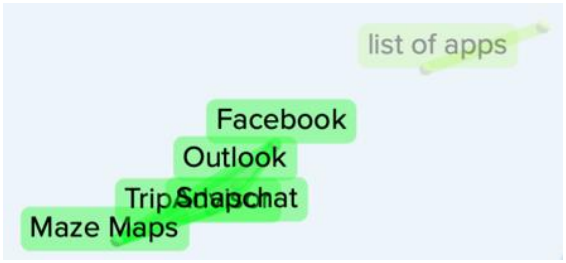
F4.13, Schematic analysis of the cluster type dendrogram

Proximity of separate points and groups (3D cluster diagram)

Optimal Workshop (optimalworkshop.com) allows to visualise the data in an interactive digital space, where it is possible to see the relationship between the cards in 3 dimensions. Each of the points represent one card and the distance of the same colour clusters indicate the frequency of the cards being sorted in one group (see Figure F4.14). The data representation gives a clear visual overview of the grouping preferences for the participants also suggesting the names for the groups. It can be concluded that the 3D cluster diagram suggests to have 4 main groups with some sub-groups: 1) list of applications (Figure F4.15); 2) areas and planning (Figure F4.16); 3) introduction and settings (Figure F4.17); 4) road filtering (Figure F4.18). As it is visible in Figure F4.14, the "landmark illustrations" does not necessarily belong to one group but the closest would be "areas and planning" (Figure F4.16), which also echoes the results of similarity matrix.

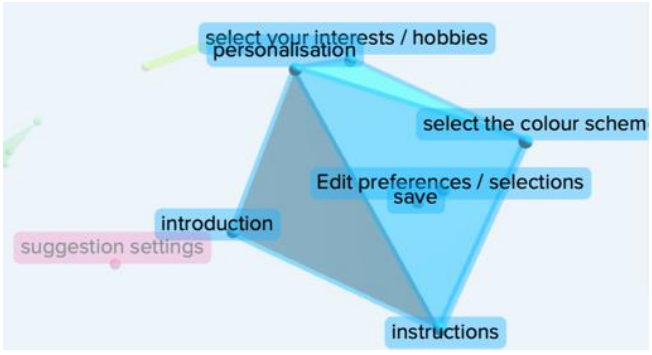


F4.14, 3D cluster division into 7 separate groups



F4.15, List of applications

F4.16, Areas and planning

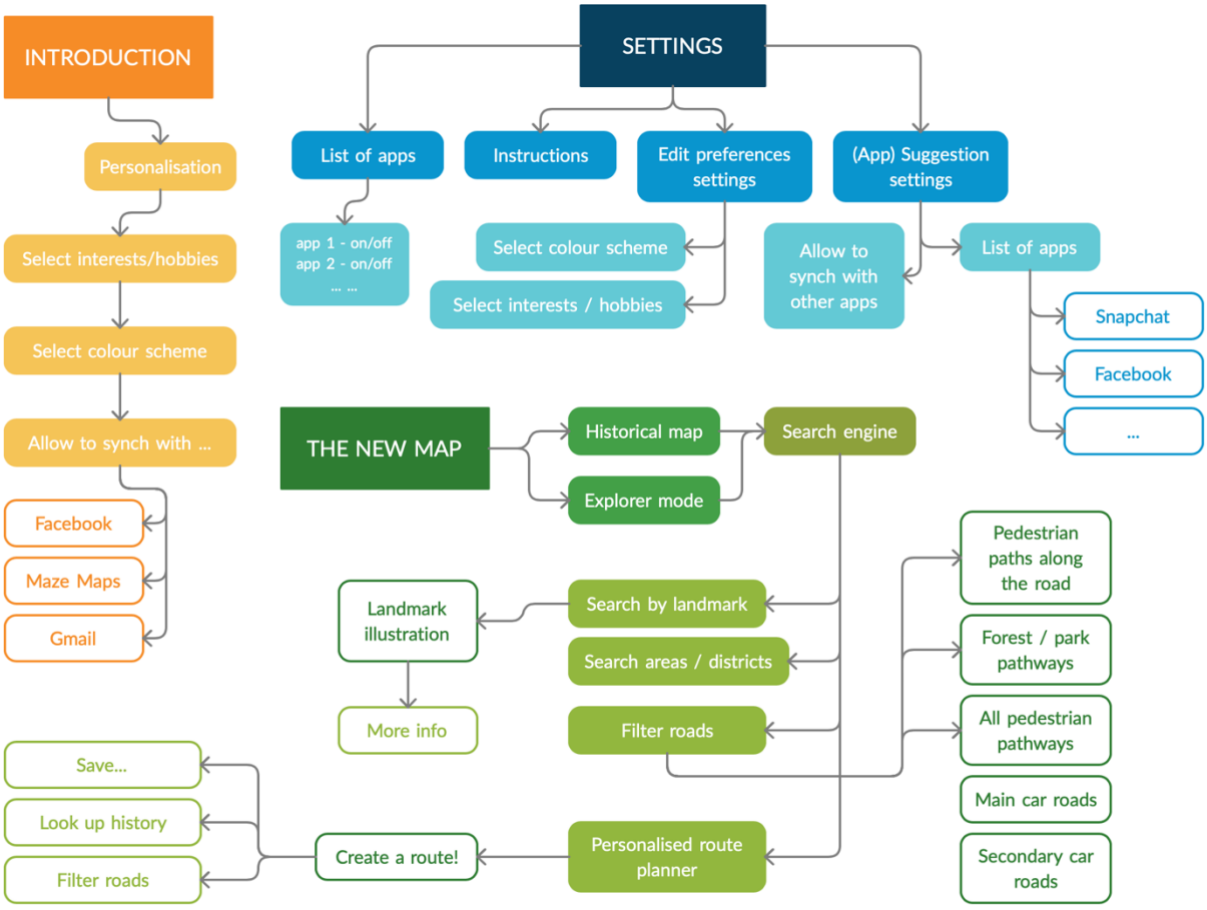


F4.17, Introduction and settings

F4.18, Road filtering

4.4.5. Concluding remarks and discussion

After looking at 3 types of data analysing systems – similarity matrix, dendrogram and 3D cluster diagram – the sorting of the cards can be summarised in 3 separate groups allowing some of the features repeat: 1) introduction; 2) the new map layer(s); 3) general settings (see Figure F4.19). Some of the features are accessible in various location, for example the introduction options can also be edited later in settings. Card sorting showed that the variety of filtering options can be extended with other criteria, for example, landmarks. The feature "landmark illustrations" was placed in very different groups, meaning it can have different functionality in each section. It can be used as a filter, as an additional layer and have a special marking in search suggestions.



F4.19, Summary of card sorting in hierarchical diagrams

Keeping in mind that the card sorting exercise included mostly the new features and only some functions, the results would have been more precise and detailed, if the base functions would have also been listed. Due to the constraints of situation Covid-19 had created, the amount of

cards was reduced to the minimum for keeping the participation rate higher. The reason behind this could be related to the fact that the participants were not offered any physical benefit out of the card sorting, as they would if the exercise would happen physically. Originally snacks and coffee were planned during the exercise to make a comfortable and relaxing atmosphere. Because of an online form, there were a lot of turn-downs after the invitation and the response rate was 3 times lower than expected.

Virtual card sorting cannot reveal the flaws or ideas of the information architecture, that could have been discussed in an on-place exercise where all participants are interacting. Virtual card sort can be a good pilot exercise that takes place before the actual on-place card sorting, because it is a fast method to get the brief idea of the grouping patterns. The verbal conversations are the key to most successful and rich data gathering. In this case improvement could have been a verbal instruction instead of text-based over a phone call, for example.

4.5. User study summary

The user study shows that almost all surveyed participants enjoy exploring a city environment, but half find it difficult to orientate sometimes. If an inclusive universal design is considered and it aims to cover all the (pedestrian) user age groups, it would certainly be a digital map tool created for as intuitive use as a paper-based map including the other types of considered features as outdoor signs, street names and numbers and landmarks as different age groups use different tools. As the digital map tool has been prioritized in the user study, it can be suggested that it has the potential to strengthen the other tools so that they could be used in a combined setting improving the wayfinding experience for the pedestrian. For example, the issue of having a lot of dead-end streets can be solved by offering alternative routes and steep shortcuts can be displayed in a more detailed map view.

Based on interviews and surveys user profiles are created that consist of 3 possible ways for group arrangements: age group categories (18-30; 30-50; 50+); by expected lever of tech adaptability (novice, informed and expert users); by usage purpose (faster navigation, city explorer). It can be assumed that the exploration purpose would be used a lot by the age group

50+ and the other age groups in a decreasing manner. The faster navigation purpose is assumed to be used by all age groups equally according to the individual needs, but it can be also argued that experts and informed users would tend to use it more often. Based on these categories the created personas cover 4 segments of users:

a. Female in age group 30-50, informed user in a need for exploration. Presents the historical information usage in a digital map;
b. Male in age group 30-50, expert user in a need for faster navigation. Presents the application synchronisation option;
c. Female in age group 18-30, informed user in a need for exploration and faster navigation. Presents the personalisation advantages;
d. Male in age group 50+, novice user in a need for exploration. Presents the information on visual differences of the built urban form.

The card sorting exercise provides a possible information architecture solution, if the previously discussed features would be combined and implemented in a digital map system. The new features would be grouped accordingly:

a. Introduction that involves personalisation of the map application;
b. Newly added information organised in layers with a search engine and a route planner;
c. Settings section where it is possible to change preferences and synch options.

5. DESIGN PROPOSAL

5.1. Methods for creating a design proposal

The hypothesis state that adding a social, cultural and historical information to a digital navigation tool would strengthen the mental connections between outdoor urban spaces. The concepts of socio-cultural aspects of urban space are discussed in the literature review. In order to implement and display these concepts in a digital map, it is necessary to collect the data about these aspects. Data collection process will take place in the Ålesund central area and will involve (a) gathering official data from existing digital maps and if possible from organisations as Ålesund Kommune, etc., (b) field mapping methods that are described in Kevin Lynch's "Image of the City" (1960) and (c) implementing the already collected data from the user study. The data collection is supposed to result in recognition of Lynch's described 5 elements of the city (paths, nodes, areas, landmarks and edges) in the central area of Ålesund displayed in a form of a map.

In order to acknowledge the necessary features that can potentially solve the issues discussed in the results of user study, competitive analysis are performed, where different digital maps are compared. For this study 4 existing navigation applications are chosen that put emphasis on pedestrian wayfinding. According to strategy that Amanda Short (Short, 2017) offers, 4 most popular applications are found: Google Maps, HERE WeGo and Maps.me. Norkart is chosen out of regionality reason, as the most detailed map application about Norway. The features of these apps are compared and analysed by using categories and diagramming.

A first sketch prototype is developed as a pilot study to be tested on couple of user groups. The previously gathered features and collected data from field study are implemented in this prototype that in low-fidelity shows the scenarios performed by 4 personas, presented in the "Personas and scenarios" chapter. To get a feedback about the prototype a session is held together with a small group of participants where scenarios are explained followed by a focus group type of discussion. The aim is to narrow down the feature set and choose a specific feature set that would be developed further to a high-fidelity prototype for the experiment.

5.2. Field research

5.2.1. Methods for acknowledging the elements

The data collection methods for the field research involve randomly selected participants who are performing the following exercises:

a. Mental map drawing of different routes in the city

b. Asking for giving directions to specific places

c. Asking a person to name as many places possible within a short amount of time

d. Asking person to draw districts and describe them

According to prior research that was carried out in the University of Iceland and included mapping the city of Reykjavik, there are several methods that can be used for recognising Lynch's described city elements. The research concluded that each element can have the most convenient method that can be used for the mapping purposes:

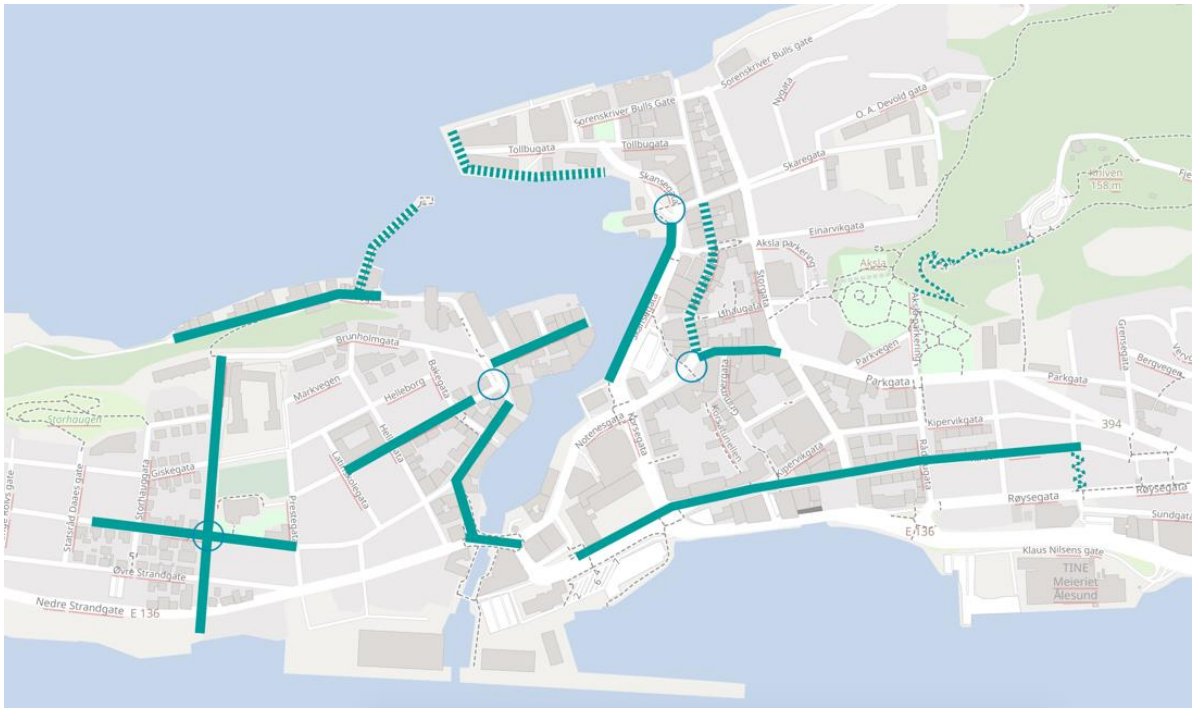
- Paths: Asking for direction + existing digital map comparison
- Edges: Drawing mental maps
- Districts: Digital map study + drawing the districts
- Nodes: Drawing mental maps + online survey
- Landmarks: Online survey + asking to name places

5.2.2. Mapping the elements

PATHS

In order to recognise important streets and pedestrian pathways, it was asked for direction to many different places within the city. Also the study was combined with analysing the existing urban structure by looking at digital maps in different scales. Previously planned data collection from institutions as Ålesund Kommune was not successful, therefor a backup plan was used – to walk and observe the streets as a pedestrian. By doing this the most active and most quiet

streets were marked down discovering the potential nodes and junctions, where the paths usually cross (see Map M5.1).

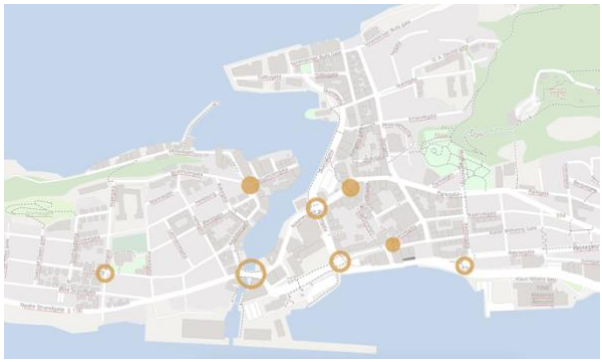


M5.1, Map with the paths creating the potential junctions or nodes

EDGES AND NODES

8 participants agreed to anonymously perform the mental map drawing exercise. The participant could choose the destination he remembers the best and draw an imaginary journey to the place. The drawings revealed edges and nods (Appendix-10), that were complicated for the participant to understand when explaining the meaning of the "city elements". By drawing a sequence of events, the person does not need to understand what the specific elements mean or how to recognize them, he simply puts them as the turning

M5.2, Map with edges

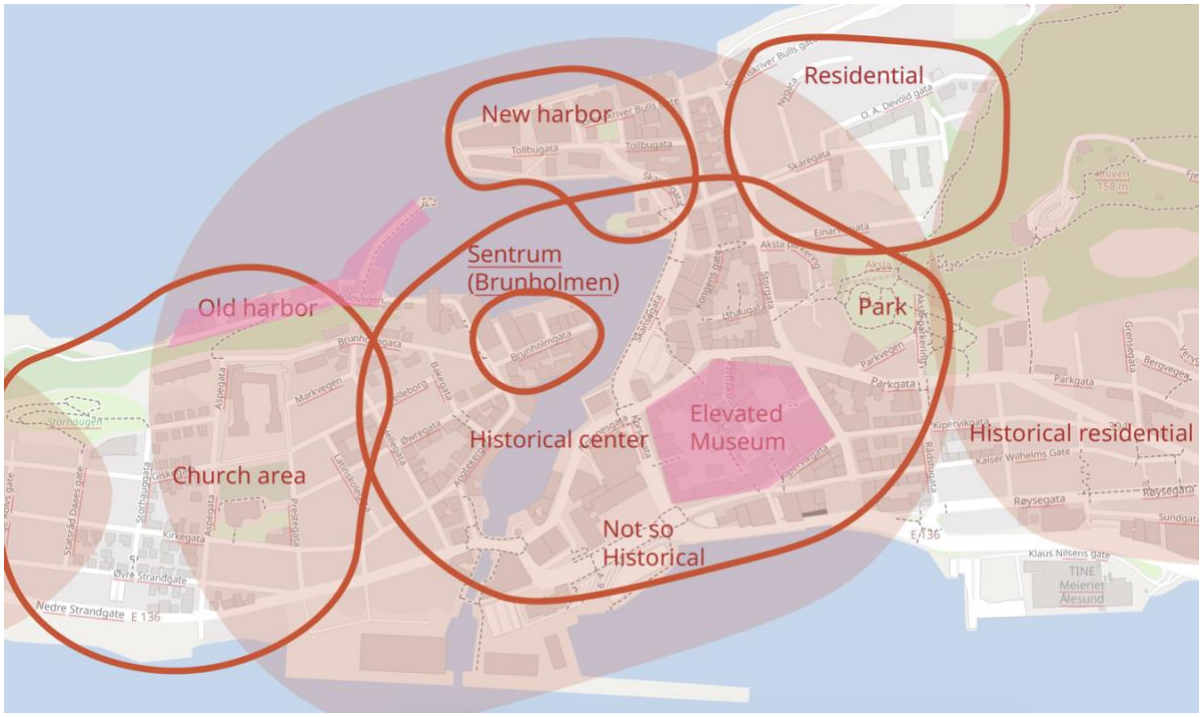


M5.3, Map with nodes

points of their story. By transforming the drawing into map (Map M5.2 and Map M5.3), it gave a better understanding about character in certain areas of the city.

DISTRICTS

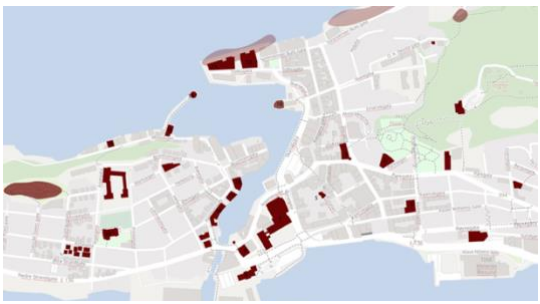
Drawing the districts without having any help of cartography materials results in participant recognising the borders and the differences between the areas. The district drawing method is similar to mental mapping – using memory to recognise and visualise certain places in the city making connections between these places (Appendix-10). In this case the comparison of officially marked borders in digital maps was not possible to do because the scale of Ålesund Sentrum area is not so large to have officially marked borders for different territories. The mental mapping exercise was digitalised and the common features displayed with circles and colour patches (see Map M5.4).



M5.4, Map with neighborhoods

LANDMARKS

In total 5 participants were asked to name as many "landmarks" it is possible in the timeframe of 1 minute. The definition of a "landmark" was given before and explained what it is related to. The places that overlapped the most were looked up in an existing map platform and noted down



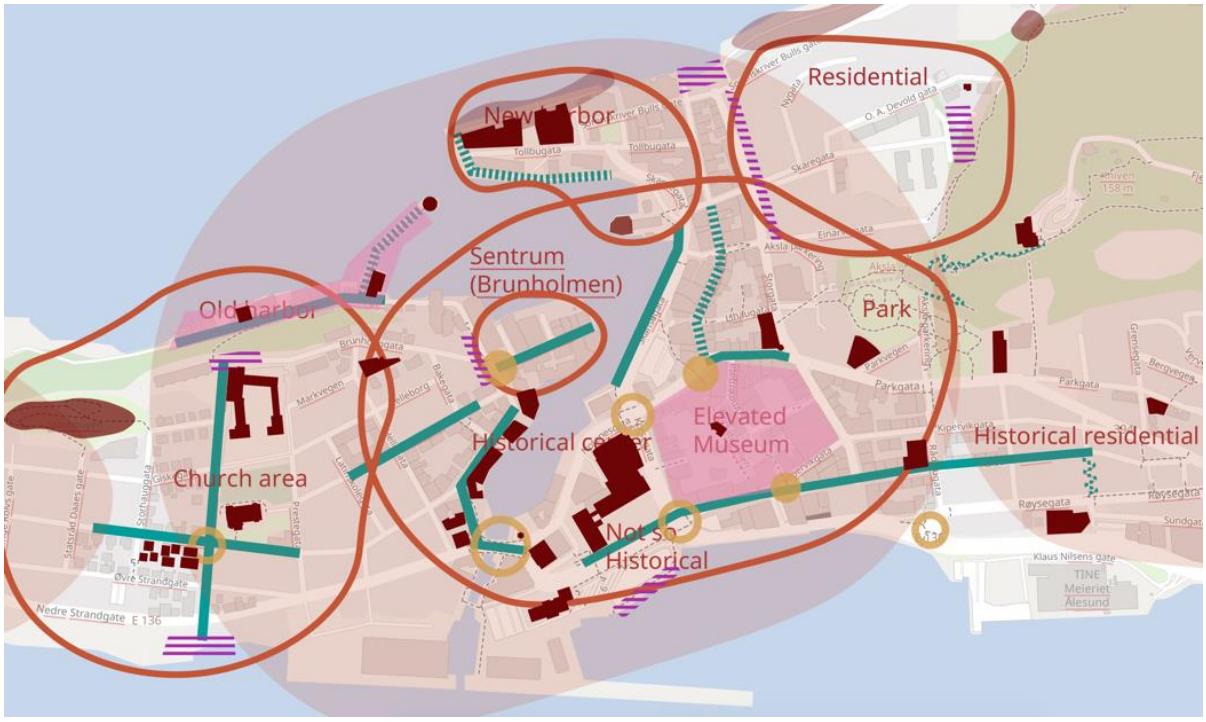
M5.5, Map with landmarks

M5.6, Map with contemporary landmarks and historical overlay

digitally (see Map M5.5). Parallel to the exercise, a research was done on the officially recognised landmarks and point of interest for tourists that were combined with the results of the online survey from "User research" section. The marked landmarks were put as an overlay on a map dated from 1915, that shows the historical building blocks and some key functions of the city (see Map M5.6). It is possible to see which landmarks are historical points of reference and which are contemporary.

THE 5 ELEMENTS

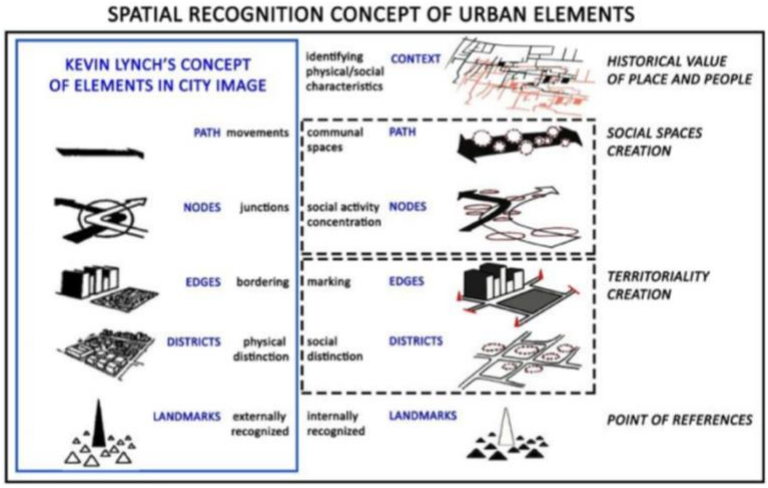
The collected data during the field mapping are combined in one graphical map (see Map M5.7), where it is possible to observe the interrelated relationships between the urban elements. As Lynch describes *"districts are structured with nodes, defined by edges, penetrated by paths, and sprinkled with landmarks."* (Lynch, 1960, p.48-49). It makes sense to look at the elements not as separate entities but observe them as a whole where one complements the other. It can be argued that the area of central Ålesund has different territories, that can be characterised with specific landmarks and paths that lead to and from them. Nodes are formed usually where junctions are making the place more active.



M5.7, Map with all city elements combined

The socio-cultural elements

According to Rully Damayanti's work (2015) that was discussed in the first chapter of the thesis ("Elements of the city - extended"), the city elements K. Lynch describes can be re-defined adding the social, cultural and historical aspects, as presented in R. Damayanti's diagram (see Figure F5.20). The "Spatial recognition concept of urban elements" will be used as basis for extrapolating the collected field research data and implementing them into further design concepts.



F5.20, "Spatial recognition concept of urban elements" by Rully Damayanti (2015)

Territoriality in R. Damayanti's work consists of two combined elements – edges and districts. Edges are the physical and/or mental borders that mark the distinction between districts found in the city. After analysing mental maps and talking with participants it was possible to combine area markings with the potential edges (see Map M5.9). The transition points were described as "the more elevated part", "the ocean begins", "building style change", etc., meaning that there can be several influential factors that indicate the change of the territory. When the new city elements are formed according to R. Damayanti's work it is necessary to mark not the physical distinction, but rather the social (Figure F5.1). This means that there cannot be strict edges identified, rather the social identity of place can form the different territories making

M5.8, Map with paths and nodes combined

M5.9, Map with neighborhoods and edges

the borders overlap. Paths and intersections are the elements that promote social activity and life in urban landscape. Where the most active flows meet, a junction is formed concentrating the social activity and creating basis for social spaces (see Map M5.8).

One of the important aspects that form the social identity of a place is R. Damayanti's described "historical value of place and people" (Figure F5.1). It is described as "context" element where physical and social characteristics of place are identified. Physical character is the built urban form that is visible today, but social character is rooted in the historical events that led to the formation of this place. In order to show this complexity the historical city map can be combined with the existing urban landscape map in a way that it is possible to trace the changes in urban patterns (see Map M5.10). These changes are believed to create a subjective understanding and recognition of social identity aspects.

K. Lynch describes landmarks as externally recognised points of reference that stand out of the context by contrasting with different character, as scale, style or other visual determinant (Lynch, 1960). R. Damayanti adds a cultural and social meaning to it by giving a precondition to be internally recognised (recognised by the community that inhabits the area). In her work she describes the points of reference together with socialising places that extend the meaning of the built form (Damayanti, 2015). In order to recognise the internal landmarks, the collected data about important places in Ålesund from its inhabitants were combined with previously discovered "nodes" (see Map M5.11).

M5.10, Historical map overlay

M5.11, Map with landmarks and nodes combined

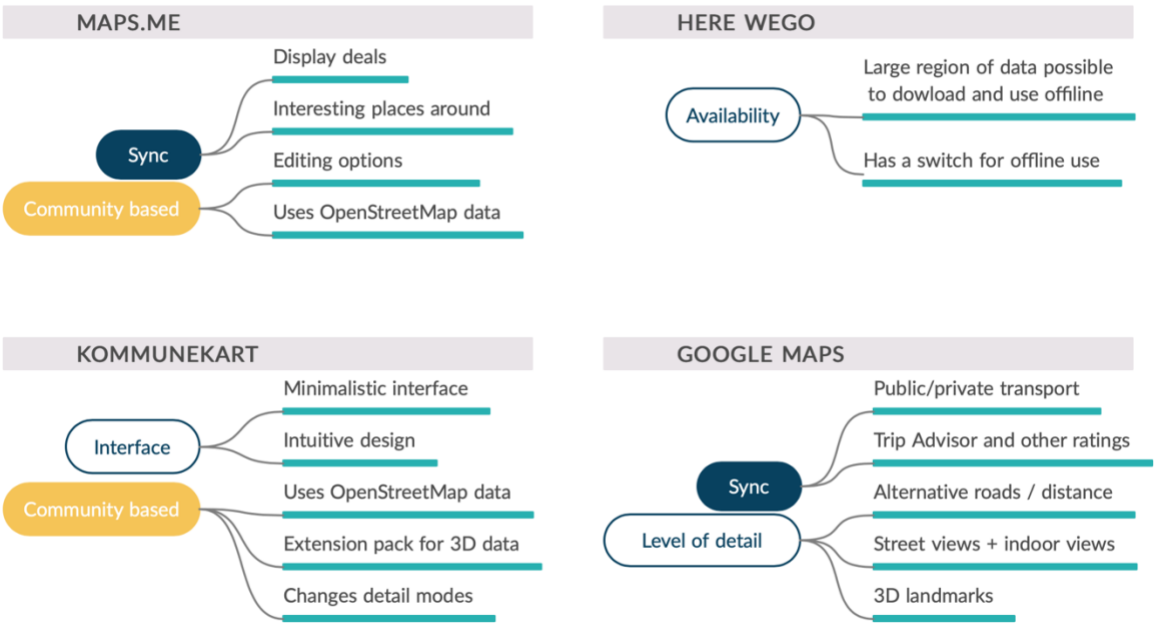
5.3. Exploring the features through competitive analysis

A competitive analysis were conducted in order to gain knowledge about the existing features and functions map applications have, weather they work or fail, about their strengths and weaknesses. The first step is looking into the market and identifying the competitors. For this case applications that are available on phone and/or smart device are chosen, because the design extension for the navigation system puts emphasis on the pedestrian and on-the-go usage. Amanda Short in her article about mobile app improvement suggests to use three methods for competitor identification: keyword research, the media and customer feedback (Short, 2017). In this case the following keywords were used in Google search: “pedestrian navigation”, “navigation apps”, “the best”, “top 10”, “most popular”, “best in 2019”, “best in 2020”, “best for Android”, “best for iOS”, “for walkers”, “apps for navigation”, “commute”, “hiking”, “travel”, “cycling”. For researching the media some sites as - uxplanet.org, mobileappdaily.com, digitaltrends.com - can be useful for general idea about the trends in app design, although not specifically in pedestrian wayfinding. In the case of a general navigation app, the customer feedback can vary infinitively, but after a search by “the most popular navigation app” the results show that 67 % of respondents say that they use Google Maps most frequently (Panko, 2018).

For creating a competitive analysis matrix, four map platforms that are available for free on smart devices were chosen. Google Maps as the most popular and frequently used app (Panko, 2018), HERE WeGo and Maps.me as the secondary most popular pedestrian navigation apps for Android devices (Lucic, 2019) and Kommunekart is a platform developed by Norkart, the leading company of GIS and municipal technical management systems in Norway (“Norkart AS”, 2019). It gives a detailed overview and navigation possibilities in all the regions within Norway. The analysis matrix consists of strengths and weaknesses that are divided into 9 topics (see Figure F5.2, Appendix-11). The most weaknesses share “user experience” and “level of detail” group, where users complain about inaccuracy of GPS, lack of alternative suggestions, lack of generally more detailed map and complicated information input/search engines. On the other hand these weaknesses are solved in other apps by synchronising map system with other applications that give more options and personalisation for the user, also providing a community based map (as OpenStreetMap) with a lot of detail in pedestrian scale and making

the interface more minimalistic and intuitive. Generalising the categorisation, it can be concluded that the 4 map platforms mostly succeed in these topics - synchronisation with other application features; with a community based system that allows to edit therefor provides detailed overview; intuitive interface design; level of detail with different modes and regional availability. Each of the map application has their own categories in which they succeed the most (see Figure F5.3), but for further research Norkart by Kommunekart will be used as it has the most minimalistic and intuitive interface design along with a very detailed GIS base.

F5.21, Categories according to users



F5.22, Application strengths categorized

5.4. Pilot prototype

5.4.1. Method

The main findings of the field study and competitive product analysis are implemented in a prior prototype that is the first design method. It aims to discuss the usability and necessity for the proposed features as the potential design solution. As the features are narrated using the previously developed personas and scenarios, the aim also is to proceed with one segment of users and one set of features that could potentially answer the research question the best. The pilot prototype is designed also based on the results of the cards sorting exercise, where users categorised the chosen features in 3 main groups – introduction, the new map layers and settings section. The prototype explores introduction and the new map layers more in depth, that involves the synchronisation possibility and more advanced search engine. Simple and fast design method as free-hand sketching is used to visualise the prototype on a re-used newspaper. The usability test is conducted with 3 participants, who have a background related to creative work. The participants are selected based on their professional experience within the design field in order to proceed with a focus group type of discussion after the test.

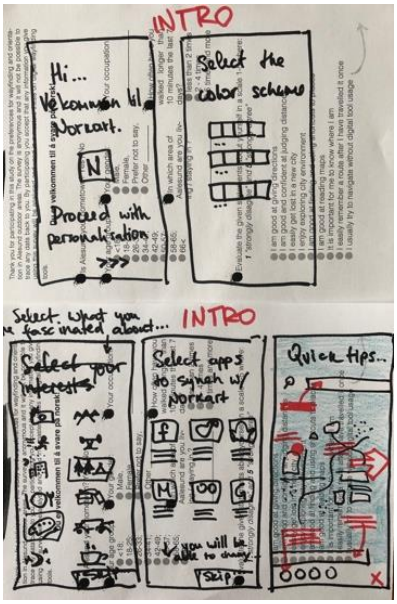
The pilot prototype is divided into 5 section:

1. Introduction of the application
2. The usage of the historical map layer
3. Route personalisation
4. Synchronisation with other applications
5. Using option to display more information on the map

5.4.2. The prototype design choices

INTRODUCTION

The introduction is the very first screen that welcomes and instructs the user to proceed with the personalisation process. Previous studies showed that the option to customize and personalise the app improves the performance and helps users to meet their goals faster, which makes the application more desirable for usage. As the user study showed a part of users would agree to perform poorly when it comes to navigation. The personalisation would be a tool that would actively help users by suggesting places of interest and giving the possibility to customize their routes according to their habits. Introduction for the digital map is categorised in 4 main selections (see Sketch S5.1):



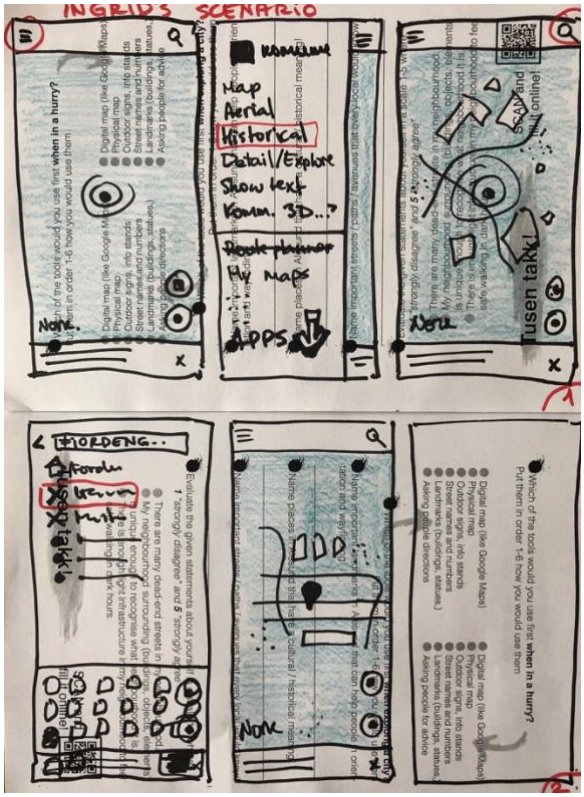
S5.1, Introduction sketch on a re-used paper

1) Choice for the colour scheme with preview;
2) selection of interests, hobbies, fascinations;
3) Social platform and other app synchronisation question;
4) Quick instructions (tips) for the map usage that explains the new features.

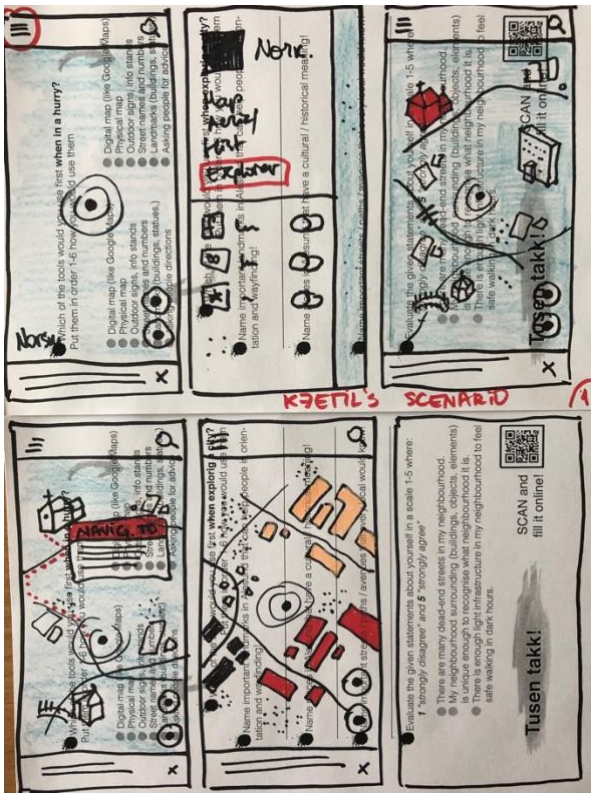
DETAILED MODE AND HISTORICAL LAYER

The map application is based on Norkart that was chosen after competitive analysis to have the most minimalistic interface. The main menu includes 2 additional informative layers “Historical map” and “Detailed mode”. As the literature review showed, historical map overlay can provide the user with more “context” and positively influence the acknowledgement of points of reference in the city. The “Detailed mode” has landmark illustrations with additional information on them as well as differently marked territories. As discussed in field and user study sections, these features improve the legibility of the city for a pedestrian. The “Historical map” is an overlay that combines the existing city setting with a map that represents the urban

structure potentially 100 years ago (see Sketch S5.2). An advanced search engine could be synchronised with archives therefor providing the option to display historical street/house names on the map. Synched with online encyclopaedic type of information source, The "Detailed mode" would display illustrated landmarks for increasing visual remembrance and provide a differently coloured areas that react on a tap for "more info" (see Sketch S5.3).



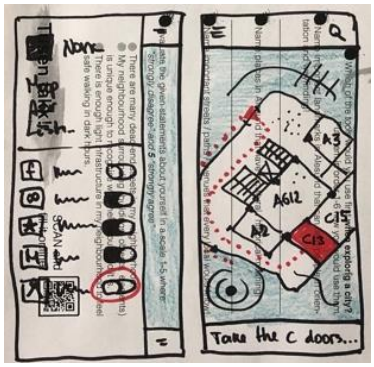
S5.2, Historical layer usage scenario sketch



S5.3, Detailed mode usage scenario sketch

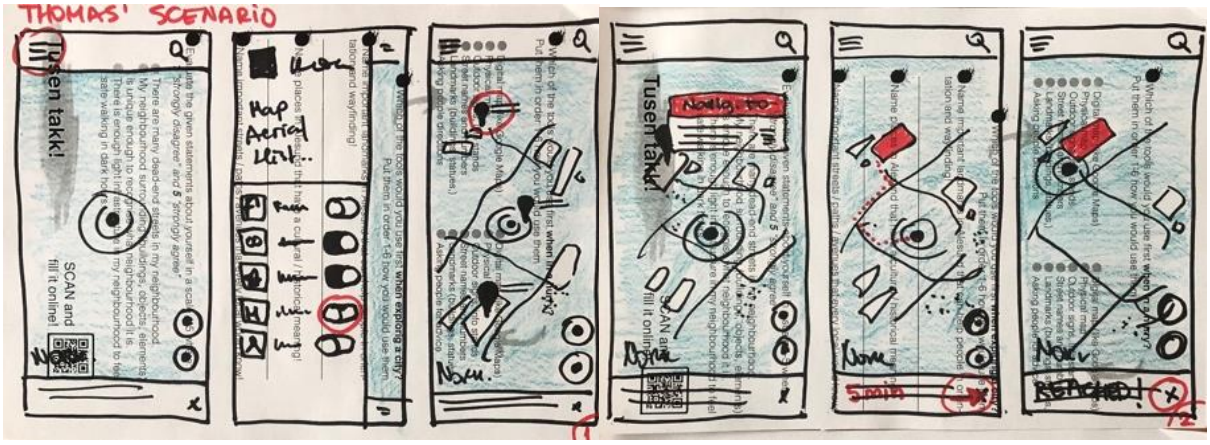
SYNCHING WITH OTHER APPS

Some existing features that are known from social media platforms as location suggestion and information sharing amongst different apps are made possible because different application platforms can be synchronised. The synchronisation option is one of the features that has not reached its full potential in digital navigation tool design. To combine different types of features and make the app more versatile, it is proposed to have a synchronisation option that allows to merge GPS with other relevant information extending the possibilities of location based services. In this case



S5.5, Switching between indoor and outdoor way-finding

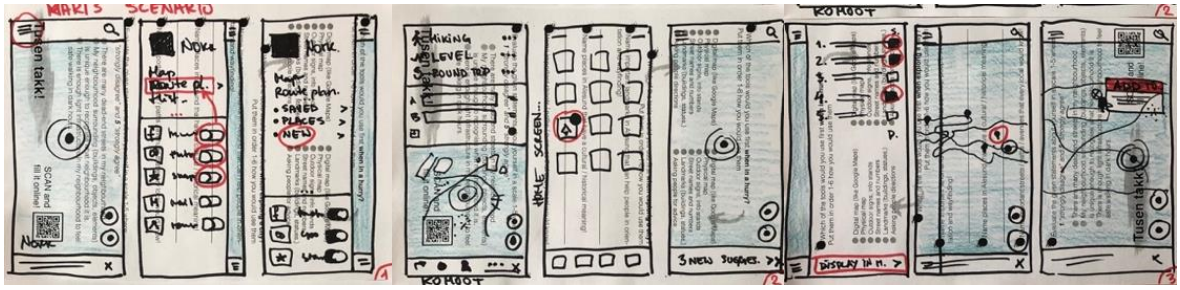
synchronisation with email and indoor wayfinding system is represented (see Sketch S5.4). Locations are recognised from emails and displayed as suggestions in the map application allowing user the direct access to the email by tapping the specific location. It is suggested to combine indoor and outdoor wayfinding systems in one map application (see Sketch S5.5), when the technology will allow it. This would improve the flow of usage and increase the performance time for achieving the initial goal. These specific applications (email and indoor wayfinding) were chosen to represent a model that would be used for faster navigation from point A to point B.



S5.4, Email and map synchronisation scenario

ROUTE PERSONALISATION

This scenario represents the need of exploration of the unknown environment in a long-term, therefor it combines a route personalisation with the option to synchronise events from the social media (see Sketch S5.6). It can be argued that by displaying alternative route options that have various characters, the wayfinding experience can be improved thus creating a more thorough image of the city. By suggesting the local events based on users interests, it can potentially improve the understanding of different characters of the urban space that can accommodate different social activities. The route personalisation feature is an extension to a common search engine (box with typing and searching option), that would allow user to pick



S5.6, Route personalization combined with the synchronization option of other apps allowing user to receive suggestions and notifications

different route types and create their own maps. The interface solution for the engine can be based on an existing navigation app “Komoot” that has an advanced planning set for displaying terrain details and the required fitness level. The events from social media user is interested in can be displayed as suggestions for adding to the map and displaying more information about them on a tap. This feature allows to stay more connected to the social life of the city and make more spontaneous decisions on daily basis.

5.4.3. Focus group discussion results

After an open discussion with a focus group of 3 design related persons, the results can be summarised in a table, where all the given suggestions are marked down emphasising the ones who would have to be prioritised in further work (see Table T5.4). Closing the focus group an evaluation of the relevance to initial research hypothesis[1] was made putting the feature sets in 1-3 categories, where the connection to socio-cultural aspects are determined as: 1 is “distantly relevant”, 2 is “relevant” and 3 is “directly relevant”.

Features	Suggestions from the focus group	Value, 1-3
Intro. Possibility to	• Very important to have a SKIP button • Add all the options available later in settings to change	

[1] H: If the digital device provides information about urban form, social, cultural and historical aspects of a city, pedestrian's awareness of social identity of place is increasing thus improving the mental connections between outdoor urban locations.

personalise the map	• Important to have include in quick tips where you can edit the previously mentioned suggestions and synching with apps • This is good for improving the usability	1
Detailed explorer mode. Displays POI and variety of areas	• For tourist perfect, but how the locals will use? When the scenarios are told, much easier to imagine the usage and seems much more interesting, so it is important to tell a story and make the user aware for what purpose it can serve • Free time activity more. People will not use it when in hurry. • There are a lot of people who actually have troubles with orienting themselves, this is a great practise for them also for children to develop understanding of wayfinding. • The social activity aspect can be included • A good idea is to add information about the landmark or a link to more info	3
Historical map layer. Historical street search option	• I cannot imagine how it would be "synched" with archives, is it even POSSIBLE? • Good in a sense of making people aware of their history and surroundings, especially for locals, because there are a lot of people who doesn't know their history • Not quite sure about the search function in the historical map, should make a clear model of it. • It would good to have the possibility to change the layers transparency	3
Synch with other apps. Access to other app' features	• The technology in app creation is not that advanced yet to merge different applications in one platform, there should be innovative and realistic data engineering solutions then • It would definitely the future scenario of apps • There should be possibility to switch on and off the synched apps, so there would not be information overload	1
Personalise your route, save it. Event suggestions	• Komoot is an easy and understandable (intuitive) app for walking and creating routes, the base functions can be integrated from Komoot. Can encourage healthy lifestyle. • For suggestions, very nice if they are visible in the map as an overview, that user can zoom in and out • Good to have a list of suggested events near the map so it would be possible to see both, location and the description	2

T5.4, Summary of focus group exercise with prioritized suggestions marked out

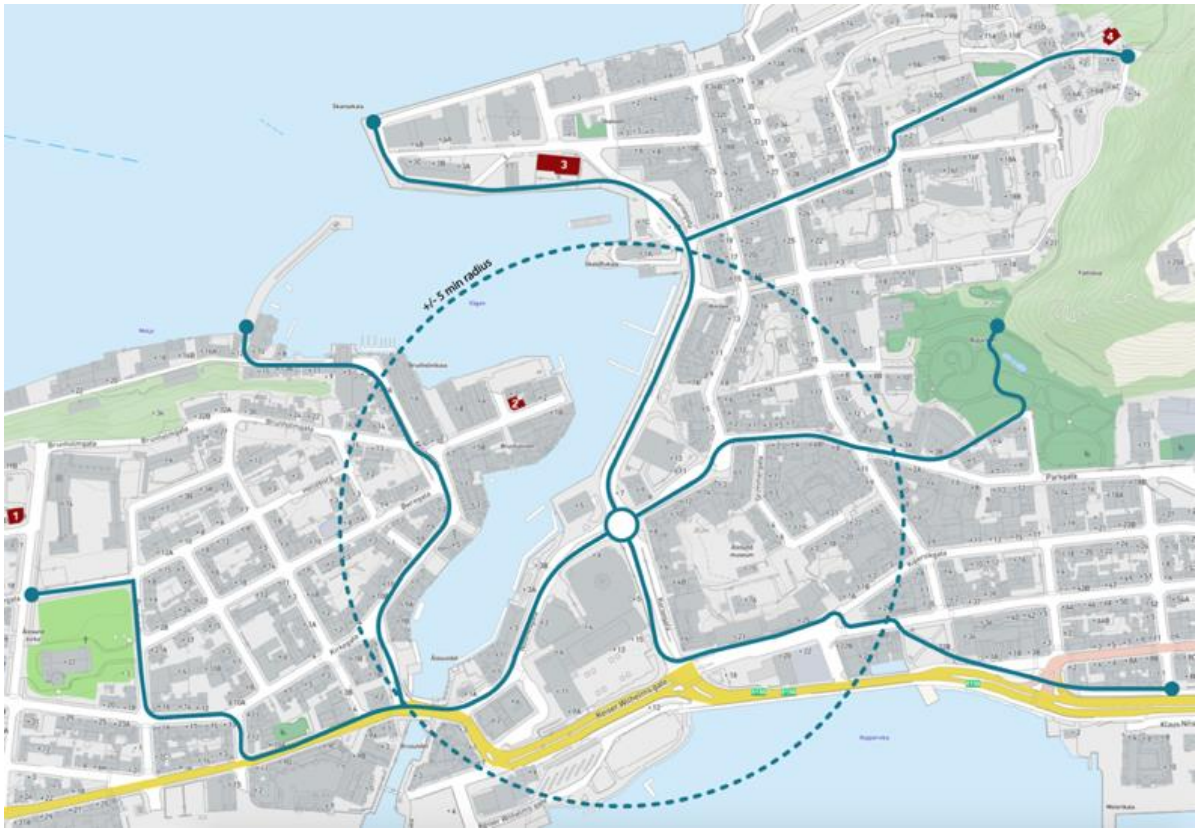
It is chosen to proceed further with the two feature sets “Detailed explorer mode” and “Historical map layer” as they are mostly related to the socio-cultural aspects discussed in hypothesis. They have the potential as well to be extended further in terms of social activity and more detailed urban context. The chosen population segment is primary tourist oriented and universal for all age groups. The external factor that influenced this decision is time limitation. As within the timeframe of thesis it is not possible to design all of the discussed feature sets, therefor the focus will be put on adding additional information to an existing digital map system, that would potentially improve the understanding of socio-cultural aspects of the city.

5.5. Design proposal for the “Explorer mode”

5.5.1. Method

The final design proposal is based on previously selected feature sets “Detailed explorer mode” and “Historical map layer”. By creating the high-fidelity prototype it is necessary to take into account the testing methods that will be used later on. For this reason the device selected for presenting the prototype will be a smartphone, thus making it possible to conduct the experiment in real life urban environment imitating the actual wayfinding process. The previously conducted field study will serve as the groundwork for the information displayed in the app. Software as Adobe Suit and Figma are then used as the design methods to create the illustrative layers and develop the information architecture for the app. While developing the application it is necessary to pay attention if it is possible to launch it on the smart device, if possible, then different model devices in order to avoid errors during the experiment.

For the designing process it is necessary to determine boundaries and the “centre” of the map. As the research is about Ålesund, from the central point in the city approximately 5 minutes walking distance radius is drawn (see Map M5.12). The borders of the map are chosen 10-15 min walking distance from the central point and already potential places are marked down that will be needed to look for during the experiment. To narrow down the working area, the four marked places set the “boundaries” for the map prototype, in which the “Explorer mode” concept will be visualised.



M5.12, Method for choosing the central point and picking the 4 locations

5.5.2. Information organised in layers

The prototype presents the Explorer mode as a separate section, a potential addition that can be integrated in an existing digital map application. Its main components are 4 informative layers that are displayed on top of a base map. The layers are developed after combining the results of user and field studies. The field research and R. Damayanti's "Spatial recognition concept of urban elements" concept is used as the main framework, where the collected data are extrapolated into layers as: Landmark illustrations; Social spaces; Territoriality and Historical landscape.

I5.1, Landmark illustrations within the central area of Ålesund

In order to develop "Landmark illustrations" layer a map from Socio-cultural elements chapter was used, where the potential landmarks are displayed together with nodes and junctions, thus supporting the R. Damayanti's definition of "internally recognised landmarks". The marked places were transferred then to illustrative drawings (see Illustration I5.1) and positioned on the base map forming the first layer (see Map M5.13). The second layer informs the user about the fact that Ålesund Sentrum is considered to be a whole, that actually consists of several different neighbourhoods. These territories are formed from the social distinctions "districts" that are marked with "edges" (Damayanti, 2015). The combined diagram map of "districts" and "edges" is taken from the field study section and the differences are displayed in colour blocks forming the "Territoriality" layer (see Map M5.14). In order to show the map user which places in the city are more socially active and passive, the information about communal spaces, that are usually formed on the

M5.13, Landmark illustrations integrated in the map

M5.14, Territories of Ålesund marked in different colours

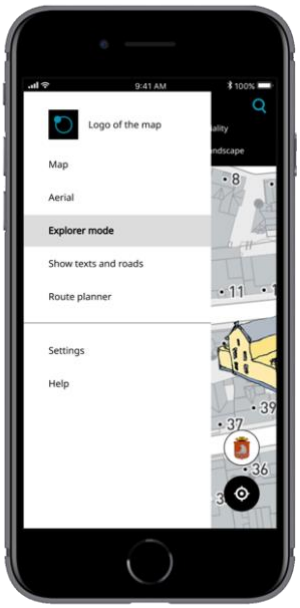
M5.15, Socially active places and streets marked with orange colour

M5.16, A historical map drawing from 1911 as an overlay on the contemporary urban landscape of 2020

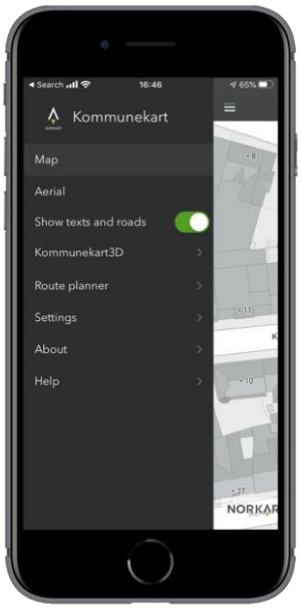
main paths, are combined with the social activity concentration points “nodes”, thus creating “Social spaces” layer that displays the concentration of social activity (see Map M5.15). The initial idea was to display real-time activity during different hours of the day, but that can be implemented in the later stages of the prototype. The current social activity information is taken from the field study and user study sections by interviewing participants and analysing data from the “ edges” and “paths” diagram maps. The last informative layer “Historical landscape” consists of the base map and a 100 year old drawing of Ålesund that is set as an semi-transparent overlay (see Map M5.16). It should be possible for the map user to identify physical and social characteristics of the urban setting and see how different are the contemporary urban patterns from the historical ones.

5.5.3. Application interface design

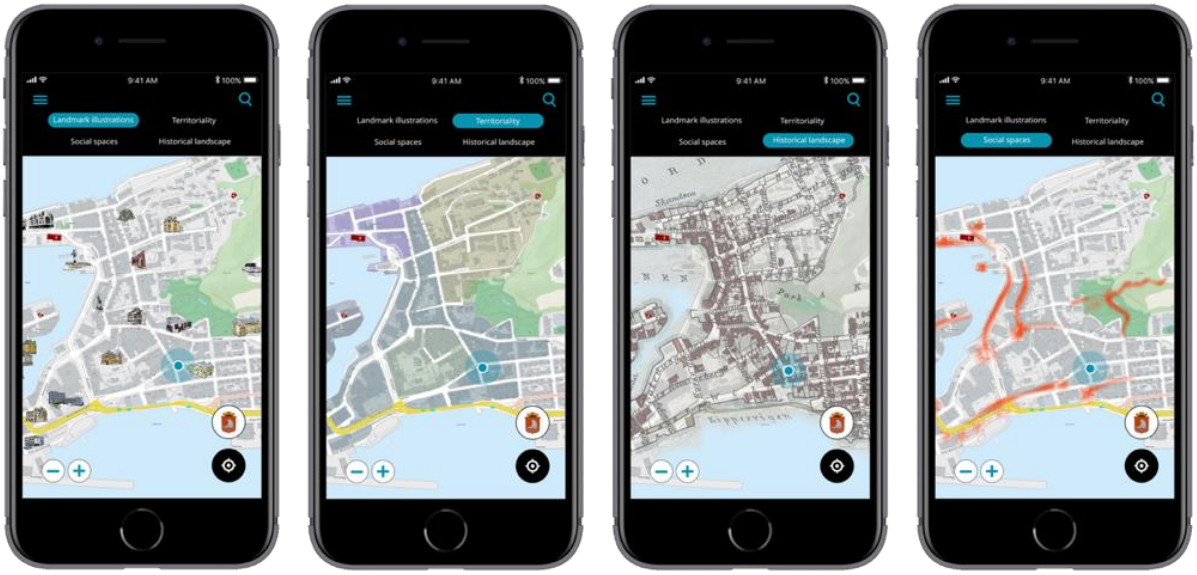
The base map design is inspired from Kommunekart application by Norkart, where the GIS data are very detailed and the digital app interface - minimalistic and intuitive (see Illustration I5.2). The four layers can be accessed by opening the main menu at the left top corner and choosing the "Explorer mode" (see Illustration I5.3). The prototype then adds a layer menu to the base map. It is possible to switch between the layers by tapping the specific name of the layer. The bright blue colour acts as an indicator for the currently active layer (see Illustration I5.4). The colour scheme is kept as simple as possible – black, white and blue for indication.



I5.3, Interface of the prototype



I5.2, Kommunekart interface

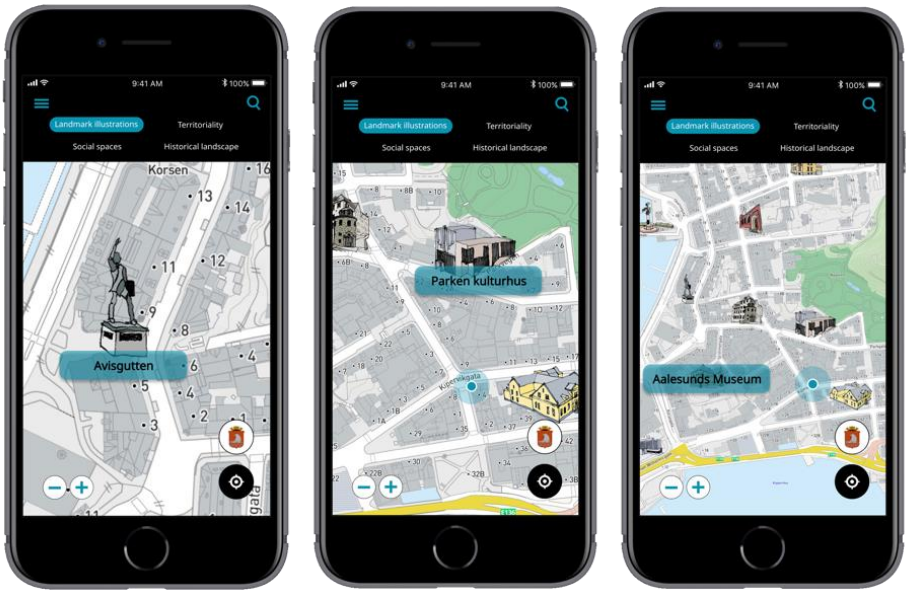


I5.4, The interface of the designed prototype displaying the 4 layers within "Explorer mode"

The main needs of the user were considered when adding features to the map prototype. The features and functions user would use while performing the experiment. It is possible to move the map around both horizontally and vertically, although it is only possible to change the scale of the map not as intuitive as in actual digital map apps. The "Zoom in" and "Zoom out"

functions are enabled on “+” and “-“ buttons, where the user is capable of zooming in or out 3 times, meaning that the map prototype has 4 different scales (see Illustration I5.5). By changing the scale of the maps, also the scale for the additional landmark information in “Landmark illustrations” layers is adjusted (see Illustration I5.6).

I5.5, The four scales accessible in the digital map prototype



I5.6, The informative box’s size adjustment according to the used scale in the map

5.5.4. Further development stages for the prototype

There are many possible ways to increase the fidelity of the designed prototype thus making it more user friendly and intuitive. The final prototype puts focus on the very basic functions that are necessary to be performed during the experiment. It might be assumed that the current stage of the prototype would influence the internal validity of the final results. The next steps for the prototype would involve implementation of a GPS and an expansion of the map that covers a larger area of Ålesund. As mentioned previously, the other sets of features could be implemented to make variety of actions passible, as synchronisation with social media and possibility to personalize the map application.

5.5.5. Conclusive summary, discussion

The main findings from the field study showed that there can be several methods for mapping the city elements that are described by K. Lynch (1960), and only combining them it is possible to observe the urban patterns and see the image of the city better. In order to acknowledge R. Damayanti's re-defined elements the mapping methods at the first place need to involve inhabitants of the city. By involving the community it is possible then to understand the different socio-cultural characters of places and trace their influential factors, that in the end results in discovering the identity of different urban environments. Ålesund - with its very characteristic Hellebroa bridge that connects two islands at the very heart of the historical center – seemingly is divided into two halves, but the field mapping results shows that the edge of a water is not an obstacle to perceive two physically separated parts as a whole.

After performing competitive analysis, exploring the existing digital navigation applications and doing the first design sketches, it is possible to say that not all of the features and functions can be related to the processes of discovering socio-cultural characters within the city. Therefor only the "Detailed explorer mode" and "Historical map" were chosen to be developed further and merged into a one design proposal. The developed prototype is specifically designed for the experiment, therefor only the necessary part – the Explorer mode that enables four layers – is designed as an interactive digital navigation tool for a smart device.

The final prototype designing process deviated from the initial plan that was created at the first phase of the thesis. It was anticipated to gather data for the field research from official and reliable sources, as Ålesund Kommune, although it was not possible. It can be said that the field study methods are needed to be repeated for more reliable data collection in the future studies. In order to extend the list of features and functions of the existing digital navigation tools, it could be suggested to perform case studies in combination with competitive analysis. To ensure better usability there could have been more iterations for low-fidelity prototypes and user tests at the first phases of the designing process. The same applies for high-fidelity prototype, the more iteration process is performed, the better usability gets, thus improving the reliability for the end experiment results.

6. THE EXPERIMENT

6.1. Methodology

6.1.1. Participants

The method for choosing the participants was initially planned as judgement or purposive sampling, where the researcher chooses whom to ask for participation (Shantikumar, 2018). The purpose was to create a representative sample of Ålesund inhabitants, that would consist of at least 30 participants, 50% male and 50% female, would cover the age groups 18-24, 25-32, 33-40, 41-50, 50+. It would be necessary to have locals and non-locals with various occupations, that could be seen in the previously developed user profiles. Due to the constraints of time and social isolation procedures, the amount and previously planned requirements for selecting participants are reduced. The previously agreed rules on the equal amount of male and female participants are kept, but other demographic requirements are loosened. A snowball method (Shantikumar, 2018) is used to reach out for participants with more diverse backgrounds in order to avoid biased data, where participants are only from educational field. Ålesund Kommune and Smart City Framtidslab is contacted in aim to reach out for as many participants as possible.

6.1.2. Data analysis methods

In the experiment section the data analysis puts more emphasis on the qualitative data, as the character of the research is more qualitative and theoretical. Methods as content and narrative analysis are used, where the documented information is analysed in form of texts and illustrative diagrams. In order to get familiar with the data all the individual answers are structured and read through several, common patterns observed, rehearsing the main goals and research questions while comparing them with the collected data. It is necessary to develop a framework for analysing the data (giving codes or groups) and then starting to note down the similar patterns, identifying common themes and exploring the potentials of answering the research questions (Bhatia, 2018). Narrative analysis method would be used to analyse data from different sources as for example, combining the results from field research and user study and comparing them to the results of the experiment.

6.2. Procedure

6.2.1. Planning the process

The process in total is planned to take 2 hours per 1 participant:

1. Participant is greeted in the central area of Ålesund (most likely a café with an accessible Wi-Fi). Brief introduction is given about the project.
2. The participant is asked to download the Figma Mirror application on their smart device, where later the prototype is opened (or they are asked to download it before the meeting).
3. It is explained to the participant what to expect from the prototype, about its limitations and possibilities. The lack of GPS system in the prototype is highlighted. Also the information prototype provides is explained before the experiment
4. Participant is then asked to navigate to four different places one after another that are visible on the digital map. He/she is encouraged to use the informative layers while orienting outdoors and try not to use other navigation apps.
5. While the participant is navigating, he/she is asked also to mark down:
    a. Places that seem to be socially active
    b. Differences that can be seen or felt between the areas (if any)
    c. At least one change in urban form that has happened historically
6. It is explained to the participant, that it is fine also not to mark the previously asked things, if they cannot be found. It is also possible to write down simply thoughts and any other comments or feedback
7. When the participant has turned back to the starting location (the walk itself can take around an hour), a discussion follows in a form of semi-structured interview.

The interviews are noted down by using a worksheet for each participant (Appendix – 12):

Demographic section
Gender: Age: Occupation: Local:

General mindset
How often do you use digital maps for orienting when walking?
Experience
How would you describe your experience with the map prototype? What are the aspects that seemed helpful in way-finding? Where there aspects that made way-finding more difficult? Which of the layers were most used or most helpful? Which of the layers were not used at all? Would it be as easy to find the given locations without the map layers?
Specific layer usage
Can you describe what would socially active place usually have? Did you manage to find some during the walk? Do you think that Ålesund Sentrum has different areas or territories? Can you say how can you see or feel that they are different?..
Closing
Did you found out something new today? Do you have any other thoughts, comments, suggestions?

T6.5, The interview questions during the experiment

6.2.2. Risk assessment

The potential risks for the final experiment (R2) can be identified as following and summarised using a risk matrix method (see Table 6.6):

a. Not being able finish the map prototype until the planned experiment is scheduled. Mitigation: Make more detailed schedule or keep in mind a person(s) that can help finalising the design process. Limit the design features.
b. Map prototype is created on desktop, but it is not possible to launch it on the participant's mobile device. Mitigation: In the designing process constantly test the prototype on a mobile device, use several mobile devices that are different.
c. Participant' smart devices will be different so the experience of the designed prototype can also differ causing not so reliable results. Mitigation: evaluate the differences by doing a pilot test on different devices, evaluate the impact of results.
d. It is not possible to reach the planned participant amount, very low participation rate. Mitigation: Do the experiment in the same planned setting, with as many participants as possible, loosen the sample criteria

e. It is bad weather while the participant is asked to do the walk, lack of motivations that results in inaccurate results. Mitigation: plan the experiment time by observing weather conditions, warn the participants about the often changing weather.
f. Participants withdraw from the experiment or do not complete it fully. Mitigation: While instructing the participant inform them that they have the right not to complete the task, but are strongly encouraged to complete it. Explain that the most important part of the experiment is the final feedback session.
g. Participants cancel the experiment meeting on the last minute, resulting in 2h gap in the planned schedule. Mitigation: Choose a meeting place where it is comfortable to sit and wait for the participants while doing other useful things parallelly as well.

Risk	Impact	Likelihood
R2a	High	Medium
R2b	High	Low
R2c	Low	High
R2d	Medium	High
R2e	Low	High
R2f	High	Low
R2g	Low	Medium

T6.6, Risk matrix

6.3. Results

6.3.1. Experience and mindset

The participants use digital map tool very often when they are in an unknown place, but also sometimes navigating in the local environment. Participants use digital map device on daily basis where public transport option, distance/time calculation and offline viewing features come in handy. Some of the participants rate themselves as poor in reading maps and being able to perceive and memorise more visual appearance of the built form, navigate using street names and larger points of references as mountains.

During the experiment the most troubles for participants occurred because of the limitations of the prototype. The following features were listed as very needed: zooming in and out by pinching and dragging the screen, not with "+" and "–" signs; the GPS location displayed while using the map, possibility to re-centre the map to the current position; larger area of the map. Participants seem to agree on having landmark illustrations as an advantage for wayfinding, but most of them were also interested in testing the other layers and "verify" if the feeling they get corresponds to the displayed information. Some participants used not only the information given on layers but also the geometrical understanding of the built form - the shape of blocks and streets for identifying their location.

6.3.2. Layers

As almost all participants mention, the social space layer (see Map M6.17) would be more relevant in times when social activity is actually happening in outdoor environment. Although participants list some of the possible target situations when it could be used: when student arrives in Ålesund and wants to meet new people and when tourist arrives and wants to see the points of interest or in contrast, wants to avoid the crowd and take more quiet streets. The participants' image of a social space has two conditions - it should be a connector to a destination and it should have services around. The other factors as junctions, attraction points, terrain and landscape are variables for more or less active social space.

M6.17, Social space layer

M6.18, Landmark illustrations layer

The local participants agree amongst themselves that landmark illustrations (see Map M6.18) might be more useful for a tourist or a person who is not familiar with the surroundings rather than a local. The non-local participants used landmark layer as the main navigation layer in all cases. Although almost all participants say that illustrated landmarks do make wayfinding more intuitive when the GPS is not functioning. As one of the local persons describe: "*I feel that I got a verification that I am at the "right place" when I see the landmark on the map, when I am standing next to or looking at the actual landmark.*" After the experiment it can be concluded that landmark illustrations are relevant for both – locals and tourists – because both groups have persons who have poor ability to read map or navigate in general, and landmark illustrations have proved to support wayfinding ability in these cases.

The territoriality layer (see Map M6.19) is not very helpful in wayfinding, when it is needed to navigate from A to B, according to participants. The layer would be useful for city exploration and sightseeing activities, that tourists and non-locals could take advantage of. Some of the participants had difficulties tracing the borders of the different areas and understanding them, so they suggest to add a legend to the layer or other type of explanation. Also having not so strict borderlines displayed in the map is a reasonable suggestion, because every person can perceive them differently. The territories described by the participants differed in such aspects: general noise level, intensity of traffic, crowdedness, architecture style, shape and materials, type of function (education, retail, living, recreation, etc.), level of natural landscape elements (gardens, trees, flower beds, etc) and even the style of car parking.

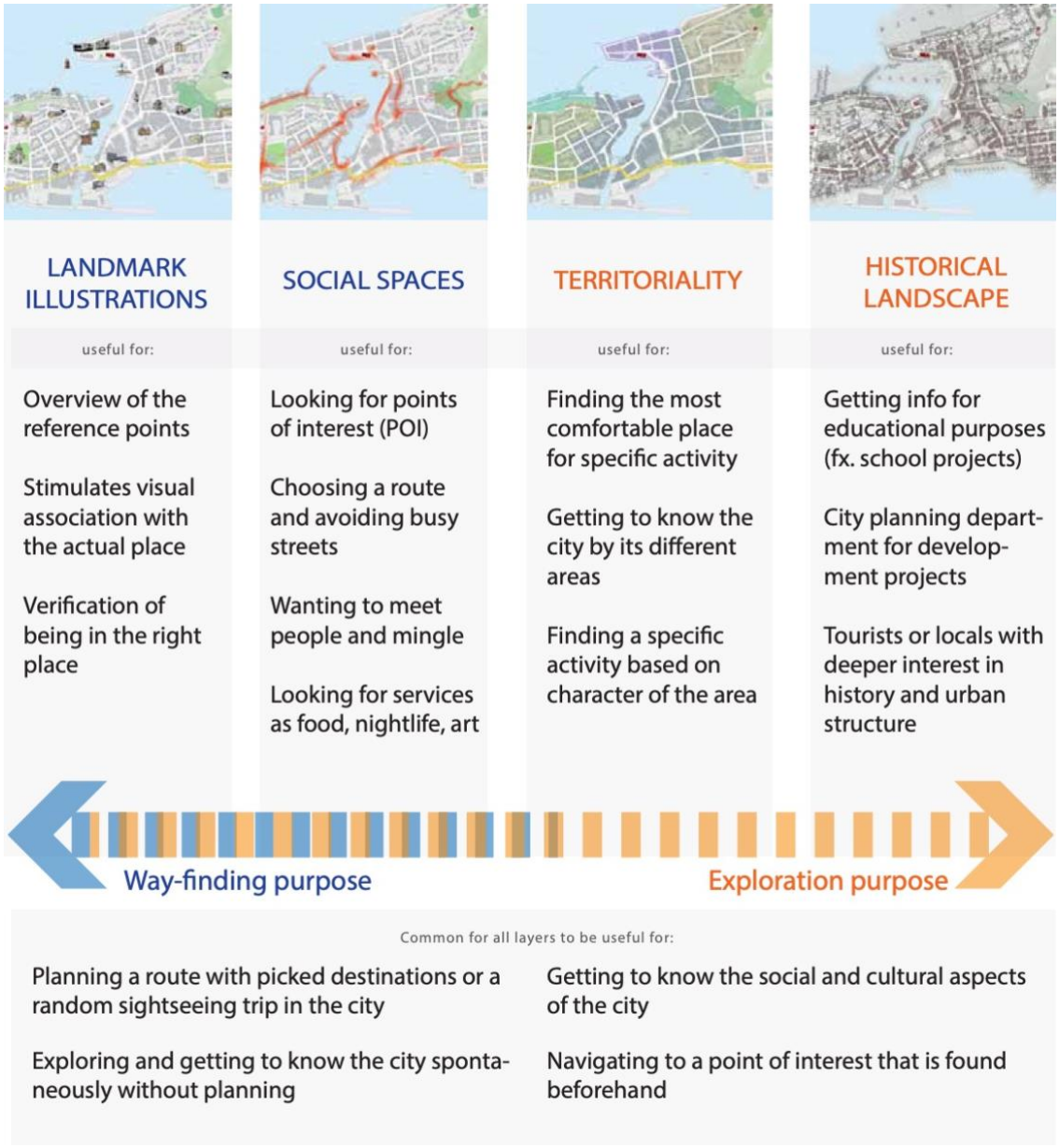
M6.19, Territoriality layer

M6.20, Historical landscape layer

Participants seem to agree that the historical landscape layer's (see Map M6.20) main purpose is not to help in wayfinding but to inform about the history of the city. The informative character is targeted towards specific audience, as people who are interested in urban structure, planning and historical development. After the discussions, it is possible to conclude that if the layer would be more developed, as the usability would be improved and more information added, then the tourists or other ordinary visitors of Ålesund (perhaps also locals) could take advantage of this layer. It would also work better not by its own, but together with other layers, as landmarks and territoriality, for example.

6.4. Summary

To get a general overview of the experience participants had from the walk and interaction with the map prototype, it is possible to display the summary of results in a diagram (see Figure F6.23). The four layers can be used for both purposes – wayfinding and exploration – but experiment showed that people would tent to use landmark illustration and social space layers more specifically for navigating to a given point, but territoriality and historical landscape layers for the exploration of city environment. It is necessary to point out that landmark illustrations and in some cases social space layer can be successfully used for both – wayfinding and exploration – but the historical landscape layer, for example, is not helpful in navigating to a specific destination at all. Every layer can serve for a different purpose and as discussed with participants the most can be achieved if there is a possibility to view them as overlays on top of each other forming different combinations.



F6.23, The result summary – usage of the designed layers

6.5. Validity of the results

The internal validity of the results could have been raised by rolling out the possible circumstances that may have influenced the results. In this case it was seen that landmark illustration' layer can be successfully used for both exploration and faster way-finding purposes. In the process of the experimented the first "home" screen was showed the landmark illustration' layer, which could have been substituted with a regular map without any layers switched on giving the opportunity for the participant to choose their first layer for using.

The participant could have been biased by having a set layer already for use thinking that it is the main layer for usage although all 4 layers have equal importance. Results also show that historical landscape layer is the least used for navigating purposes. This layer had the most technical issues related to loading time and displaying an accurate image. These factors could have influenced the decreased motivation for using this layer. In order to raise the external validity the experiment was conducted in a real life setting although deviating from the previously planned sample size. As the sample size was around 3 times smaller than planned, the generalizability extent of the results decreases.

The initially planned research was supposed to be a combination of both quantitative and qualitative research methods for conducting the experiment and analysing the results. The given timeframe and lack of technical equipment in the end situation was the reason for choosing qualitative data collection methods over quantitative. Due to the general lack of participants and social distancing restrictions, a lot of exercises before and for the experiment were digitalised, which resulted in dominance of virtual feedbacks and qualitative data collection. The validity of data could have been possible to increase if the initially planned on-place exercises would have been performed and real life feedbacks given from the planned participant sample.

The created layers serve as a concept for further work in developing way-finding tools that can be integrated in digital map systems. As the tested prototype is a low-fidelity prototype and excludes the usage of the whole map as well as GPS location is disabled, the next steps for more valid and reliable user testing would be to implement the following features: GPS with a real-time location dot, improved user interface, usability of a whole map application that may or may not involves the previously discussed features as personalisation and synchronisation with other apps. The results of the experiment show the specific usage that participants of Ålesund have found to be important for each layer of the designed map. These results can serve as basis for further development of a way-finding strategy which uses either digital or physical navigation tools for people encouragement to explore the city on feet.

7. CONCLUSIONS

There are several cognitive and physical factors that influence person's mental connectedness between different places in a city. The literature review concludes on categorising these factors in two groups: 1) the built urban form that consists of the city elements: path, edge, landmark, districts and nodes; and 2) the socio-cultural values that give places their identities. These groups together form a more thorough understanding of the urban landscape and represent a clearer image of the city. Nowadays the widely accessible smart devices are equipped with GPS and location based services, making it possible to be used as tools that help in building the mental connections between places in the urban environment. Wayfinding process can be enhanced with voice control, augmented reality, synchronisation with different information platforms and editing tools. The example of Legible London shows that systematically used design aspects of a physical map signage can as well significantly improve cognitive wayfinding for a dense city environment. It can be argued that the following design features added to the digital map's interface extrapolates the perception and knowledge of urban form for the pedestrian thus providing more thorough image of the social identity of place:

- implementing simple and intuitive editing tools
- organising information using layers, "modes", colours, contrasts and clickable icons
- implementing voice control (AI) and augmented reality features
- linking street names with the actual buildings
- displaying more details about walkability, like walking distance circles
- adding axonometric landmarks and personalizing the digital map
- synchronising a digital map with other social platforms

It can also be concluded that in order to create a more comprehensive experience of the city, the pedestrian should be encouraged to have an "explorer" mindset, that promotes the willingness to gather and process the information city provides not only with the built form, but also with the cultural context. A lot of empirical experiments in pedestrian wayfinding categorise them in two bold groups, the ones who use a navigation device (active) and the

ones who do not (passive). It can be argued that the information that is displayed on the digital device should not encourage these categories, rather promote mixing them, creating a desire to explore.

A user study in the area of Ålesund, Norway has been conducted where data about inhabitant's way-finding mindset and experienced were gathered. As the digital map tool has been prioritized the most amongst the way-finding tools, it can be suggested that it has the potential to strengthen also the other tools so that they could be used in a combined setting improving the wayfinding experience for the pedestrian. The digital map would be used for both purposes – navigating faster from place to place and exploring the city environment. It can be assumed that the exploration purpose would be used a lot by the age group 50+ and the other age groups in a decreasing manner. The faster navigation purpose is assumed to be used by all age groups equally according to the individual needs, but it can be also argued that experts and informed users would tend to use it more often.

After conducting the field study in the central area of Ålesund by using methods that involve both – looking at the built urban form and the socio-cultural context of the places – it can be said that these methods used separately would give an incomplete image. The built urban form consists of physical elements that are defined as paths, edges, landmarks, nodes, and districts; and marking these elements directly without the social and cultural input, can result in false interpretation of collected data. For example, Ålesund - with its very characteristic Hellebroa bridge that connects two islands at the very heart of the historical center – seemingly is divided into two halves, but the field mapping results shows that the edge of a water is not an obstacle to perceive two physically separated parts as a whole.

The collected data from reviewing literature, inhabitant input and individual observations were combined in a digital wayfinding application prototype. The design consists of four additional informative layers that can be manually turned on and off and integrated in an existing digital map application as a separate "mode". These layers link the built urban form with the socio-cultural characteristics of the Ålesund central area, by organising the information after R. Damayanti's "Spatial recognition concept of urban elements" in the following layers: Landmark illustrations, Social spaces, Territoriality and Historical landscape. Experiment has indicated that all of the layers can be successfully used for exploration purposes, but when it comes to

navigating faster from place to place, the landmark illustrations and social spaces are the most helpful.

Each of the proposed layers are useful for specific goals that user wants to achieve, although all of them have also common usage scenarios as: planning routes with selected destinations; exploring the city spontaneously; getting to know the social and cultural aspects of the city and navigating to general points of interest. It can be concluded that the hypothesis “If the digital device provides information about urban form, social, cultural and historical aspects of a city, pedestrian's awareness of social identity of place is increasing thus improving the mental connections between outdoor urban locations” can be supported by the experiment results where the participants define each layer useful for:

- providing visual stimuli and association with the actual place (landmark illustrations);
- looking for points of interest and meeting people to mingle (social spaces);
- finding a specific activity based on character of different areas (territoriality);
- getting in-depth knowledge about history and urban structure (historical landscape).

8. DISCUSSION

The main research question was, if digital tool usage can strengthen the pedestrian mental connections between outdoor urban spaces by providing “hints” for social identity of these places. The “hints” were operationalised in this case as additional information about cultural, sociological and historical aspects. The researched literature describes mental connectedness as a logical arrangement and recognition of city elements, whereas a mental map represents the relationship of these elements and routes that are memorable and relevant to person’s needs. The study has showed that there can be several factors that weaken the mental connections between outdoor urban spaces, and the lack of socio-cultural context input was the factor that was considered the most important. The cultural, sociological and historical aspects of a place combined with the built form create the identity of place, that if acknowledged by a person can improve the mental connectedness between different urban areas. As nowadays digital map is one of the common tools for pedestrian wayfinding, the following advantages can be listed that potentially help to discover hidden social and cultural context and help with way-finding process in general:

1) location based services that promote information production and knowledge sharing;
2) hands-free and AR devices that allow to fully interact with the urban environment;
3) interface design that organise the information for intuitive use;
4) synchronisation between different informative platforms, as social media and/or Wikipedia.

The results of the experiment where the designed prototype is tested within the central area of Ålesund indicate that the hypothesis can be supported with the feedback from the participants. Several usage possibilities and scenarios were reported where all of them promote exploration purpose and two of them help more in way-finding purpose. This means that the designed prototype can encourage the pedestrian to discover the identity of different areas within the city by using the cultural, sociological and historical information that is organised and displayed in a form of layers within the map application.

It was expected to define clearly and elaborate on the research variables because of their relatively abstract meaning (mental connectedness between urban areas, awareness of the

identity of place in relation to socio-cultural aspects), which has been done in the literature review, using anthropology and urban planning related scholar' works. The concepts are abstract enough to be interpreted in various different ways, meaning that the more aspects are covered, the better understanding on how to measure them. Within the experiment it was expected to observe the relationship between these variables, which was done mostly using qualitative research methods. A stronger link could have been developed between the defined variables and measuring methods for the final experiment. If the timeframe allows in the future work, a control group would be useful to introduce in the experiment process in order to increase the internal validity. It would have been also possible to raise the reliability of the results by using not only post-experiment interviews, but also organising drawing exercises and implementing a location tracking device in the prototype and timing the navigation process. This way the qualitative and quantitative data would be balanced in amount and provide more room for interpretation.

The main target audience of the study was the non-local inhabitants that are not supposed to be familiar with the central urban environment of Ålesund. As the sample of the intended population deviated from the expected one, the study would have a need to be repeated with emphasis on sample size and demographic information in order for the results to be generalizable. The data gathering and testing process collapsed with the Covid-19 crisis, which made the research process more complex and time consuming, resulting in decreased external validity. In order to have statistically significant data from user research and field study, the sample size would have to be increased in all cases.

The results present design strategies and methods that can improve digital map systems, thus improving the experience for the users. This thesis can be a groundwork for potential further development in form of guidelines for improving the digital map systems, particularly in the context of getting a better understanding of the explored area in Ålesund. The further recommended generalised work would need to cover more thorough research on the anthropological aspects that create the social identity of place and how it relates to the processes of the contemporary society and urban life. Also there are many successful way-finding solutions that do not necessarily involve digital tool usage, meaning that it is possible to reconsider the role of a portable smart device in the everyday life of individuals. This thesis

is focused on one set of design features that are presented as digital map layers. There can be several other scenarios investigated and tested that involves advanced urban way-finding tool usage as augmented reality features, hands-free devices and voice control. Nevertheless, all urban wayfinding methods are important tools for an individual who moves through a city, that can make the experience either discouraging or enjoyable.

REFERENCES

Afrooz, A., White, D., & Parolin, B. (2018). Effects of active and passive exploration of the built environment on memory during wayfinding. Applied Geography, 101, 68-74. doi: 10.1016/j.apgeog.2018.10.009

Ahmed, M., Abel-Rahman, A., & Ali, A. (2015). *Development of Intelligent Façade Based on Outdoor Environment and Indoor Thermal Comfort.* Procedia Technology, 19, 742-749. doi: 10.1016/j.protcy.2015.02.105

Arquati, D. (2008). *PEDESTRIANS IN CENTRAL LONDON LOST AND FOUND: THE LEGIBLE LONDON WAYFINDING SYSTEM.* PTRC and Contributors 2008. Retrieved from https://www.eltis.org/sites/default/files/case-studies/documents/pedestrians_in_central_london_5.pdf

Augé, M. (1995*). Non-places: Introduction to an anthropology of supermodernity*. London: Verso.

Bartie, P., Mackaness, W., Lemon, O., Dalmas, T., Janarthanam, S., & Hill, R. et al. (2018). A dialogue based mobile virtual assistant for tourists: The SpaceBook Project. Computers, Environment And Urban Systems, 67, 110-123. doi: 10.1016/j.compenvurbsys.2017.09.010

Baxter, K., Courage, C., & Caine, K. (2015). *Understanding Your Users*, 2nd Edition.

Bhatia, M. (2020). *Your Guide to Qualitative and Quantitative Data Analysis Methods - Atlan | Humans of Data*. Retrieved 14 April 2020, from https://humansofdata.atlan.com/2018/09/qualitative-quantitative-data-analysis-methods/

Bock, T. (2020). *What is a Dendrogram? How to use Dendrograms* | Displayr. Retrieved 13 April 2020, from https://www.displayr.com/what-is-dendrogram/

BREAKFAST LLC. (2019). *Points | The most advanced wayfinding sign on Earth*. Retrieved 2 November 2019, from https://pointssign.com

Brynskov, M., Carvajal Bermúdez, J., de Waal, M., Fernández, M., Korsgaard, H., & Mulder, I. et al. (2014). *Urban Interaction Design: Towards City Making* [Ebook] (1st ed.). Amsterdam: UrbanIxD: *Designing Human Interactions in the Networked City*. Retrieved from https://issuu.com/urbanixd/docs/urbanixd_towardscitymaking

Chang, Y. (2003). *Spatial Cognition in Digital Cities*. International Journal Of Architectural Computing, 1(4), 471-488. doi: 10.1260/147807703773633482

Damayanti, R. (2015). *Extending Kevin Lynch's Theory of Imageability through an investigation of kampungs in Surabaya, Indonesia* (Ph.D). University of Sheffield.

Digital age. (2018). In YourDictionary. Retrieved 2 February 2019 from https://www.yourdictionary.com/digital-age

Dziuban, C., Moskal, P., Cassisi, J., & Fawcett, A. (2016). *Adaptive Learning in Psychology: Wayfinding in the Digital Age*. Online Learning, 20(3). doi: 10.24059/olj.v20i3.972

Elvins, T., Nadeau, D., Schul, R., & Kirsh, D. (2001). *Worldlets: 3-D Thumbnails for Wayfinding in Large Virtual Worlds. Presence: Teleoperators And Virtual Environments*, 10(6), 565-582. doi: 10.1162/105474601753272835

Erçevik Sönmez, B., & Erinsel Önder, D. (2019). *The influence of GPS-based navigation systems on perception and image formation: A case study in urban environments*. Cities, 86, 102-112. doi: 10.1016/j.cities.2018.12.018

Fendley, T., de Graaf, K., Gullam, S., Durrant, N., Taylor, R., & Muller, M. et al. (2006). *Legible London: A wayfinding study* [Ebook] (pp. 10-11, 24-29, 34-40). AIG London Ltd. Retrieved from https://segd.org/sites/default/files/2018-egd-cc-wb-research-london.pdf

Ghume, S. (2017). *Explore the world with Google Maps — Pros and Cons* [Blog]. Retrieved from https://medium.com/@snehalghume/explore-the-world-with-google-maps-pros-and-cons-23bab11c5ecf

Gibson, D., & Pullman, C. (2009). *The wayfinding handbook*. New York: Princeton Architectural Press.

Gupta, M. (2016). *Is Google Map The Best Choice For Navigation? The Pros And Cons* [Blog]. Retrieved from http://www.crunchytricks.com/2019/11/google-map-best-choice-for-navigation.html

Harvey, D. (2008). *The right to the city*. International Journal Of Urban And Regional Research, 27(4), 939-941. doi: 10.1111/j.0309-1317.2003.00492.x

Healy, Y. (2020). *Dendrogram*. Retrieved 13 April 2020, from https://www.data-to-viz.com/graph/dendrogram.html

Herbes, B. (2018). *Wayfinding for pedestrians in urban areas: Making places more walkable, legible and liveable*. Available at: http://www.swdc.wa.gov.au/media/100057/pedwayfinding_bruce%20herbes.pdf

Holston, J. (1989). *The modernist city* (pp. 31-58). Chicago: University of Chicago Press. https://davidharvey.org/media/righttothecity.pdf

Jeffrey, C. (2017). *Wayfinding perspectives*. In A. Black, P. Luna, O. Lund & S. Walker, Information Design: Research and Practice (pp. 509–526). New York: Routledge.

Juhlin, D. (2016). *Is closed card sorting an outdated technique for IA?* - Optimal Workshop. Retrieved 13 April 2020, from https://blog.optimalworkshop.com/closed-card-sorting-outdated-technique-ia/

Lee, C. (2020). *Review: "Useful and free but..."* [Blog]. Retrieved from https://www.trustpilot.com/review/maps.me

Li, C. (2006). *User preferences, information transactions and location-based services: A study of urban pedestrian wayfinding*. Computers, Environment And Urban Systems, 30(6), 726-740. doi: 10.1016/j.compenvurbsys.2006.02.008

Loomis, J., Golledge, R., & Klatzky, R. (1998). *Navigation System for the Blind: Auditory Display Modes and Guidance. Presence: Teleoperators And Virtual Environments,* 7(2), 193-203. doi: 10.1162/105474698565677

Lucic, K. (2019*). Top 10 Best Android Navigation Apps – 2019* [Blog]. Retrieved from https://www.androidheadlines.com/2019/06/best-android-navigation-apps-2019.html

Lynch, K. (1960). *The Image of the City*. Cambridge: MIT Press.

Lynch, K. (1972). *WHAT TIME IS THIS PLACE?.* Cambridge, Mass. and London England: The MIT Press.

Lynch, K. (1981). *A theory of good city form*. Cambridge, Mass: MIT Press.

Lynch, K., Banerjee, T., & Southworth, M. (1990). City Sense and City Design: Writings and Projects of Kevin Lynch (pp. 517-519). Cambridge [MA]: The MIT Press.

May, A. J., Ross, T., Bayer, S. H., & Tarkiainen, M. J. (2003). *Pedestrian navigation aids: Information requirements and design implications*. *Personal and Ubiquitous Computing*, 7(6), 331–338.

Morgan, J. (2014). *A Simple Explanation Of 'The Internet Of Things'* [Blog]. Retrieved from https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/

Norkart AS. (2019). Retrieved 19 April 2020, from https://www.norkart.no/norkart-in-english/

Ohm, C., Bienk, S., Kattenbeck, M., Ludwig, B., & Müller, M. (2016). *Towards interfaces of mobile pedestrian navigation systems adapted to the user's orientation skills*. Pervasive And Mobile Computing, 26, 121-134. doi: 10.1016/j.pmcj.2015.10.006

Panko, R. (2018). *The Popularity of Google Maps: Trends in Navigation Apps in 2018* [Blog]. Retrieved from https://themanifest.com/app-development/popularity-google-maps-trends-navigation-apps-2018

Pearce, T. (2018). *Building a business case for City Wayfinding* [Blog]. Retrieved from https://citywayfinding.com/building-a-business-case-for-city-wayfinding/

Rall, E., Hansen, R., & Pauleit, S. (2019). *The added value of public participation GIS (PPGIS) for urban green infrastructure planning*. Urban Forestry & Urban Greening, 40, 264-274. doi: 10.1016/j.ufug.2018.06.016

Rzeszewski, M., & Kotus, J. (2019). *Usability and usefulness of internet mapping platforms in participatory spatial planning*. Applied Geography, 103, 56-69. doi: 10.1016/j.apgeog.2019.01.001

Shantikumar, S. (2018). *Methods of sampling from a population*. Retrieved 1 May 2020, from https://www.healthknowledge.org.uk/public-health-textbook/research-methods/1a-epidemiology/methods-of-sampling-population

Short, A. (2017). *Standing Out From The Crowd: Improving Your Mobile App With Competitive Analysis* [Blog]. Retrieved from https://www.smashingmagazine.com/2017/12/improving-mobile-app-competitive-analysis/

Sidjanin, P. (2007). *On Lynch's and post-Lynchians theories.* Facta Universitatis - Series: Architecture And Civil Engineering, 5(1), 61-69. doi: 10.2298/fuace0701061s

Singh, R. (2016). *Factors Affecting Walkability of Neighborhoods*. Procedia - Social And Behavioral Sciences, 216, 643-654. doi: 10.1016/j.sbspro.2015.12.048

Spinney, J., Reimer, S., & Pinch, P. (2017). *Mobilising Design* (1st ed.). Taylor and Francis.

Suran, O., Smyth, M., Helgason, I., Zaffiro, G., Brynskov, M., & Mitrovic, I. (2014). *The UrbanIxd Manifesto: Interaction Design in Networked City* [PDF] (1st ed.). UrbanIxD: Designing Human Interactions in the Networked City. Retrieved from https://issuu.com/urbanixd/docs/urbanixd_manifesto

Suran, O., Smyth, M., Helgason, I., Zaffiro, G., Brynskov, M., & Mitrovic, I. (2015). *City|Data|Future - Interactions in Hybrid Urban Space* [PDF] (1st ed.). UrbanIxD: Designing Human Interactions in the Networked City. Retrieved from https://issuu.com/urbanixd/docs/city_data_future_issu

The Open University. (2016). *Study Session 5 Urbanisation: Trends, Causes and Effects: View as single page.* Retrieved 8 June 2020, from https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=79940&printable=1

Vandenberg, A., Hunter, R., Anderson, L., Bryant, L., Hooker, S. and Satariano, W. (2016). *Walking and Walkability: Is Wayfinding a Missing Link? Implications for Public Health Practice.* Journal of Physical Activity and Health, [online] 13(2), pp.189-197. Available at:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5578416/#idm139642106052400aff-info

Walford, N., Samarasundera, E., Phillips, J., Hockey, A., & Foreman, N. (2011). *Older people's navigation of urban areas as pedestrians: Measuring quality of the built environment using oral narratives and virtual routes. Landscape And Urban Planning,* 100(1-2), 163-168. doi: 10.1016/j.landurbplan.2010.12.006

Warren, A. (2015). *Google Maps: Pros and Cons* [Blog]. Retrieved from https://prezi.com/dxs7x2wmktqy/google-maps-pros-and-cons/

Wentz, E., York, A., Alberti, M., Conrow, L., Fischer, H., & Inostroza, L. et al. (2018). *Six fundamental aspects for conceptualizing multidimensional urban form: A spatial mapping perspective*. Landscape And Urban Planning, 179, 55-62. doi: 10.1016/j.landurbplan.2018.07.007

Wesselman, S. (2015). *Kevin Lynch: Relevant or Relic? A Critique* [Blog]. Retrieved from https://samwesselman.wordpress.com/2015/10/23/kevin-lynch-relevant-visionary-or-relic-a-critique/

WHO | Physical Activity and Adults. (2020). Retrieved 4 February 2020, from https://www.who.int/dietphysicalactivity/factsheet_adults/en/

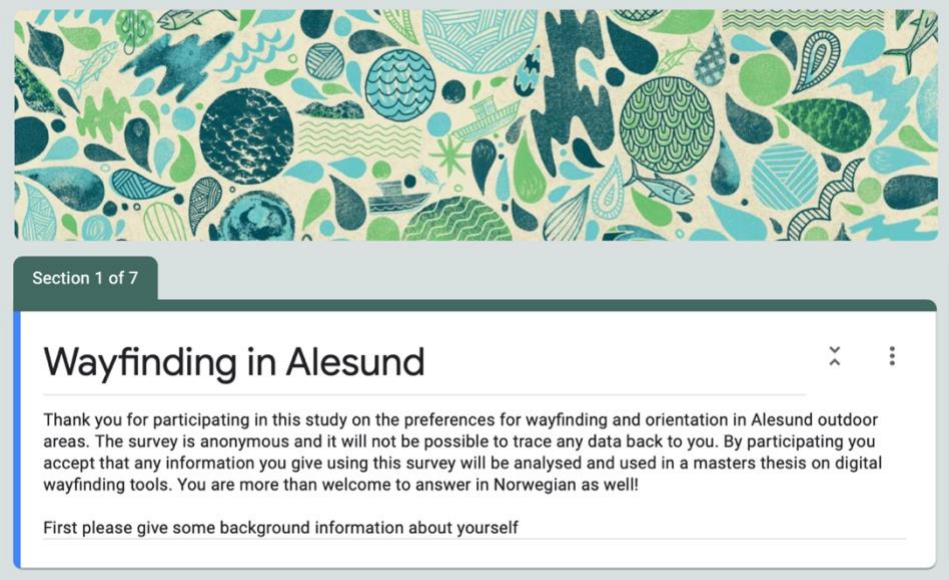
Willis, K., Hölscher, C., Wilbertz, G., & Li, C. (2009). *A comparison of spatial knowledge acquisition with maps and mobile maps*. Computers, Environment And Urban Systems, 33(2), 100-110. doi: 10.1016/j.compenvurbsys.2009.01.004

Wurman, R. (2003). Richard Saul Wurman. In A. Kelly & M. Kelly, *Building Legible Cities 2: Making the case* (pp. 34-35). Bristol: Bristol Cultural Development Partnership. Retrieved from http://aprb.co.uk/docs/building_legible_cities2_0.pdf

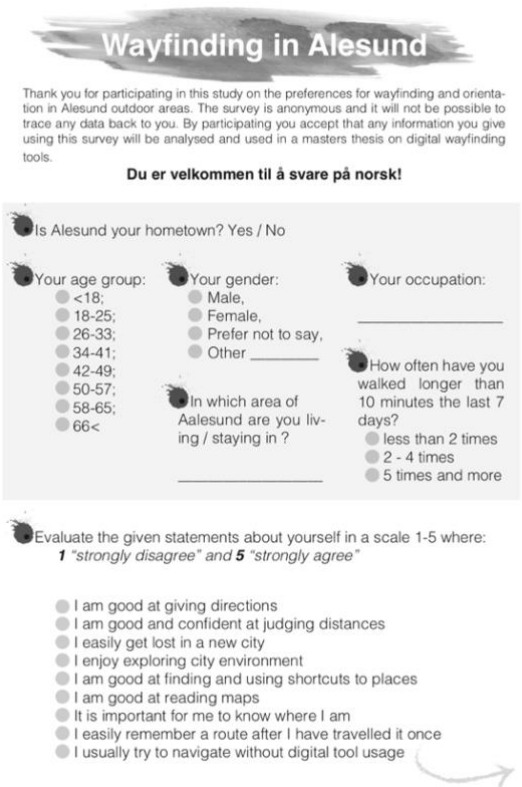
Zomer, L., Schneider, F., Ton, D., Hoogendoorn-Lanser, S., Duives, D., Cats, O., & Hoogendoorn, S. (2019). *Determinants of urban wayfinding styles*. Travel Behaviour And Society, 17, 72-85. doi: 10.1016/j.tbs.2019.07.002

APPENDIX

Appendix – 1, Online survey screen-shot



Appendix – 2, Printed copy of the survey



Wayfinding in Alesund

Thank you for participating in this study on the preferences for wayfinding and orientation in Alesund outdoor areas. The survey is anonymous and it will not be possible to trace any data back to you. By participating you accept that any information you give using this survey will be analysed and used in a masters thesis on digital wayfinding tools.

Du er velkommen til å svare på norsk!

Is Alesund your hometown? Yes / No

Your age group:
- <18;
- 18-25;
- 26-33;
- 34-41;
- 42-49;
- 50-57;
- 58-65;
- 66<

Your gender:
- Male,
- Female,
- Prefer not to say,
- Other _____

In which area of Aalesund are you living / staying in ?

_____

Your occupation:

_____

How often have you walked longer than 10 minutes the last 7 days?
- less than 2 times
- 2 - 4 times
- 5 times and more

Evaluate the given statements about yourself in a scale 1-5 where:
1 *"strongly disagree" and* ***5*** *"strongly agree"*

- I am good at giving directions
- I am good and confident at judging distances
- I easily get lost in a new city
- I enjoy exploring city environment
- I am good at finding and using shortcuts to places
- I am good at reading maps
- It is important for me to know where I am
- I easily remember a route after I have travelled it once
- I usually try to navigate without digital tool usage

Which of the tools would you use first **when in a hurry?**
Put them in order 1-6 how you would use them

- Digital map (like Google Maps)
- Physical map
- Outdoor signs, info stands
- Street names and numbers
- Landmarks (buildings, statues,)
- Asking people directions

- Digital map (like Google Maps)
- Physical map
- Outdoor signs, info stands
- Street names and numbers
- Landmarks (buildings, statues,)
- Asking people for advice

Which of the tools would you use first **when explorig a city?**
Put them in order 1-6 how you would use them

Name important landmarks in Alesund that can help people in orientation and wayfinding!

_____

Name places in Alesund that have a cultural / historical meaning!

_____

Name important streets / paths / avenues that every local would know!

_____

Evaluate the given statements about yourself in a scale 1-5 where:
1 *"strongly disagree" and* ***5*** *"strongly agree"*

- There are many dead-end streets in my neighbourhood.
- My neighbourhood surrounding (buildings, objects, elements) is unique enough to recognise what neighbourhood it is.
- There is enough light infrastructure in my neighbourhood to feel safe walking in dark hours.

Tusen takk!

SCAN and fill it online!

Appendix – 4, User profiles

ECONOMIST

Age	34-41, 42-49
Gender	Male and female
Job titles	Politician, economic consultant, accounter
Experience	project accounting / project controls environment
Education	Mater's or Bachelor's degree in finance / accounting
Location	Volda, Sentrum
Income	Monthly average 61 090 NOK
Wayfinding tool	First priority: Digital map usage
Walking activity	5+ times more than 10 min for the last 7 days

STUDENT

Age	18-25, 26-33
Gender	Male and female
Job titles	Full-time/part-time student, intern, frivillig, exchange, visiting
Experience level	Academic research projects, projects outside academic setting
Education	Bachelor / Master / PhD enrolment
Location	Gåseid, Nørvasundet (campus/Larsgården), Spjelkavik, Klipra, Sentrum
Income	Possible internship (in Norway) +/- 30-40k NOK
Wayfinding tool	Digital map First priority; physical map then and signs
Walking activity	5+ times more than 10 min for the last 7 days

WRITER

Age	66+
Gender	One Male
Job titles	Creative text writer, editor, journalist, content strategist, critique
Experience	Critiques, reviews, prizes, book release
Education	Professional Degree in Education usually

Location	Sentrum
Income	Monthly average 53 990 NOK
Wayfinding tool	Asking for advice and using a physical map
Walking activity	5+ times more than 10 min for the last 7 days

RETIRED

Age	50-57, 58-65, 66+
Gender	From respondents, mostly female
Job titles	On a disability benefit (?) (Uføretrygd), retired, fisherman
Experience level	-
Education	May differ
Location	Aspøya west, Aspøya, Skarbøvik
Income	Around 18 000 NOK monthly
Wayfinding tool	interacting with environment, Rather asking people,
Walking activity	5+ times more than 10 min for the last 7 days, 2-4 also

MANAGER

Age	34-41, 42-49 26-33
Gender	Mostly female
Job titles	SERVICE SYSTEM PROJECT MANAGER, office manager, store manager, Company owner
Experience	Project documentation, time management, leading
Education	Highest education
Location	Sentrum (Konges gate), VOLSDALEN, Skarbøvik, Nørve
Income	Monthly average 66 410 NOK
Wayfinding tool	Digital map First priority, then physical, interacting with environment/people
Walking activity	5+ times more than 10 min for the last 7 days, 2-4

TEACHER

Age	34-41, 50-57
Gender	Female
Job titles	Dance teacher, lecturer,
Experience	Experience and qualification of the specific subject
Education	Teaching and Learning higher education
Location	Hessa, Aspøya
Income	Monthly average 51 820 NOK
Wayfinding tool	Digital map First priority when in a hurry, physical map for exploring
Walking activity	Less than 2 times walking for more than 10 min last 7 days

NURSE

Age	42-49
Gender	One Female
Job titles	Nursing assistant, home care nurse, operational nurse, staff
Experience	General nursing tasks, observation/mapping
Education	Higher education in nursing, Authorisation as a nurse
Location	Sentrum
Income	Monthly average 41 280 NOK
Wayfinding tool	Digital and physical map
Walking activity	5+ times more than 10 min for the last 7 days

STAY AT HOME MOM

Age	42-49
Gender	Female
Job titles	Online jobs, virtual assistance, online marketing
Experience level	various
Education	various
Location	Sentrum, Hatlane

Income	various
Wayfinding tool	Physical then the digital map usage
Walking activity	Less than 2 times for more than 10 min for the last 7 days

ENGINEER

Age	26-33, 42-49, 50-57
Gender	Mostly men
Job titles	Chief Technology Officer, Architect, road constructor, IT
Experience level	Software skills, specific skills in the field
Education	Higher education in Science and Engineering
Location	Sentrum, Hessa, Fjelltun, Skarbøvik
Income	Monthly average 66 150 NOK
Wayfinding tool	Digital map First priority (and asking people, interacting w/ outdoor environment)
Walking activity	2-4, 5+, -2

DESIGNER

Age	42-49
Gender	Male and female
Job titles	Graphic designer, exhibition set planner
Experience level	Software skills, illustration, creative thinking, UX
Education	Bachelor or Master degree in arts, design or other relevant field
Location	SPJELKAVIK, Moa
Income	Monthly average 46 420 NOK
Wayfinding tool	Digital map First priority
Walking activity	Less than 2 times

SECURITY GUARD

Age	26-33
Gender	One Male

Job titles	Transporter, currier, investigator, entrance security
Experience	First aid, physical training, knowledge of law, tech knowledge
Education	Qualification / professional training
Location	Nørvasundet
Income	Monthly average 33 670 NOK
Wayfinding tool	Digital map First priority
Walking activity	5+ times more than 10 min for the last 7 days

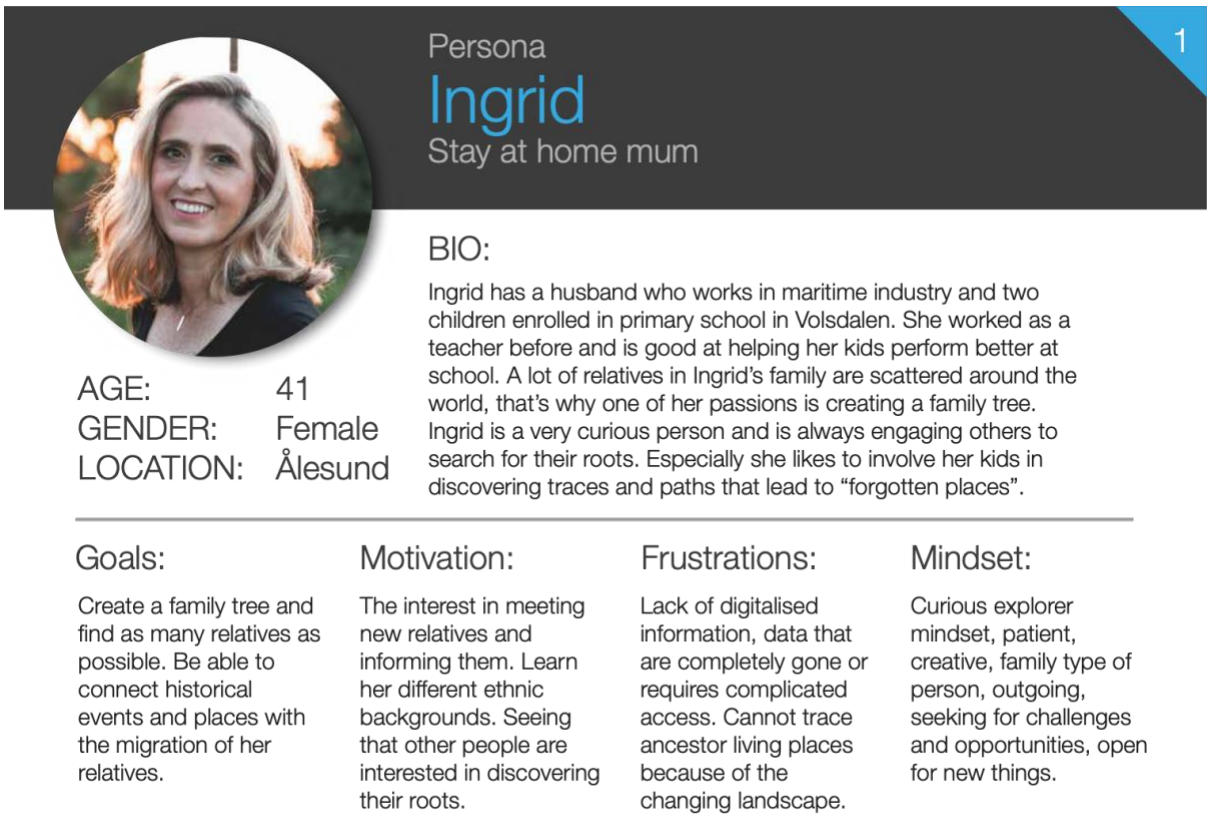
COSTUMER SERVICE, RETAIL

Age	18-25, 26-33, 58-65
Gender	Slightly more female than male
Job titles	Book seller, receptionist, store assistant
Experience	Problem solving and communication
Education	Highschool education diploma
Location	KLIPRA, sentrum, moa
Income	Monthly average 37 270 NOK
Wayfinding tool	Digital map first priority, for some physical map first priority
Walking activity	5+ times more than 10 min for the last 7 days

COMMUNITY WORKER

Age	42-49
Gender	One Female
Job titles	Miljøarbeider
Experience level	Various, can be related to healthcare, teaching, psychiatry etc.
Education	Healthcare education, Teaching
Location	Aspøya
Income	Monthly average 32 160 NOK
Wayfinding tool	Digital map First priority
Walking activity	LESS than 2 times

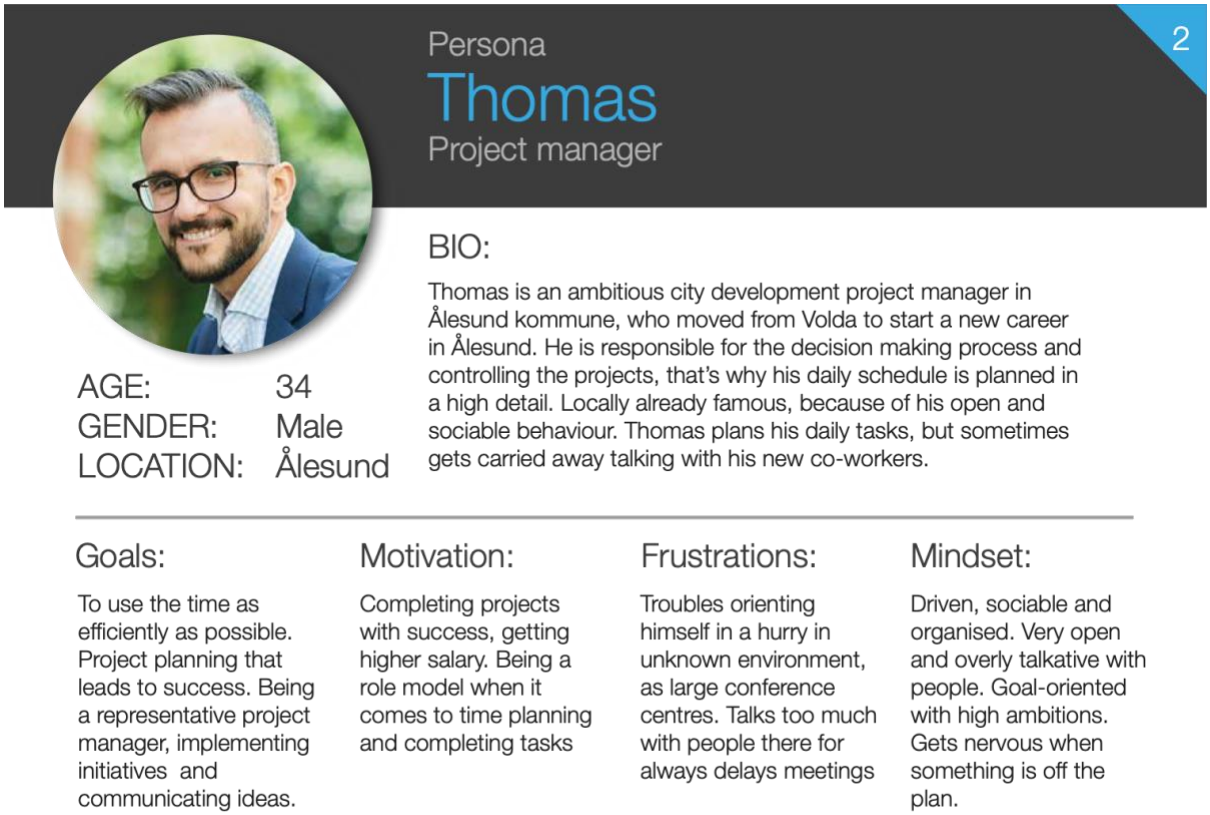
Appendix – 5, Ingrid and her scenario on family tree



01 INGRID'S SCENARIO

In the process of creating her family tree, Ingrid has got to know a lot of close relatives, that live in different locations in Norway. Her cousin from Trondheim has planned a first time visit to Ålesund and is very interested in finding out more information about her great grandparents. After discussing this topic with her cousin, Ingrid has the names and the old address where they lived in Ålesund. For more details, they are planning to visit the place and see if the address still exists. To quickly locate the place Ingrid takes her smart phone and opens the digital map services. She turns on the historical map mode and enters the information she knows to search the central area of Ålesund. As the map is synchronised with the historical achieve data of the city, they do not need to go and search for paper based maps. The digital map displays the area of interest and Ingrid with her cousin are on their way to the place. As they move through the city, it is possible to see how the landscape has changed throughout the time. When they reach the old Fjordgaden, now called Fjordgata, they talk to the people who live there and gather more information about the great grandparents of her cousin. Ingrid is fascinated about her hometown, because every time she takes a "historical tour", she discovers new facts and places that are rooted deep in the history of Ålesund.

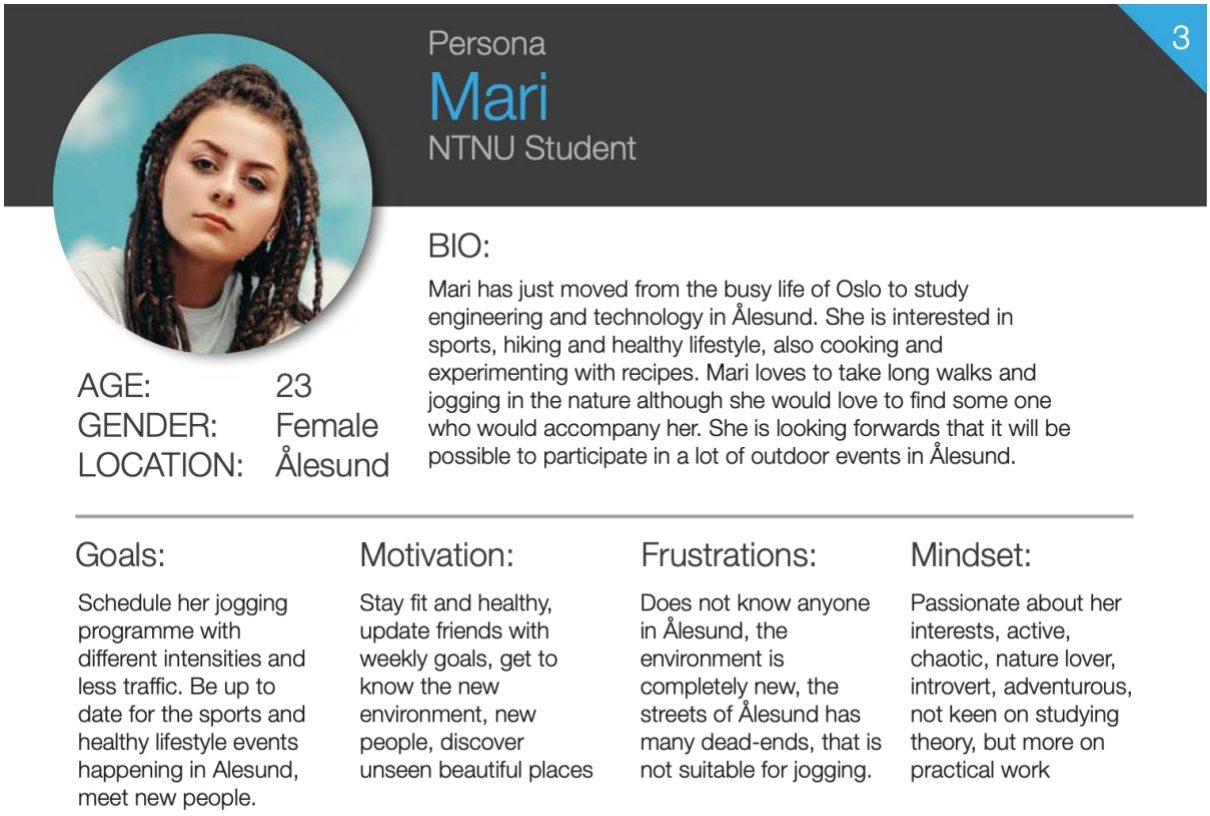
Appendix – 6, Thomas and his scenario on always being late



02 THOMAS' SCENARIO

Thomas is always excited to use the latest technologies and see how they can make the daily task performance more effective. His job as a project manager in Ålesund commune includes meeting a lot of new people, creating networks and attending conferences. He is currently managing the renovation of green public areas in the abandoned sites of Ålesund and has a kick-off meeting with the project team today in the NRK Smart City Lab, that he has never visited before. Unfortunately the conference for project risk assessment took place longer than he expected, so there is not much time left to prepare for the upcoming Smart City Lab meeting. Thomas has to find out the location of the NRK building and navigate to the correct room. As he is a bit late, stressful situations does not help him in orientation. As his digital calendar is synchronised with map systems, he opens the invitation and can immediately locate the building and estimated time for walking to the place. When Thomas gets to the place, he sees a lot of entrances to the building but luckily his digital map is synchronised with Maze Maps, that display the indoor plans of the buildings. As the Maze Map recognised the location and building from the invitation in Thomas' email, it suggests to navigate directly to the Smart City Lab taking into consideration Thomas' location and choosing the closest available entrance. Thomas successfully navigates through the building and is right on time to start the meeting.

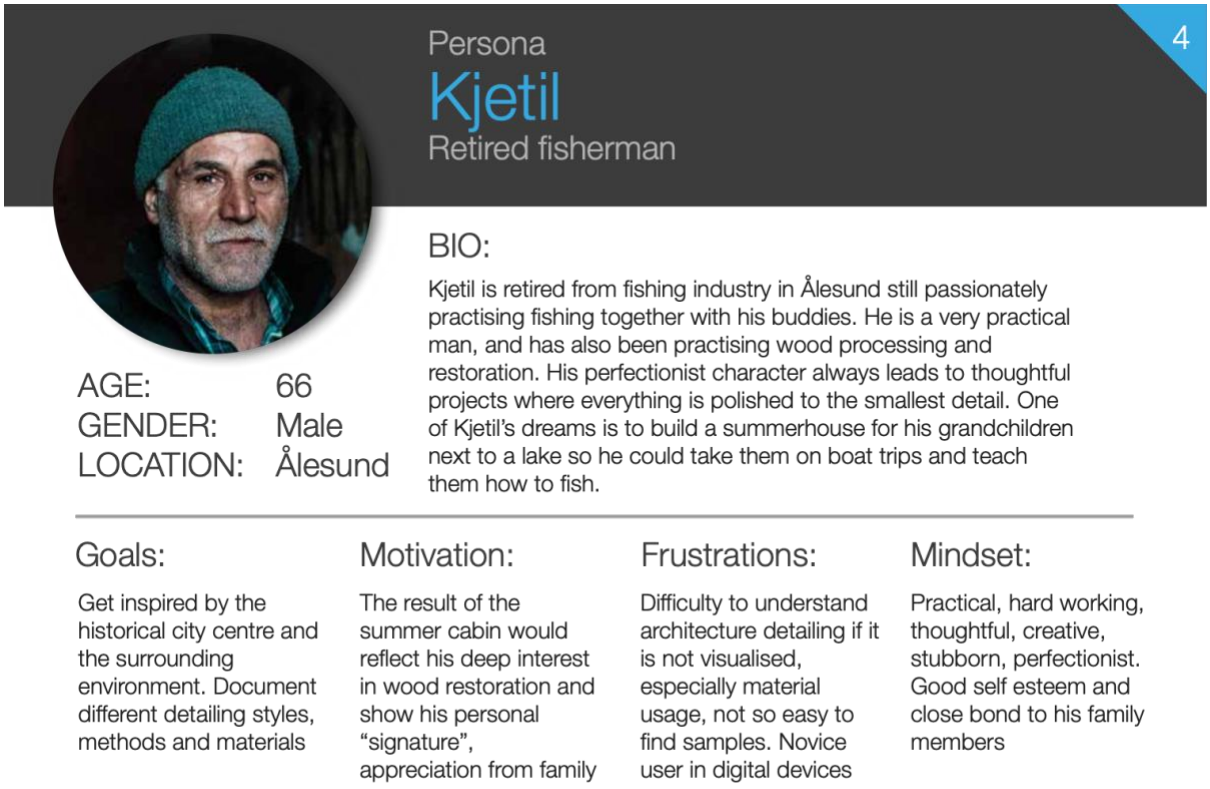
Appendix – 7, Mari and her scenario on finding friends and activities



03 MARI'S SCENARIO

Moving from Oslo to Ålesund was a big step in Mari's life and she is looking forwards to get to know the unfamiliar environment and meet new friends. As she has visited Ålesund only as a tourist, now she has the ability to explore the surroundings and she is excited to do it by exercises and different sports activities. Mari loves to do yoga, jogging, dancing, cycling, hiking and is a fan of healthy meal preparing. She does not have any friends here that would suggest her activities, but she can get suggestions by personalising digital map on her smart device. To create her week schedule she is synchronising the map with social media platforms as Facebook and allows notifications for nearby sports events that are displayed on the map. By answering to few introductory questions and adding interests, the map filters the events that are happening in a specific time period around her location. The ones that seem not interesting, Maria just switches off. She also creates daily walking / jogging routes by filtering the roads with less traffic, different incline and accessibility, as well as resting places. She saves the routes to her personalised maps and every time she goes walking, jogging or cycling, she switches on the location tracking so that she could see later her progress.

Appendix – 8, Kjetil and his scenario on getting inspired while not getting lost



04 KJETIL'S SCENARIO

Kjetil is a retired fisherman who lives in Skarbovik together with his wife. He is still very passionate about fishing and going on boat trips now and then with his buddies. As he retired from the maritime industry, he now has a lot of free time in his hands. As the spring comes, Kjetil is ready to start building his dream project – summer cabin next to a lake accompanied with a boat house and sauna. He is very ambitious and wants to build the cabin in a specific style with different detailing hierarchy. To get inspiration and acknowledge different detailing styles and methods, Kjetil is willing to go on several tours through his hometown Ålesund. As a helping guide he use a digital map on the smart device, his grandson gave him for Christmas. He is a novice user and has oriented himself mostly using paper-based maps, but now he is willing to try something new. By turning on the "Exploration" mode in the digital map, turns out the displayed image does not differ very much from the physical tourist maps he had used some time ago. As Kjetil navigates through the city, he goes to the marked landmarks and on the way he sees how the style of surrounding buildings change. The map differentiates the areas and Kjetil can notice it in the change of the building details. When he has documented different architectural styles and details, he is happy to return home and proceed with the planning of his dream cabin.

Appendix – 9, Cards for card sorting

look-up history

Place to see where user has been or places searched for

select colour scheme

User can change the colour scheme to more contrast / colour-blind / other colour palettes

Outlook

Map detects and suggests to display locations from emails and invitation

introduction

slides that user swipes through when opening the app for the first time

TripAdvisor

Map displays deals and user ratings based on user's interests

save

system saves and applies the changes made by user

select your interests / hobbies

User selects interests and hobbies from given "lists"

list of apps

List of applications that are synchronised with the map

main car road

Street that has the "main" importance in map system

Maze Maps

Map switches from outdoor navigation to indoor way-finding for specific buildings

search engine

Enables user to locate in information by typing the keywords

historical map layer on / off

Map displays a historical map overlay preserving the current location

allow to synch with other apps

User chooses to synch or not the map with other preferred applications

forest / park path

A path that is usually not attached to street and runs through forest / park areas marked in the map system

create a route

Action for starting a new personalised map draft

personalisation

Process where user selects / enters preferences

Snapchat

Map uses the avatar from Snapchat and displays friends locations

pedestrian path along the road

A path that is attached to a road or street for cars

more info...

opens a window with brief description or re-directs to website that provides a thorough description

search areas / districts

displays areas that are associated with keywords in search engine

secondary car roads

Street that usually runs through neighbourhoods and has the "secondary" importance in map system

edit preferences / selections

User can change the interests / hobbies and synced apps

filter roads

Advanced search engine that allows user to specify his preference

suggestion settings

Specific suggestion allowance for every synced application

explorer mode on / off

Enables / disables new layers for the map system

personalised route planner

Edit mode where custom routes can be saved

all pedestrian paths

Paths designated for pedestrian and cyclist mobility

Facebook

Map displays the events user is interested in going

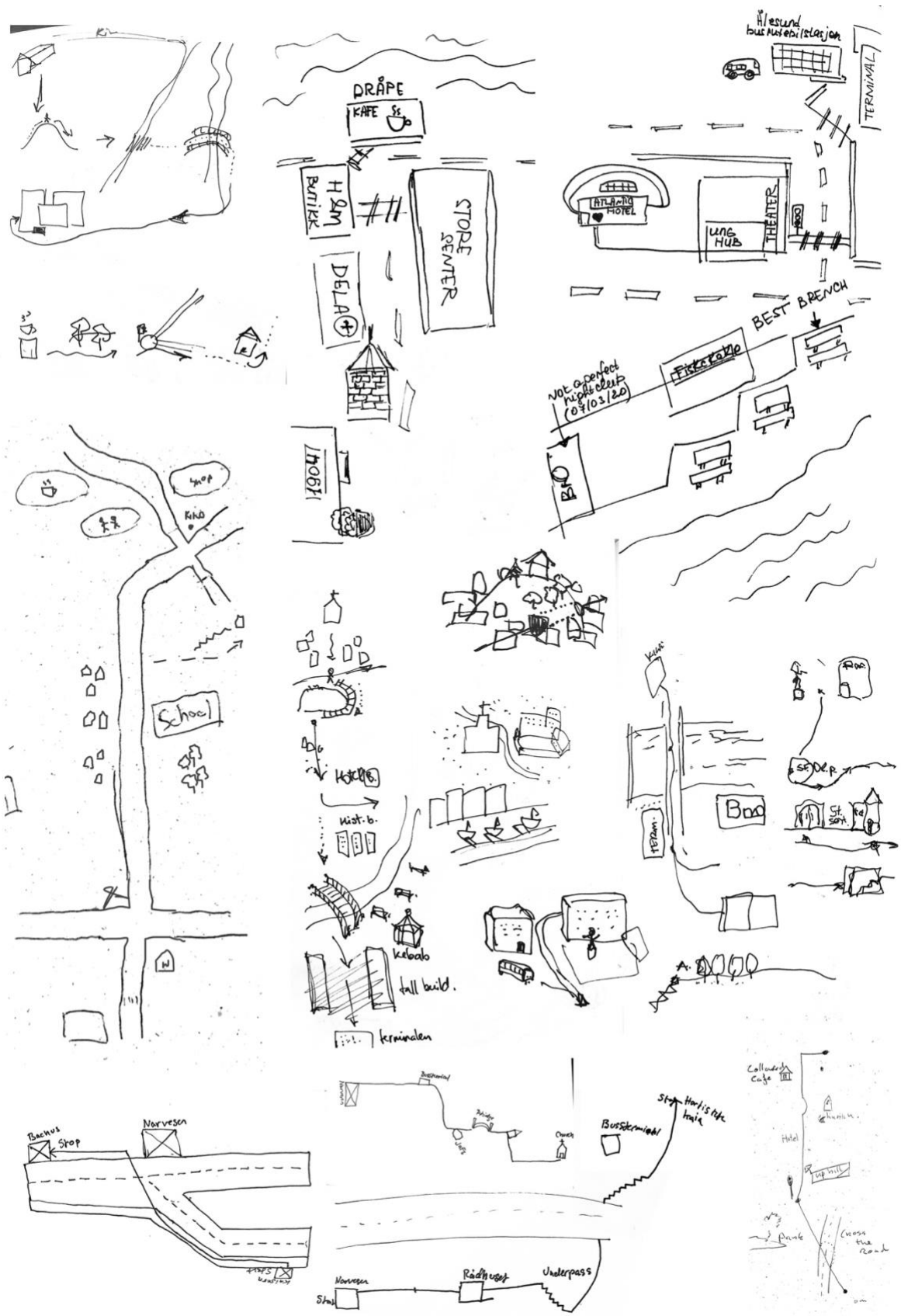
instructions

Presentation of the instructions on how to use the new features

landmark illustrations

3D landmark illustrations marked on the map at their location

Appendix – 10, Example set of mental map drawings



Appendix – 11, Competitive analysis

NAME OF THE APP	STRENGHTS	WEAKNESSES
walking directions / community based / level of details synchronisation / Hands-free / interface User experience / availability / features		
Maps.me (reviews taken from *Trustpilot.com*, platform for public product reviewing online)	1) a community-based map: uses OpenStreetMap data as its base 2) Anyone can freely edit and contribute to the map 3) By using compression of the map data, MAPS.ME is able to speed up the rendering of their maps to one's device 4) Shows a nicely organize list of interesting places to visit close to your current location. 5) Automatically downloads vector maps for offline use. 6) There is a night mode option. 7) Displays information from booking.com about hotels and apartments.	1) Annoying ads 2) Confusing voice commands 3) "It also has a tendency to not be able to pinpoint locations mistakenly assuming you are inside a building or under some cover" (Lee, 2019) 4) Not as useful for navigating while hiking/climbing/etc. 5) No way to distinguish between fastest, efficient or shortest route 6) no way to hide certain buttons like the traffic button, or to configure the language used to display city names. 7) No "tourist detail" maps
Kommunekart (Norkart) (reviews made on personal evaluation in comparison with other apps)	1) Very simple and minimalistic interface design on the mobile version of the map 2) a community-based map: uses OpenStreetMap data as its base, therefor possible to get a very detailed overview of the surroundings 3) free to download as an app and desktop version, but also there is a possibility to purchase a pack of extensions, as very detailed 3D data, mainly useful for urban planners and architects	1) Available only for Norway 2) The desktop version of the map has more features than the smartphone app version, as "draw in the map", "terrain profiles" and "measuring / exporting options" 3) Available only in Norwegian 4) Cannot change the way of commuting, as for example, train, ferry, bus, walking etc. Has only a car oriented route planner 5) The search engine is oriented towards precise address input rather than providing information about the surrounding area

	4) desktop version features advanced land plot searching, drawing and measuring features 5) desktop version features possibility to change different angles on a perspective view 6) user-friendly for exporting the data, has a grey layer map and option to remove and switch back the texts and street names.	6) The "Kommune" switch is unnecessarily put as the main option to tap, because it is located in the most convenient place on the interface, although for a regular pedestrian it would be used the least.
Google Maps (different sources for reviews)	1) Provides very detailed information about public transport 2) Suggests alternative routes that have different time / distance 3) Mapped with private transportation facilities like Uber, Lyft, Ola (Ghume, 2017) 4) Voice-guided GPS navigation for driving, biking, and walking 5) Street View and indoor imagery for restaurants, museums, and more (Warren, 2015)	1) Real data doesn't reflect at the time of journey to mentioned distance covered 2) There is no alert for the ongoing construction or the hurdles (Ghume, 2017) 3) It doesn't always paint as accurate a picture of the route as you may need. Features like low bridges that could prevent trucks from passing is an example 4) If you are unfamiliar with the area, then you may think the path shown is going to be the fastest, but that isn't always the case (Gupta, 2016)
HERE WeGo (costumer reviews from amazon.com)	1) The voice is less aggressive and verbose than Siri. 2) possible to download the maps and use offline, actually works 3) the look and menu are pretty simple and straight-forward 4) will take you not only to the apartment complex, but directly to the building WITHIN the complex	1)Does not provide alternative route 2) telling you to go a certain direction on a certain street without telling you how to get to that street. Voice doesn't work in the walking mode. 3) doesn't make trails or routes that are available for saving 4) not the best in searching for places or planning routes - not intuitive when it comes to finding places of interest outside of your location area 5)too monotone colours

Appendix – 12, Experiment analysis sheet

Participant nr.	Gender	Age	Occupation	Local
01	Female	40	Librarian	Yes
02	Male	25	Artist	Yes
03	Male	42	CFO Tech Company	Yes
04	Female	28	Mechanical engineer	Yes
05	Female	37	Adviser in Ålesund kommune	No
06	Male	26	Student	No
07	Female	30	University lecturer	No
08	Male	25	Student	No

General mindset:

How often do you use digital maps for orienting when walking?

01: I cannot read maps very good so I tend to use street names and buildings more. I memorise by the visual appearance.

02: I am a local so don't use digital maps that much, but when I am in a foreign city I would use it all the time.

03: I use digital maps for orienting when walking all the time when I am in a city/area I do not know very well. Even in my home town Ålesund I use Google maps to look up an address, to see the path to the place I am going to.

04: I use digital maps Very Often, while driving and walking

05: As a planner person I am used to use maps so I am quite good when it comes to orienting myself when I see a map. But without a map I can also navigate, not that freely nor comfortably, I would definitely prefer to have a map. I like to use mountains as the landmarks, then it is easy to get around, when I come to flat areas, it becomes confusing.

06: I usually have a look at Google Maps beforehand while visiting a new place. Also, use the map for navigation while walking in a new place. I always save the local area map on my phone so that I can use it offline.

07: Digital maps as Google maps is very good for public transport and defining distances, also service opening times is well integrated in them. I use Google Maps for these reasons and of course also navigating daily to a new place.

08: Always when orienting in an unknown place, but also always in more or less known

Experience:

How would you describe your experience with the map prototype?

What are the aspects that seemed helpful in way-finding/made it difficult to navigate?

01: Nice to use the map, would do it again, wayfinding was more exciting. Helpful: Street names in the historical layer. Landmark illustrations. It was frustrating sometimes because there were no street names on the main map.

02: The prototype was lagging, did not load, but was ok in general. Landmark illustrations can useful for the ones who do not know the city

03: I feel that I got a verification that I am at the "right place" when I see the landmark on the map, when I am standing next to or looking at the actual landmark. The GPS must be implemented, so that the map follows me, and centre me in the middle of the map. Zoom in/out function must be done as it is normally in maps.

04: I was more concentrated to actually see if the information map provides is true. Was interested in social space map and also tried to pass as many landmarks as possible. The landmark illustrations were helpful, the fact that each area had a landmark you can associate with. Historical layer is interesting but not useful in wayfinding itself.

05: It was very interesting because the map actually helped to discover places that I never thought about or never visited. The map shows them quite accurate.

06: It felt like using a map printed on a paper. The landmarks on the map were the most useful in way-finding. The territorial map helped as well to determine my location on the map based on the geographical characteristics and shape of the path. To locate my initial staring point was a bit difficult. I used my surroundings and geometrical sense to locate my initial position on the map.

07: The landmarks are very nicely drawn, pity that the map is only for Sentrum and not larger area. It was annoying not being able to zoom in and out as in normal maps. It was good that you explained at the beginning what each layer is about, if not, they would need some instructions.

08: It was very cool and interesting, it was actually possible to navigate according to landmarks, of course the prototype had some annoying limitations, but that's ok.

Which of the layers were most/least used or most/least helpful?

01: Social spaces not useful, landmarks the most useful

02: Social spaces or the historical layer not useful, Landmarks and territoriality most useful

03: Historical map most useless, regular map most helpful + the landmark layer.

04: Historical map not used, most useful landmarks and social spaces

05: Historical the least, then territory, then social spaces and most useful landmarks

06: Historical map didn't help, mostly used landmarks and territorial

07: Social spaces not relevant now, but landmarks and territory is.

08: Landmarks was most useful, didn't use others that much

Specific layer usage:

Social spaces layer

01: I don't think I need that layer. Maybe useful for students who have just arrived in Ålesund and want to meet new people.

02: The Social space layer could be more developed with official data. The social activity depends on if the street has a destination and something on the way, that can make people stop and mingle while they are on the way to their destination

03: I used the social layer on the map, finding all the highly congested red areas, comparing them with real life surroundings. These days there were not many people however. Socially active places would have road crosses and famous places, like Hellebroa and the strip by the harbour, and also stores, like outside Bunnpris for example. I did understand that the social layer could be extremely helpful during normal times (non-corona), as you would be able to go to the most visited places.

04: I used the social layer to check if there are actually people around the marked places, in these times, of course, there are a lot less. Social places would be the quickest connections and more flat areas. People use these types of shortcuts for time saving. Also touristy places that have points of interest. Very typical meeting place is the junctions just before the bridge where people say "let's meet at the place where traffic lights don't work"

05: Social spaces – walked the alternative roads not the social spaces that were marked, and discovered a lot of new nice things. I think this is relevant for tourists as well, because they know the destination but they can also avoid the crowd and choose alternative way to get there.

06: I checked the social layer, but due to covid-19 I couldn't find any socially active places. I think Socially active place usually has crowds, noises/sounds and litter.

07: There can be seen people here and there but in these times very difficult to distinguish between more and less active places. In normal times, it would be better to test it.

08: Maybe good for tourists, in these times no particular use

Landmark illustrations layer

01: Landmarks made it easy to find places even without the GPS location. Landmark illustrations are very useful for people who cannot orient themselves and have troubles reading a top view map, as I do, for both – tourists and locals.

02: Landmark illustrations can useful for the ones who do not know the city, but as I knew I didn't really need the map to navigate to them. Don't know how much useful they would be for a local like me.

03: I feel that I got a verification that I am at the "right place" when I see the landmark on the map, when I am standing next to or looking at the actual landmark.

04: Not so useful for a local, but landmarks useful for tourists or in general people who are bad at orientation, in that case can be locals as well. The Brosundet colourful buildings are the super typical Ålesund attraction points, so if tourists see that they immediately recognise them as the "centre of the city" and can locate themselves.

05: For Landmark illustrations would be Good to add "utsiktpoints" viewing points

06: There are instances when no landmark was seen around my tentative location, so maybe more landmarks would be useful. The Landmarks are drawn from a particular angle which sometimes created confusions.

07: Landmarks could have names on a tap

08: As I used mostly landmark illustrations for wayfinding, it was completely enough to orientate and find my way, didn't use other layers for that

Territoriality layer

01: Bridge actually is not dividing the places, it still feels like one. The area around the church is maybe less historical than the very heart of the centre and has more international people. In the area behind Aksla hill the buildings look more poor and not renovated. At the harbour t's very touristy, "hurtig rute" place looks so American. Territoriality map didn't help at all in wayfinding itself, just exploring probably.

02: Definitely there are different areas, but tourist visiting the city for the frst time would not maybe notice it. People who walk the streets more often can sense the differences better. The architecture maybe (some parts are have more wooden buildings, some are more "funky",

some more historical). Also different because of the people who inhabit, in some you can meet more families, in some more students, others have more business people.

03: There are old buildings from after the 1904 fire, but also newly developed areas. This was also reflected on the layer in the map. I could see how the different areas and territories had different colours on the map, but it was not so easy to see the changes in real life on some of the borders. The area layer has a good potential, as you can see how various areas of the city changes architecturally. I liked this feature.

04: The elevation can define the territories, or the sea can be the border that encloses the new harbour area for example. But also if the area is more quite, less traffic, it is different from the historical centre, more living area. IN the Territory layer I did not understand the strict borders, but change in environment can be described as more quiet versus more active. The blocks next to road can be coloured also blue because the gravel makes a lot of noise, also more traffic.

05: There definitely are different areas, but they are not that obvious for tourists, although locals also don't really pay attention, because they just navigate faster from place to place. For example, City hall and Jugenstil centre gives a contrasting feeling because of the historical versus modern.

06: I think there are three different territories: Shopping stores/restaurants (places to hangout), educational/religious institutions and residential/private areas. Places to hang out usually have Bright eye-catchy lighting, music/noise, lots of movements; Education + religion differs with building shape, like towers, etc; Residential areas have Colourful walls, nicely decorated windows, interior seen through the window, car parking style, structure of the building, garden/plants in the surroundings. The layer itself would need more specifications.

07: It is possible to feel the difference, but the layer would need specifically explanation and the borders sometimes are not that strict, it could be displayed more blurry.

08: I could feel the different areas by seeing that some are on a higher elevation, for example. Some areas just feels more "shabby". The layer could definitely use a code, for example, for industry; for tourists; for fun.

Historical landscape layer

01: For me it was important to have street names, because other layers lacked it, I used historical landscape layer for that purpose

02: Historical layer is more for tourists. It's more practical and I would use it maybe once as a local rather than on regular bases, maybe just to check out of interest.

03: the historical layer did not help in way-finding very much. Some kind of information given to the map user when you come to historical places could be a nice to have feature.

04: Historical layer is interesting but not useful in wayfinding itself. It was possible to tell From the historical map that maybe the city is very same as it is, but the shore line is different

05: Historical landscape for wayfinding, maybe for exploring better. Historical landscape was difficult to USE because it was not so precise and detailed, but if historical layer could be abled together with landmarks , then maybe would be useful. Historical map could be useful more for education, or commune archive cultural department.

06: The historical map didn't help in wayfinding.

07: It is a very interesting feature to have, but would be more useful if the GPS would work, then it would be possible to compare reality to the historical map. It would not help in everyday wayfinding, more as a hobby maybe for someone.

08: For tourists maybe too "deep", specific people could use it, like urban planners, people who are interested in urban planning and history. Maybe some students for their school projects. It is very informative though.