



The use of a user-centric smart mobile application prototype for supporting safety and security in a city: A design science method

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Abstract

Cities have always been the drivers of innovation, growth and change. Cities around the world are still rapidly expanding, especially on the African and Asian continents. Cape Town is one of those cities, where urbanisation rates are high, and crime is persisting at alarmingly high levels with crime rates being among the worst in the country and the world. Additionally, the city is home to 7 of 10 worst-performing police services in the country. Combining these factors, there is a need to look at 'smart' ways of growth which includes facilitating a safe and secure city for citizens. Although Cape Town is pursuing smart initiatives, these have failed to place communities and individuals among the key stakeholders in the smart planning process. This research focuses on further researching smart city initiatives in Cape Town, placing citizens at the centre of the development process. As Cape Town's mobile phone penetration rate is high and access to Internet is rapidly expanding, this research aims to use crowdsourcing techniques for developing a smart mobile application prototype that is focused on enhancing community engagement and facilitating increased perceived feelings of safety and security for citizens. The study uses a Design Science Research method with Cape Town citizens as the main stakeholders, to propose an artifact based on their wishes, needs and current issues faced with regards to safety and security in the city. The proposed artifact focuses on enhancing community engagement, through a chat room and user-logged incident reports, as well as a customised safe route planning functionality where users can send emergency signals to co-members with the use of GPS live location tracking. The research shows participants are willing to adopt the use of the mobile application prototype, given there is substantial community buy-in, and the functionalities in the app are easy to use and quickly accessible. The study further identifies the need for better police follow up and involvement, as the city's police system could benefit from crowd-sourced crime-data in reducing the number of crimes in neighbourhoods to make citizens feel more safe and secure.

Keywords: Smart City, Cape Town, mobile application, safety and security, community.

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List of Abbreviations

ABBREVIATION	DESCRIPTION
IoT	Internet of Things
UN	United Nations
SAPS	South African Police Services
DSR	Design Science Research
COCT	City of Cape Town
ICT	Information and Community Technology
CDS	City Development Strategy
FOC	Fear of Crime
TAM	Technology Acceptance Model
PU	Perceived Usefulness
PEU	Perceived Ease of Use
UCT	University of Cape Town
CAQDAS	Computer-assisted qualitative data analysis
GPS	Global Positioning System

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1. Introduction

1.1. Introduction

Cities have always been the drivers of innovation, growth and change (Albino, Berardi & Dangelino, 2015). Urban populations are still rapidly increasing, and interestingly, 95% of urban expansion is expected to take place in developing countries, mostly located on the Asian and African continents (City of Cape Town IDP, 2016). As urbanisation rates in these countries are high, there is a growing demand to relieve pressure off urban areas, facilitate economic growth and improve safety and security for citizens (Letaifa, 2015). *Smart City* technologies are a potential solution to urbanisation-related issues and are furthermore argued to attract new business and city investments, create job opportunities and improve productivity (Galdon-Clavell, 2013). Although *Smart City* definitions are context-dependent, smart cities are usually argued to deploy Internet of Things (IoT) and information and communication technology (ICT) to connect information, people and city elements for the benefit of creating a better manageable, sustainable and liveable city, while maintaining a competitive edge (Albino, Berardi & Dangelico, 2015). To facilitate this, a smart city is dependent on its citizens and participatory governance and should take a user-centred approach as it is focused on enhancing liveability (Oliveira & Campolargo, 2015).

Although explored quite extensively across Western and Asian cities (Deloitte, 2014), smart city concepts have remained relatively unexplored within developing countries on the African continent, although African cities are attempting to pursue smart city agendas (see Backhouse, 2020). As there is no one-size-fits-all model, smart city implementations across Western or Asian countries cannot simply be duplicated to apply to African cities. Cities need to be addressed differently when looking at smart city development strategies.

Developing countries are characterised by rapid urbanisation, social and economic inequality and high urban crime rates (Backhouse, 2020; Loideain, 2017). Research has shown that when pursuing smart city developments, developing nations have not focused enough on delivering a ‘smart and safe’ city that fights crime and ensures public safety for its citizens (Loideain, 2017; Lemanski, 2014; Bornheim & Fletcher, 2020; Isafiade, 2016; Lacinák & Ristvej, 2017; Nel & Liebermann, 2000; Ballesteros et al. 2014). An inclusive and safe city should be a prime focus when addressing smart city strategic developments, especially in developing countries (Loideain, 2017). Failing to do so creates a vicious cycle, where fear of

crime leads to distrust and anti-social behaviour that reduces sense of community (Cvijikj, Kadar, Ivan and Te, 2015). In the longer run, a safe and secure city environment is critical for a smart city that wants to be sustainable and attract foreign business and investments (Isafiade, 2016), and is furthermore said to create trust among citizens and trust in local authorities (City of Cape Town, 2017).

Therefore, this study aims to look at community-based crowd-sourcing technologies that are focused on increasing perceived safety and security of citizens in developing cities that are characterised by high urbanisation rates, high urban crime rates and fear of crime. One such smart technology is the use of mobile applications for the benefit of smart urban development. Literature has increasingly covered the role of mobile services as smart technology solutions in harnessing safety and security of citizens in the urban context (see Blom et al., 2010; Blythe, Wright & Monk, 2003; Cvijikj et al., 2015; Kadar, Te, Rosés Brüngger & Cvijikj, 2016; Ariffin, Solemon & Bakar; 2014). Studies show that people are very willing to download safety apps that include live tracking capabilities (McCarthy et al., 2016), reliability and transparency in terms of where data is stored, and functionalities that adopt users to send emergency signals to loved ones (McGrath, 2015) to enhance perceived feelings of personal safety (Maxwell, Sanders, Skues & Wise, 2020). Furthermore, personal safety apps are argued to be usable to the community because they are local and belong to the citizens, the end users (McGrath, 2015). This research aims to contribute to this while also investigating under-researched topics that are at the basis of this dissertation. These problems will be stated in section 1.2.

In developing smart technologies, citizen involvement is unmissable, as “establishing trust with citizens is highly regarded as a key factor in ensuring the effectiveness and longevity of smart devices and ecosystems, particularly if this data will be used for law enforcement purposes” (Loideain, 2017, p.328). This research aims to investigate the use of a proof of concept that focuses on increasing safety and security of citizens in the urban, smart city context. The research takes Cape Town as its case study, which is South Africa’s third largest city with approximately 3.7 million residents and argued to be the crime capital of South Africa, while furthermore ranking as one of the world’s highest in terms of homicide rates (Loideain, 2017; Jabar, Bjorkman & Matsopoulos, 2019; Toruk, 2001). Western Cape crime rates are the highest and fastest growing in the country, making crime prevention and control a concern and high priority for city management (Isafiade, 2016) to which this research aims to contribute.

1.2. Problem Statement

Cities need to be addressed differently when evaluating the planning and implementation of smart city developments. Cape Town, the city central in this study, is still said to be the homicide capital of South Africa, with a homicide rate that is six times higher than the global average (Jabar et al., 2019). Even more strikingly, Cape Town is home to seven of ten worst-performing South African Police Services (SAPS) when dealing with homicide incidents (Jabar et al., 2019). Therefore, there is a need to focus city developments and smart city initiatives around public safety and emphasise citizens' needs and wishes for making the city smarter in terms of safety and security. As smart city implementations often fail to place citizens at the forefront for the sake of efficient planning with an eye on better manageable systems (Loideain, 2017), this research aims to achieve the opposite by creating a proof of concept that enhances safety and security of citizens in the context of smart urban developments.

1.3. Research Purpose

To strive towards a city that is perceived safer by citizens, this research offers an alternative perspective that takes on a user-driven approach for developing a smart mobile application prototype with the aim of increasing perceived feelings of safety and security. This approach is taken on using a design science research (DSR) methodology, which is realised through creating an *artifact* with the goal of solving a practical problem, which here are a disproportionally high crime rate and increased perceived feelings of a lack of safety and security among citizens.

1.4. Research Questions

Following from the previous subsections in this section, the following research question is introduced:

How can a 'smart' community-based crime-focused mobile application influence feelings of safety and security for Cape Town citizens?

Additionally, to answer above research question, the following secondary research questions are introduced:

1. *What are the safety and security related challenges experienced by the citizens of Cape Town?*
2. *Which requirements should be satisfied by the mobile application to enhance citizens' feelings of safety and security?*
3. *Which circumstances should be satisfied for citizens to accept the use of a proposed mobile application for enhancing their feelings of safety and security?*
4. *How can the proposed mobile application lead to greater community engagement within a smart city?*

1.5. Contribution

This research contributes to the under-researched topic of a smart city across the African continent and appoints Cape Town, a city characterised by rapid urbanisation, high crime rates and social, spatial and economic inequality, as the case. The study aims to contribute to research and practice by applying results from the case to cities on the continent with similar urban characteristics and developmental traits to expand knowledge on smart city developments across the African continent. In doing so, this research takes on a user-centric approach aiming at addressing, understanding and detailing the needs and wishes of citizens with regards to fear of crime and feelings of safety and security in the context of a smart city.

As mobile phone penetration is high across the continent and access to Internet is rapidly expanding, a mobile prototype ought to contribute to research and practice by introducing a smart application that is accessible to its users. As the mobile prototype proposed in this research aims to use crowdsourcing and is dependent on user input as well as existing crime-related city data, the prototype provides a technology intended to facilitate greater community engagement and feelings of safety. As previous research has attempted to show that communities with greater engagement and social cohesion in a neighbourhood exhibit lower crime rates (Kadar, Te, Brünegger & Cvijikj, 2016), this study attempts to contribute to this notion by investigating how the use of a mobile application could increase community engagement and positively impact feelings of safety and security among citizens.

1.6. Relevance

Issues relating to safety and security and fear of crime negatively impact urban life for citizens, and several studies suggest that improving the social engagement within communities might alleviate such issues (Kadar et al., 2016). Additionally, it has been argued that ICT can play a similar role in addressing social issues relating to personal safety and security (Blom et al., 2010). Mobile devices and wireless technology continue to evolve and are already taking on a central role in different aspects of society (Oyelere, Suhonen, Wajiga, & Sutinen, 2018). Mobile devices are gaining interest because of its wide availability, low cost and general interest. The benefits of mobile devices, which includes flexibility, mobility and compactness, introduce a new level of user engagement with mobile devices that can be used to the benefit of development in different fields, such as economy, education and infrastructure (Oyelere et al., 2018). Furthermore, it has been argued that “the acceptance of the mobile phone in Africa has increased interest in literacy and introduced new opportunities to societies’ deprived, marginalised, and less privileged” (Oyelere et al., 2018, p.471). Therefore, this research’s relevance is justified by approaching the issue from a socio-technical viewpoint to generate insights for the goal of designing a prototype that supports urban individuals within communities that are subject to crime and decreased feelings of safety and security.

2. Literature Review

This section presents a review of academic literature that is fundamental for this study to build on. The following section will discuss definitions of smart cities, smart city application and plans in Cape Town, and user involvement in the context of a smart city. Addressing these topics is relevant to answer the research questions presented in the previous section.

2.1. Smart Cities

2.1.1. Definitions of Smart Cities

The United Nation Population Fund states that since 2008, more than half of the world’s population lives in cities and this percentage is even expected to rise to 70% by 2050 (UNPFA,

2020). In many parts of the world, urban areas are rapidly expanding to the extent that some cities even grow out to become megacities of more than 20 million inhabitants (Albino et al., 2015). Growing cities bring challenges that local authorities need to respond to. Such challenges are concerned with public safety and security, quality of living, public transportation and infrastructure, employment and economy and environmental performance (Griffinger et al., 2007). As a result, questions arise with regards to how a city could be “smart” and designed in such a way that the implementation of technologies can facilitate public safety and security for citizens thereby positively impacting the overall quality of living (Choi, Hwang, Kim, Seong & Ahn, 2016).

“Smart city” is a fussy concept. Although there is no single accepted definition of a smart city, and definitions are context-dependent, it is commonly argued that a smart city is an urban area that deploys IoT and ICT for the benefit of creating a better manageable, sustainable and liveable city, while maintaining a competitive edge (Kloppers, 2015; Albino et al., 2015). Smart cities commonly focus on a variety of dimensions, such as safety, economy, people, governance, mobility, environment and living, and comprises of people, businesses, organisations and city processes in order to achieve the desired goals for the city (Nam & Pardo, 2011). The end goal of a smart city, then, is to increase quality of living for citizens and deliver benefits for governments on a national and provincial level, as well as for local city-level municipalities (Deloitte, 2017).

Today, more than half of American cities have invested or are investing in smart technologies that employ IoT (Headrick and Gobble, 2018). In China, approximately 500 pilot-programs have been put in place to develop smart cities (ibid). Several European cities and cities in the Far East rank among the smartest cities in the world, such as Singapore, London, Barcelona, Tokyo and Copenhagen, where sensors and ICT are integrated, and data analytics is performed to engage citizens and better govern the city (Griffinger et al., 2007). On the contrary, smart cities have gone relatively unexplored across the African continent (Backhouse, 2020), although Africa ranks second when it comes to fastest urbanising continent, just behind Asia (Headrick & Gobble, 2018). This rapid urban population growth is putting high pressure on cities, resulting in poverty, crime, poor infrastructure, waste management, and social and economic inequality on the rise (Degila, Sennaro & Wamba, 2017), asking for more research and development into smart city concepts.

Literature shows that African cities have potential of moving to the smart city development cycle. Mobile phone penetration is measured to be roughly 72% across the

continent, with large-scale data sharing on the rise, releasing substantial potential for smart city initiatives (Headrick & Gobble, 2018). Smart mobile devices such as smartphones and wearables are rapidly increasing and form a huge potential for future smart cities designed at meeting citizens' demands (Walid, Ben-Othman, El Koutbi, 2017), which is the focus of this study. Their equipment with embedded sensors such as GPS, microphone and camera provides a "unique opportunity to harvest large-scale sensing data with fine-grained spatial-temporal coverage" (Ogie, 2016, p.2). In addition, "applications of mobile crowdsensing cut across a wide range of areas that are critical for sustainable urban development and for improvement to quality of life for citizens, in terms of convenience, comfort, safety and security" (Ogie, 2016, p.3). This research aims to explore this and further address the topic in the context of urban cities in developing countries.

2.1.2. Smart City applications

The previous section explored the concept of the smart city and argued why smarter, sustainable and efficient cities are necessary to manage urban flows of people, services and data (Novotny, Kuchta & Kadlec, 2014). Previous studies have explored the wide variety of smart city applications, which include smart energy, smart public services, smart water and waste management, smart mobility and smart security, amongst others (Novotny, Kuchta & Kadlec, 2014). Smart city applications are necessary for communication and sharing of real-time information that facilitate the implementation and growth of the smart city (Novotny, Kuchta & Kadlec, 2014). This dissertation focuses on one area of smart city applications, which is that of smart security. Previous research into smart applications which are based on collective knowledge-sharing and crowdsourcing are successful approaches in leveraging collective intelligence. As Novotny argues, "if the stakeholders are informed fast, thoroughly, and reliably and have access to real time information at the level of individual citizen's choices and actions, they are able to quickly take appropriate action. Those distributed problem-solving decisions will make the city function better (2014, p.3)."

This dissertation uses input from citizens to develop a community-based crowd-sourcing mobile application prototype that is aimed at doing this. Next sub sections will argue why there is a need to focus smart city applications in Cape Town on the smart security pillar, and why citizens should be involved in the development process for successful adoption.

2.1.3. City of Cape Town and the smart city

Cape Town is the second largest city in South Africa with approximately 3,4 million inhabitants (table 1, table 2), and an important centre for trade, especially with respect to tourism and the mobile IT sector (Loideain, 2017).

% OF SOUTH AFRICAN CITIES	CITY POPULATION (x1000)
53,00%	< 100
27,69%	100 - 200
15,10%	200 - 500
4,20%	500 - 1,000

Table 1: Population size in South African Cities (Source: Das, 2015)

CITY	POPULATION (2020)
Cape Town	3.433.441
Durban	3.120.282
Johannesburg	3.721.516
Pretoria	1.619.438
Port Elisabeth	967.677

Table 2: Population in largest South African cities in 2018 (Source: World Bank)

The city's population is ethnically diverse, with 42.4% being coloured, 38.6% black, 15.7% white and 1.4% Asian (STATSSA, 2017). Cape Town has a Gini Coefficient of 0.58 and the city's Human Development Index is set at 0.67, indicating the city is experiencing above average income inequality and unequal socio-economic development (Western Cape Government, 2016). Overall, Cape Town experiences an increase in poverty levels with increasing unemployment rates.

South African local and national governments are building on a history of Apartheid legacies (Visser, 2000), which is important to understand when focusing on urban reconstruction and development on local and national levels. During Apartheid, the racially based system of social and institutionalised segregation had an imminent and lasting effect on spatial, economic and human development (Turok, 2001). Communities were marked by large income inequalities. After Apartheid, the local government stood the task of restructuring the city and scale investments.

After becoming a democracy in 1994, the Ministry in the Office of the President promised to establish social, economic and physical integration of the population and communities (Loidenain, 2017) through information and communication technologies (ICT). Such commitments were meant to find shape through established concept plans such as the

Metropolitan Spatial Development Framework (MSDF), focusing on ‘reintegrating the divided city’ (Turok, 2001). One of these post-apartheid goals has been focused on urban integration through decentralisation of the city structure, balancing different parts of the city in terms of housing, economic centres, and retail business (Turok, 2001). Metropolitan councils across the country have furthermore pushed towards using ICT as economic and technical solutions to urbanisation concerns and for achieving smart city status and an international competitive edge (Odendaal, 2006).

In 2002, the City of Cape Town launched their “Smart City Strategy”, as part of the wider City Development Strategy (CDS) for Cape Town. The focus of the strategy was on five areas of execution, including Leadership, Policy and Regulation, e-government, IT enabled development and IT enabled governance (City of Cape Town, 2016). A decade later, the Integrated Development Plan was launched, serving as a five-year strategic framework that guides decision making within the municipality (City of Cape Town, 2016). The plan was built around five ‘pillars’ which include the opportunity city, the safe city, the caring city, the inclusivity city and the well-run city (City of Cape Town, 2016). The points on the 5-year plan priority list constitute the drive to be a forward-looking, globally competitive city, and striving to be technology-driven for progress of the city (City of Cape Town, 2016). Through leveraging technology and tying into the advantage of building on Cape Town’s large tourist sector, the city aims to become a technical hub that grows investment offerings through, for example, the Invest Cape Town initiative, among others (City of Cape Town, 2016). The city has recently improved internet speed and overall access, introduced the use of digital platforms for access to digital public services, and opened data sources for utilisation by businesses (City of Cape Town, 2016). However, it is the ‘safe city’ pillar that is in line with the study’s central theme, which this study aims to explore further.

Although substantial effort has been put into smart development strategies and implementation, the city has acknowledged the remaining challenges to the development of a smart and safe city in line with one of the City of Cape Town’s five pillars (Turok, 2011). Western Cape crime rates are among the worst in the country and continue to have the fastest growing crime rates when it comes to murder, assault and property crime (STATSSA, 2018). As a result, there is a need to develop smart city objectives in Cape Town involving the city’s population in project planning and implementation. Appendix A provides an overview of current mobile applications focused on enhancing perceived safety of citizens in South Africa. This research aims to further built on existing literature and applications for enhanced

inclusivity and contributing to technological advancements that are community-based and use crowd-sourcing solutions in the context of a smart city. The sub sections explore the concepts of personal safety and fear of crime, as well as current safety and security related issues in Cape Town which form the basis of this dissertation.

2.2. Safety and Security

2.2.1. Safety and security in Cape Town

Public safety and security are highly intertwined with crime rates, in such that they are compromised when city crime rates are high, and cities are not actively putting in measures to combat crime (Brodie, 2015). Especially in developing countries, where resources for combating crime are generally less widely available than in developed countries, deterring crime and realising a safe and secure city is one of the main objectives for a smart and safe city (Baud et al., 2014). The Council for Scientific and Industrial Research (CSIR) summarises that the consequences of a lack of safety and security for citizens include “financial loss, increased fear of victimisation, restricted behaviour and movement, a breakdown of trust relationships, and untold short-term and long-term trauma” (Nel & Liebermann, 2000, p. 6).

According to World Health Organisation statistics, 1.6 million people die from violence-related crimes globally on a yearly basis (Jabar et al., 2019). In South Africa, crime cases are a national health priority as the country reports a six times higher homicide rate than the global average (Jabar et al., 2019). Recent official statistics show that Western Cape crime rates are the worst in the country (figure 1, figure 2 & figure 3) and in many categories identified by South African Police Services (SAPS), Western Cape has the fastest growing crime rates (table 3).

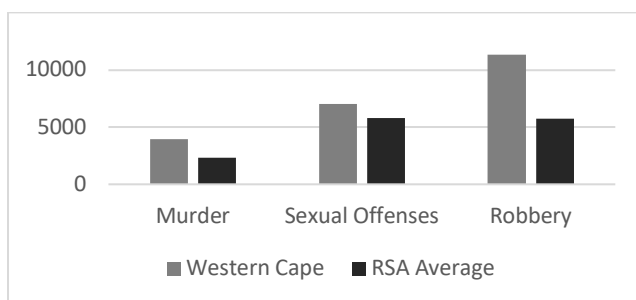


Figure 1: Western Cape Crime Rates for 3 Types of Crime (2018/19) (Source: SAPS Crime Statistics 2018/2019)

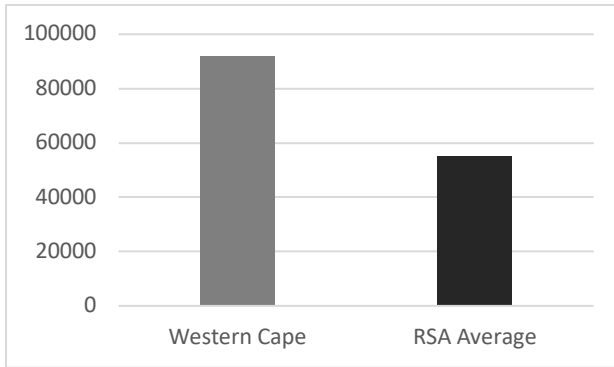


Figure 2: Western Cape Property-crimes (2018/19) (Source: SAPS Crime Statistics 2018/2019)

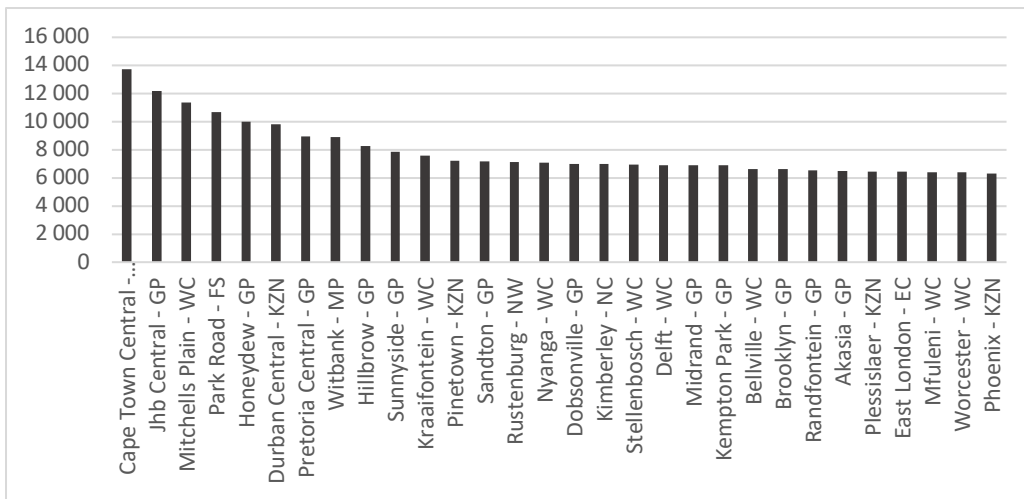


Figure 3: Community Reported Serious Crimes across top 30 SAPS stations (2018/19) (Source: SAPS Crime Statistics 2018/2019)

	WESTERN CAPE	SOUTH AFRICA
Murder	75%	25%
Sexual Offenses	-26%	-22%
Robbery	20%	-9,17%
Car Jacking	303%	16%

Table 3: Changes in numbers of recorded crimes between 2009/10 and 2018/19 (Source: SAPS Crime Statistics 2018/2019)

In addition to this, Western Cape has the highest murder rate in the country and reaches almost double the rate of the South African national average (SAPS, 2020). Assuming reporting rates are similar across provinces in the country, the Western Cape reports the highest number of cases for sexual offenses, robbery, property crimes and theft (excluding carjacking). Because of this, Cape Town is often referred to as the ‘homicide capital of South Africa’ (Jabar et al., 2019). Strikingly, statistics reflect that the City of Cape Town is home to seven out of ten worst performing municipal SAPS stations in the country (figure 4), begging for more extensive research on Cape Town’s crime rates, and finding solutions on how to improve public

safety and security of citizens (Jabar et al., 2019). Summarising, there is a need for urban integration that is inclusive and focuses smart developments around addressing safety and security related issues at the level of citizen’s wishes and needs, which will aid cities to function better through distributed problem-solving decisions (Turok, 2011; Novotny, Kuchta & Kadlec 2014). The next sub section will explore smart applications to support safety.

2.2.2. Smart City applications to support safety

As discussed, the safe city must be considered vital for enhancing effective city management, handling crime and facilitating a healthy living environment for citizens (Laufs, Borrion & Bradford, 2020). Various research has explored interventions in developing countries that seek to support safety by improving old systems using smart technologies. As stressed by Laufs, Borrion & Bradford, “gauging the perceptions of citizens on urban security is a key point in Smart City management, as it will ensure that cities not only prevent or respond to safety risks and security threats but that they also remain an attractive place to live in (2020, p.6)”. A list of smart mobile apps supporting safety can be found in table 4.

AUTHOR	SOLUTION
Ahir, Kepadia, Chauhan and Sanghavi (2018)	Smart device for women which includes several functionalities including shock function, alarm signal and GPS tracking.
Akram, Jain & Hemalatha (2019)	Smart device for women that uses fingerprint verification to alert police and nearby people when an emergency signal is sent.
Ballesteros et al. (2012)	iSave application which uses forecasting algorithms and neural networks to predict safety values, integrated for mobile device users to make users aware of their surroundings.
Mata et al. (2016)	A mobile application available in Mexico City for providing safe routes based on crowd-sensed crime data.
Moreira, Cacho, Lopes, and Cavalcante (2017)	Mobile application called “Safe Citizen” that facilitates alternative communication between citizens and police by logging incidents and communication real time with patrol dispatchers, as well as enabling of anti-throttling system.
Ferreira, Visintin, Okamoto, and Pu (2017)	A mobile application that allows university students in Sao Paolo to report security related issues on campus which automatically logs to the campus security back office for immediate maintenance.

Table 4: Smart applications supporting safety

Smart safe applications in urban spaces are crucial and help improve urban governance and planning as well as provide a better living environment for citizens (Laufs, Borrion & Bradford, 2020). Security and crime prevention should be treated as the foundation of a smart city. The previous sub section showed the importance of focusing smart developments in Cape Town on

the security pillar, as crime rates remain high across the city. This sub section has shown the previous adoption of smart application suggestions for the benefit of increased safety and security and tackling crime. The next sub section explores the concepts of personal safety and fear of crime and their interrelatedness, and why these are important to understand as a foundation for this dissertation.

2.2.3. Personal Safety and Fear of Crime

As this dissertation researches the effects of a community-based crowdsourcing mobile application prototype on feelings of safety and security of citizens in the city of Cape Town, it is important to get an understanding of the meaning of personal safety, and when a person is said to feel safe. Studies have widely addressed personal safety, however, limited studies have defined the concept of personal safety, for the reason of it not being a multi-dimensional issue that touches upon personal, social, and physical factors as well as perceptions of personal safety which differ between individuals (Waters, Neale & Mears, 2004).

Most studies acknowledge the relationship between personal safety and crime. Austin et al (Austin, Furr & Spine, 2002) find that “although fear of crime and perceptions of safety [are] separate concepts, they [have] significant theoretical and empirical commonalities (p. 422).” Similar to crime committed against an individual, personal safety is said to be jeopardised when intentional harm is being done to an individual or their property (Waters, Neale & Mears, 2004). Said, then, is that the perception of personal safety is threatened by a fear of crime (Bilsky, Pfeiffer, Niedersachsen, & Wetzels, 1993). Statistical reports show remaining high levels of criminal activity across the globe, making crime prevention and fighting a critical challenge (Cvijikj et al., 2015). A critical outcome of high levels of crime, especially crime targeted at individuals, is the emotional reaction imposed upon the individual, often referred to as the fear of crime. Many studies have focused on researching this social phenomenon, and various of these studies have linked fear of crime to the victimisation theory (Jackson, Farrall & Gray, 2011; Ceccato & Nalla, n.d). This theory says that the more likely an individual is to be victimised or has in fact been victimised, the more fearful an individual will be (Jackson, Farrall & Gray, 2011). Therefore, it is said that a community with relatively high actual crime rates produces high levels of fear of crime amongst its members. However, other studies have found that this only explains part of the notion of fear of crime and introduce what is called risk-fear paradox (Jackson, Farrall & Gray, 2011). This paradox states that most people worrying about crime are not likely to fall victim to crime. Nuancing this paradox, some

research identifies that fear of crime occurs when people can imagine themselves falling victim to crime, partly because of hearsay from people they know (Jackson, Farrall & Gray, 2011; Ceccato & Nalla, n.d).

In addition, fear of crime is fed through physical environmental factor such as poor lighting, hiding places for criminals, poor state of buildings, and a high frequency of abandoned streets within areas, as well as social factors such as the lack of police control, surveillance cameras and people in the street/area (Ceccato & Nalla, n.d).

According to Cvijikj et al. (2015), fear of crime leads to feelings of anxiety, anger, helplessness, frustration and alienation. Additionally, FOC reduces sense of community and cohesion, and gives people a sense of vulnerability (Kadar et al., 2006). The ‘routine activity theory’ supports this claim, stating that “a criminal event happens when the offender’s motivation meets the victim’s vulnerabilities and a supporting environment” (Kadar et al., 2016). In effect, high fear of crime results in reduced feelings of safety and security.

Previous research shows that providing crime related information to citizens and involving them in effective policing is assumed to be socially beneficial and leads to better public service transparency (Wallace, 2009; Kadar et al., 2016). Although a ‘safe city’ constitutes one of the five pillars for city development in Cape Town according to the IDP (City of Cape Town, 2016), it is commonly argued that citizen involvement by authorities for the benefit of safer cities has been lacking (Wallace, 2009). As a result, this research aims to involve end-users in the development of a mobile application prototype that attempts to increase community involvement and empowerment, as well as increased feelings of safety and security, partly because of reduced fear of crime and victimisation. The following section will address the importance of involving citizens in city objectives.

2.3. Citizen involvement and user-centred design

Smart cities are first and foremost associated with the implementation of a set of technologies for the benefit of a liveable city (Wortmann & Flüchter, 2015). However, various research has argued that smart city applications often put too much focus on just the technologies, and less on citizens and engagement with society (Kloppers, 2016), while communities and individuals should be taken among the key stakeholders in the smart planning process (Kloppers, 2016). The danger of failing to take into account citizens and societal engagement in these applications could result in wasting expenditures that were initially budgeted to facilitate the

implementations (Kloppers, 2016). In addition, the leverage of smart technologies is often provided by corporate giants, regularly leading to monopolisation of the smart city as a result of a shift in power dynamics from the city to corporate companies (Kloppers, 2016). Consequently, smart cities could lose their creative edge (Albino et al., 2015). As Kloppers argues, “end users should be able to make relevant contributions in developments and thus actively [be] involve[d] in the ideation, design and development of solutions and by doing so creating innovations that are better able to fulfil user needs and are aligned closer to the market (2016, p. 2).” For this reason, a design science research method is explored in this research, where end-users are placed at the centre of the development process and new knowledge is created from the lived experiences, wishes and needs from end-users. When involving citizens in the smart city development process, trustworthiness is facilitated, thereby encouraging confidence in local authorities that are responsible for the smart city developments (Loideain, 2017). Literature further suggests moving to a “Human Smart City”, that takes full advantage of its citizens and their human capital (Oliveira & Campolargo, 2015). A successful smart city is dependent on its citizens as well as a participatory governance that carefully considers the citizens’ wishes (Alam & Porras, 2018).

Summarising, this study uses a design science methodology to address the proposed research question, thereby focusing on practical problem-solving through artifacts that are both co-developed and used by end users, in this case citizens in the City of Cape Town. Section 3 will address the design science methodology more extensively.

2.4. Summary of Literature

The literature touched upon smart city concepts and implementations, which have gone relatively unexplored across the African continent (Backhouse, 2020). African cities, such as Cape Town, are argued to be transitioning cities, characterised by high urbanisation rates and income inequality, as opposed to Western legacy cities that are characterised by stable infrastructure and economic and social welfare (Deloitte, 2014). As a result, cities in developing countries must be addressed differently when evaluating the success of smart city strategies (Isafiade, 2016; Visser, 2011; Loideain, 2017; Jabar et al., 2019; Lemanski, 2003). Although the private sector and local governments have taken serious steps in putting Cape Town on the smart city agenda (City of Cape Town, 2016), initiatives have failed to lay focus on making the city inclusive for all citizens and focusing on enhancing safety and security.

Cape Town is argued to be the homicide capital of South Africa, and crime rates reach almost six times the global average, making safety a global health priority (Turok, 2011). Furthermore, fear of crime has a significant impact on feelings of safety and security and smart city developments should be focused around making a city safe and secure, especially in developing countries (Lacinak & Ristvej, 2017; Pichardo-Munis, 2011; Naudé, Rossouw & Krugell, 2009). In addition, literature has shown that smart city developments have often failed to take into account citizens' needs, thereby creating 'empty spaces' that are not closely aligned to the market (Albino et al., 2015). Lastly, cities are argued to then lose their creative edge and the real "smartness" of a city (Oliveira & Campolargo, 2015).

3. Methodology

The following section addresses research methods used during this research project. The section will introduce the primary research question and sub-questions and the method chosen to perform this research and analyse its results.

3.1. Research strategy

A phenomenological qualitative research method was chosen for this research. Where quantitative research is suitable for gathering larger amounts of data with the purpose of collecting straightforward information that can easily be categorised and analysed, qualitative research is more effective when information is complex and sensitive, and aimed at gathering opinions and experiences, which is the main objective of this study. *Phenomenology* is a qualitative research strategy that focuses on people's perceptions, experiences, feelings and emotions (Johannesson & Perjons, 2014). The type of study is aimed at understanding the "lived experiences" and perceptions of people to gain a deeper understanding of the problem at hand and gaining insights from its meaning. These insights then form the basis of constructing the prototype, for which creativity and co-creation are the most important values. This is in line with the DSR research method, which puts users at the centre of the design process and aiming to generate knowledge, insights and explanations from these users in order to develop an artifact solving a practical problem.

3.2. Reasoning

Although DSR is growing in popularity as a research method, little is known about creating theories in design science (Lee, Pries-Heje & Baskerville, 2020). Central to DSR and to the topic addressed in this research is the search for patterns that explain the interrelation of different properties which are examined through experience. Inductive reasoning refers to how new knowledge is explored, while deductive reasoning refers to refining and testing existing knowledge. According to Lee et al. (2020), “a theory can be inductively developed through discovering essential nature of observations” (p. 3). Although this research draws on an existing body of literature that explored topics related to this study’s purpose, the research does not rely on theories for drawing hypotheses that are necessary for testing to answer the research question. Instead, to answer the research question, the research relies primarily on past and current experiences, wishes and needs of participants in order to formulate prototype requirements that are focused on enhancing feelings of safety and security of citizens. Hence, as with inductive research, the study aims to derive new knowledge that can contribute to existing, however limited, research on smart city developments in Cape Town and African cities more broadly, as well as the success of a community-based mobile application for promoting community engagement for enhancing feelings of safety in the neighbourhood.

3.3. Design Science Research methodology framework

This study uses the design science methodology to evaluate the research question and sub-questions. Design science research (DSR) is defined as “the scientific study and creation of artifacts as they are developed and used by people with the goal of solving practical problems of general interest” (Johannesson & Perjons, 2014), and is a well-known research method in the Information Systems (IS) community (Costa, Soares & De Sousa, 2016). The research method considers the importance of a viable artifact and relies on the collection of data for input of the construction of the artifact, as well as for its evaluation (Costa, Soares & De Sousa, 2016).

The artifact that is developed during the study is a mobile application prototype. The goal of a smart city is to embrace ICT to create an innovative environment that increases the quality of life for citizens. A DSR method is suitable for addressing the objectives that have

been set out in section 3 of this study. The study aims to understand the essence of citizens' needs and wishes with regards to their feelings of safety and security within urban context. As users are at the centre of the design process, a DSR method is preferred and used to generate new knowledge, insights and explanations. Contrary to other research methods, DSR constructs a new reality instead of explaining an existing one. Although the type of artifact, the mobile application prototype, has been determined at the beginning of the study, its interpretation, functionalities and development are completely open. The purpose of the study is to involve end-users in all these facets of the process to create an artifact that aligns close to the market.

In answering the research questions using a DSR method, the research draws on the methodological framework from Johannesson and Perjons (2014) that is visualised in figure 6. The different stages of the design science method framework are addressed in the next subsections. In progressing through the DSR stages, the *controls* are used to define the research methods and strategies that are to be applied. The *resources* constitute the knowledge which forms the basis of the DSR method, including theories, background literature and models.

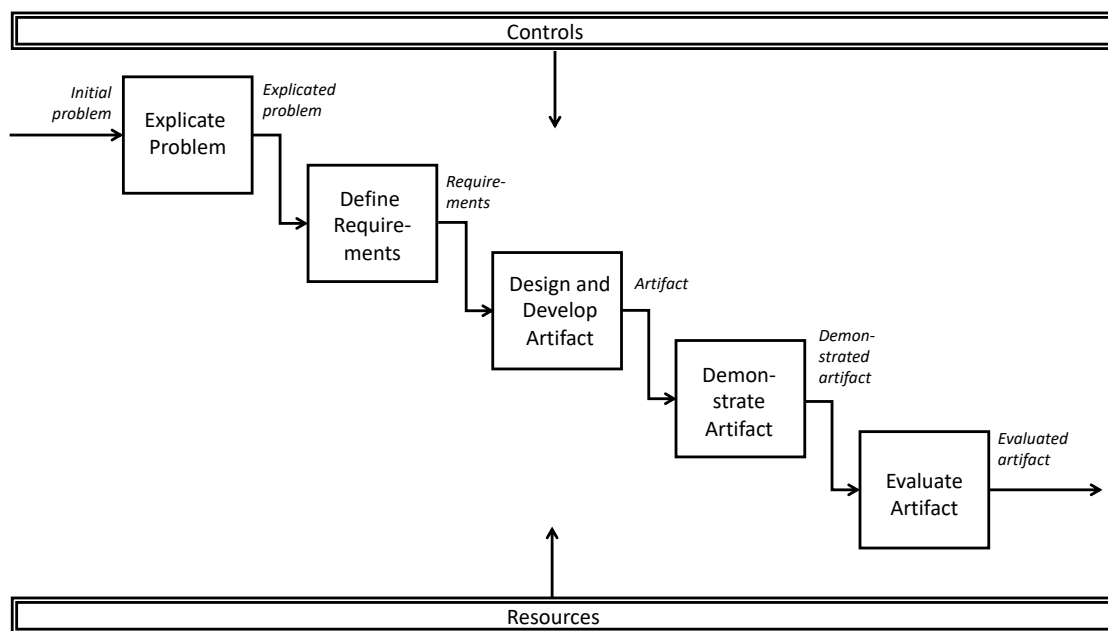


Figure 4: Methodological Framework (from Johannesson & Perjons, 2014)

3.3.1. Activity 1: Explicate problem

As defined by Johannesson and Perjons, the main question to be addressed in this activity is “[w]hat are the problems experienced by some stakeholders of a practice and why are they important?” (2014, p.91). To answer this question and thereby form the basis for defining the

requirements for building the mobile application prototype, the problems must be defined precisely, whereby the perceptions of the main stakeholders are leading to gather different views and knowledge and gain a deeper understanding of the problem. To achieve this, interviews with respondents were held according to the DSR method with the purpose of identifying lived experiences, wishes and requirements of the participants. Specifically, the research seeks to uncover experiences, wishes and needs that relate to the current safety and security-related challenges and lived experiences of citizens, as well as the (importance of) involvement of the community and law enforcement in determining these factors. It also seeks to uncover the wishes and needs for a mobile application for the purpose of enhancing safety, and how community involvement plays a role in this.

To achieve the above, a total of 12 semi-structured interviews were conducted. The information gathered through the interviews provides a better understanding of how the participants feel and think about the safety-related issues in the city, after which these are translated into insights to solve user needs. More details about the interviews, how they were conducted and how their results were analysed is described in the data collection section 3.5.

3.3.2. Activity 2: Define Requirements

The question asked in this activity is “*which requirements on this artifact are important for the stakeholders as a solution for the explicated problem?*” (Johannesson & Perjons, 2014, p.103). Where the previous activity elicited the problem discovered through the stakeholders, this stage evaluates the application requirements as proposed by the stakeholders and assesses their completeness and feasibility for implementation.

Johannesson and Perjons (2014) identify two types of requirements that are important for this research. Firstly, functional requirements define what the system must do and are dependent on user input for translation requirements into user output. The experiences, wishes and needs uncovered from participants during the interviews form the basis of these requirements, which will be translated into product features. Ultimately, when evaluating the artifact (see methodology 3.2.5), the functional requirements will form the basis of evaluating the *intention to use* the artifact by the users. Secondly, *structural requirements* refer to the operation or structure of the software system (Johannesson & Perjons, 2014). Structural requirements focus on user expectations. A well-defined structural requirement determines how easy the system is to use (Johannesson & Perjons, 2014). The structural requirements are

evaluated by the *ease of use* of a system. These evaluation techniques are defined in Davis' Technology Acceptance Model (Davis, 1989), which is further explained in the evaluation phase in section 3.2.5.

3.3.3. Activity 3: Design and development of artifact

The third activity is Design and Develop Artifact with the aim of fulfilling the requirements as proposed in the previous stage. As defined by Johannesson and Perjons, this activity is concerned with “creat[ing] an artifact that addresses the explicated problem and fulfils the defined requirements” (2014, p. 117). The input used in this stage consists of the knowledge asserted from the participants and knowledge from research literature. This activity is divided into a set of two sub-activities. In the first sub-activity a brainstorm session takes place which is visualised with paper sketches. In the brainstorming phase, ideas will be generated in a creative manner based on the results generated from the interviews and based on previous literature. The experiences and challenges identified by participants with regards to their feelings of safety and security in the urban context are translated into solutions presented in the application. The second sub-activity includes the actual build of the mobile application prototype. A UML use case diagram is used to visualise the skeleton of the prototype with its main functionalities and actors. The use case diagram is complemented with use case descriptions explaining how each of the actors in the diagram interacts with the system. Lastly, in the third and final sub-activity, the prototype is designed using the software *Sketch* which is be used for presenting the prototype in the *demonstrate artifact* phase, and for obtaining user feedback in the *evaluate artifact* phase. Due to time and resource constraints, the prototype will not be built into an actual mobile application in the present research.

3.3.4. Activity 4: Demonstrate artifact

As defined by Johannesson and Perjons (2014), the question central in this activity is “[h]ow can the developed artifact be used to address the explicated problem?” (p.133). The purpose of the phase is to show the mobile application prototype that has been designed in the previous phases can be used meaningfully in a specific case. This stage will primarily consist of descriptive insights by applying the prototype to user stories describing a real-life scenario. Each user story contains one or more acceptance criteria which are in line with the application

requirements and furthermore link to screen numbers of the prototype (see Appendix H, I) in its explanations for easier reference. The user stories define how the application is expected to behave and how these behaviours should be satisfied.

3.3.5. Activity 5: Evaluate artifact

This activity determines how well the artifact solves the explicated problem and how well it satisfies the requirements set out in the second stage. The question that is central in this activity, according to Johannesson and Perjons, is “[how] well does the artifact solve the explicated problem and fulfil the defined requirements?” (2014, p.137). In this phase, participants will be interviewed and asked for their feedback after which alterations will be made to the artifact accordingly (Costa, Soares & De Sousa, 2016).

To address the above question, 4 presumptive users from the pool of first-round interview participants are asked to participate in the second round of interviews in which they are given access to the prototype service and asked to carry out a set of tasks. The research conducted semi-structured interviews used to guide participants using the prototype, while adhering to the guidelines set by the Technology Acceptance Model for evaluation.

The research uses Davis’ TAM as a model for gathering and analysing user feedback on the mobile prototype during the evaluation phase (Davis, 1989). The TAM is one of the most widely used models for user acceptance (Cheung & Vogel, 2013) and use of technology in the Information Systems field (Cheung & Vogel, 2013). The TAM model is visualised in figure 5.

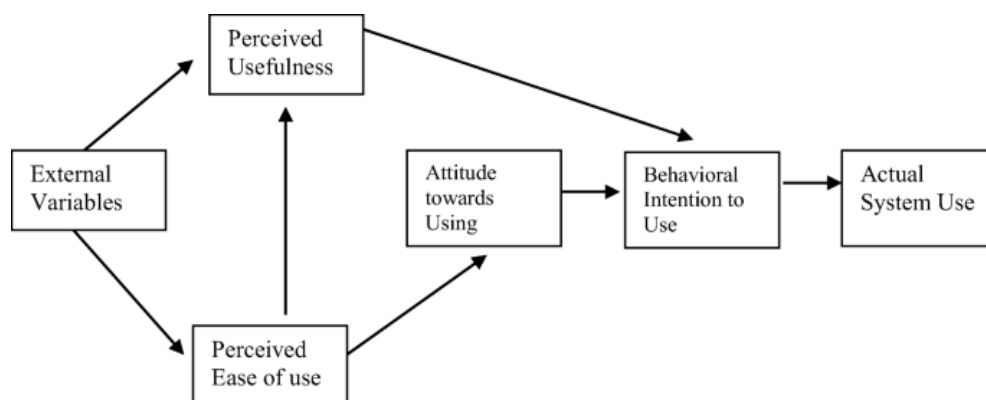


Figure 5: Technology acceptance model (Davis et al., 1986, p.24)

The model assumes that users come to accept a technology when there is a high level of Perceived Usefulness (PU) and Perceived Ease of Use (PEU) of the technology (Cheung & Vogel, 2013). This study assumes that PEU refers to when the user of the application believes that using the smart city mobile application prototype would be free of effort. PU refers to the user believing that the smart city mobile application prototype would enhance their feelings of safety and security in the city. According to Davis' TAM, PU and PEU are the most important factors in determining an individual's attitude towards the system and whether they will use it (Iriberry, Leroy & Garrett, 2006).

To predict the successfulness of the application, participants are asked to perform a set of tasks running them through the system's main functionalities. These tasks are identified as the external variables for evaluating the technology's acceptance by the interviewees. The following external variables have been chosen and are extensively described in the use case descriptions in section 4.3.2. and furthermore, reflected in the interview protocol in Appendix C.

- Task 1: Create a new account and log in
- Task 2: Set the category weights and start a safe route
- Task 3: File an incident report
- Task 4: Become member of a community
- Task 5: Add a safety resource to your folder
- Task 6: Send out an emergency signal

Incorporating the task assessments into the technology acceptance model for evaluation, the research proposes an applied TAM (see figure 6). The following section will address how this model will be used for artifact evaluation and for answering the sub questions as presented in this dissertation.

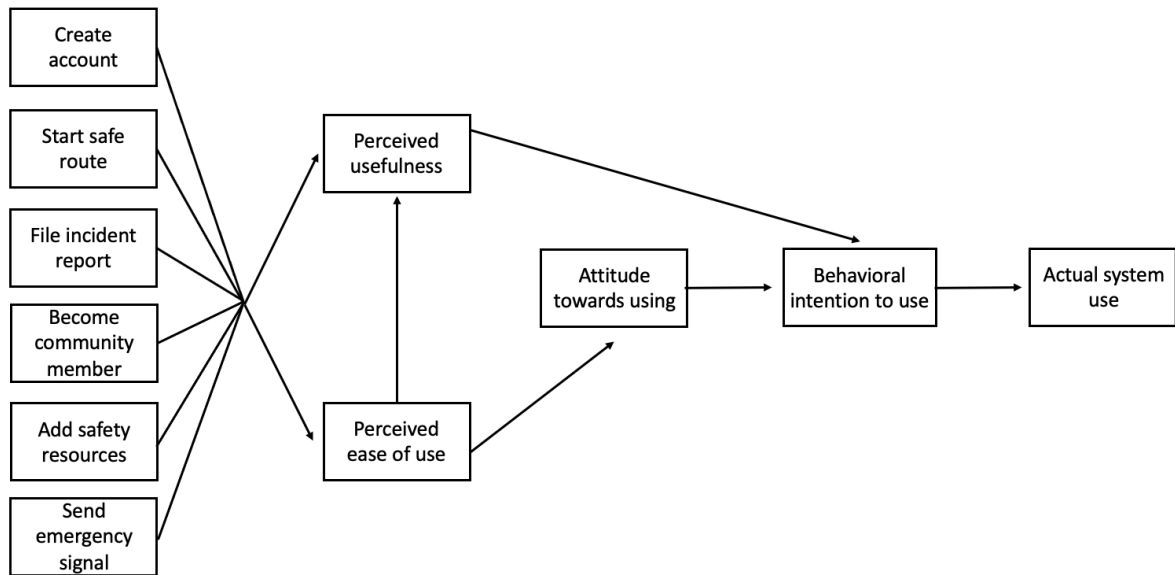


Figure 6: Technology acceptance model (changed from Davis et al., 1986, p.24) for evaluating smart mobile application prototype

3.4. Research Questions

The following research question is addressed:

How can the use of a ‘smart’ community-based crime-focused mobile application prototype influence feelings of safety and security for Cape Town citizens?

To address this research question, the dissertation identifies a set of sub-questions:

1. *What are the safety and security related challenges experienced by the citizens of Cape Town?*
2. *Which requirements should be satisfied by a mobile application prototype to enhance citizens’ feelings of safety and security?*
3. *Which circumstances should be satisfied for citizens to accept the use of a proposed mobile application prototype for enhancing their feelings of safety and security?*
4. *How can the proposed mobile application prototype lead to greater community engagement within the smart city?*

The sub questions have been set to give a consolidated answer to the research question presented. Through the DSR method, which has been presented in section 3.3., this dissertation aims to give answer to the research questions.

The first sub question, which is set to understand the current safety and security related challenges experienced by participants, aims to be answered in the first phase of the DSR method. In this phase, the dissertation seeks to understand the explicated problem that is to be solved through the artifact developed.

The second sub section is answered in the second phase of the DSR method, where participants share their wishes and needs for a mobile application prototype that can enhance their feelings of safety and security, which in turn set the requirements for the prototype that is to be developed. The last phase of DSR method, the evaluation phase, seeks to give answer to the third and fourth sub questions presented above, and this is done through the TAM framework as presented in section 3.3.5.

The third sub question can be answered by evaluating the perceived usefulness (PU) and perceived ease of use (PEU) for each of the main system variables. PU and PEU affect the attitude towards using the system and the behavioural intention to use the system, respectively. A positive behavioural intention to use, then, assumes users are willing to accept the use of a proposed mobile application prototype (Iriberry et al., 2006).

The fourth sub question is answered by evaluating the perceived usefulness (PU) of the community system variable that is presented in the prototype. Participants are asked to assess the perceived usefulness of the system variables for communities and to what extent they believe community engagement is enhanced through the wider use of the application as well as its positive effect on enhancing feelings of safety and security within the community. These system variables are chosen for evaluating the effect for users of the mobile application prototype on community engagement because they all relate back to information available with regards to the communities in the application.

Table 5 visualises how the research questions align with the research gaps.

RESEARCH QUESTION	CURRENT RESEARCH GAP
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What are the safety and security related challenges experienced by the citizens of Cape Town?	Western Cape crime rates are the worst in the country, as well as the fastest growing crime rates. Additionally, Cape Town has a homicide rate that is six times the global average, and the city's police services are rated amongst the worst in the country. Hence, there is a need to focus smart city developments around making the city safer and increasing feelings of safety and security of citizens. In addition, there is a need of understanding the experiences of citizens with regards to their feelings of safety and security in the urban spaces.
How can the proposed mobile application prototype lead to greater community engagement within the smart city?	Fear of crime endangers feeling of safety and security and reduces sense of community and social cohesion. Research shows that involving citizens in effective policing efforts is assumed to be socially beneficial and leads to better social service transparency. Therefore, there is a need to investigate opportunities for community-based efforts that make use of crowdsourcing and sharing crime-related information with citizens to reduce fear of crime and enhance feelings of safety and security.
Which requirements should be satisfied by a mobile application prototype to enhance citizens' feelings of safety and security?	Previous research shows that smart city developments have primarily focused on the technological aspect of the application strategies and failed to consider citizens. There is a need for research that involves end users in the ideation of smart developments, which could in turn lead to satisfying the challenges perceived by citizens in relation to their feelings of safety and security.
Which circumstances should be satisfied for citizens to accept the use of a proposed mobile application prototype for enhancing their feelings of safety and security?	Secondly, user-centric initiatives are argued to increased innovation in the context of smart cities.

Table 5: Research Objectives

3.5. Sampling strategy

The overarching sampling method used in this research is that of nonprobability purposive sampling (Bryman, 2012). Hence, sampling is done with the research goals in mind. The strategy chosen is purposive in nature, because it does not involve random selection of participants and the study aims to include participants from the different strata identified. Within the purposive sampling method, the study specifically performed is that of nonproportional quota sampling. In quota sampling, the population, in this case Cape Town's population, is divided into strata which are relevant to the study's topic of interest. The strata chosen for the quota sampling in this study include gender and location. These strata are considered most important for evaluation based on previous literature on crime, safety and security in the context of Cape Town as a smart city (see Blythe et al., 2004; Blom et al., 2010). Literature suggests women are less likely to defend themselves against perpetrators and further experience higher fear of crime than their male counterparts (Hollander, 2001), hence why

gender is chosen as a stratum. To determine the difference in perceptions of safety across the city and success of the application, location is chosen as the second stratum for sampling.

3.5.1. Sampling size

The total number of respondents during the first round of interviews is $N = 12$. After the last interview, there were no new themes generated from the interviews. For the gender quota, female and male respondents satisfy $N = 6$, respectively. For the location quota, the locations are split between different neighbourhoods within Cape Town. The sample overview can be found in table 6 and visualise the data that was collected from participants during the first part of the interview where demographic information was discussed. Respondents were given a case number based on the proceeded day of the interview, R1 being the first interviewee and R12 the last one. For the total pool of cases, the strata for living location and gender are satisfied as proposed in section 3.6.

CASE	GENDER	LIVING LOCATION	AGE	RACE	HOME-WORK TRAVEL METHOD	ACCESS TO PHONE	ACCESS TO INTERNET
1	Female	Observatory	27	White	Walking	Yes	Yes
2	Female	Central Business District	28	Black	Private car	Yes	Yes
3	Male	Observatory	25	Black	Private car	Yes	Yes
4	Male	Sea Point	25	White	Private car	Yes	Yes
5	Female	Sea Point	25	White	Private car	Yes	Yes
6	Female	Kenilworth	21	Asian	Private car	Yes	Most of the time
7	Male	Woodstock	29	Black	Public transport	Yes	Yes
8	Female	Salt River	24	White	Walking	Yes	Yes
9	Female	Observatory	24	White	Public transport	Yes	Yes
10	Female	Rondebosch	26	Black	Public transport	Yes	Yes
11	Male	Greenpoint	28	Black	Public Transport	Yes	Yes
12	Male	Salt River	30	Black	Walking	Yes	Most of the time

Table 6: Sample overview interviews round 1

The total number of respondents during the second round of interviews is $N = 4$. After that, data saturation was reached. For the gender quota, female and male respondents satisfy $N = 2$, respectively. The sample overview can be found in table 7 and visualise the data that was collected from participants during the first part of the interview where demographic

information was discussed. Respondents kept their case number from the first round of interviews.

CASE	GENDER	LIVING LOCATION	AGE	RACE	HOME-WORK TRAVEL METHOD	ACCESS TO PHONE	ACCESS TO INTERNET
4	Male	Sea Point	25	White	Private car	Yes	Yes
6	Female	Kenilworth	21	Asian	Private car	Yes	Most of the time
8	Female	Salt River	24	White	Walking	Yes	Yes
11	Male	Greenpoint	28	Black	Public Transport	Yes	Yes

Table 7: Sample overview interviews round 2

3.6. Data collection method

Interviews were chosen as the preferred data collection method as they allow for high engagement with respondents and facilitate greater creativity which are important objectives for development of the prototype. Rounds of interviews were performed twice, during the first stage and fifth stage of the design period, in the *explicating problem* and *artifact evaluation* stage, respectively. As a phenomenological qualitative research approach is chosen during this research in which experiences, wishes and needs with regards to feelings of safety are uncovered, interviews are the preferred method of data collection as they are suitable for gathering complex information. Interviews allow for a highly engaged dialogue between researcher and respondents in order to explicate the problem in a creative, in-depth and interactive manner, which are important objectives of the DSR method. Interviews allow for efficiency and obtaining requirements in a short period of time (Johannesson and Perjons, 2014). To make sure the interviews do not become stale and allow for continuous creative input, the research performed semi-structured interviews, to allow for ease of grouping a set of requirements, but still allowing the respondent to take initiative. Interviews were conducted via WhatsApp calls because of the Covid-19 restrictions active at the time of data collection. All interviews were recorded. Additionally, field notes were taken by the researcher during the interviews. The interview questions and participant informed consent form have been pre-approved by the UCT Faculty of Science Ethics Committee. Consequently, participants were informed of the nature of the research and submitted their approval for audio-recording and the use of data without their names nor affiliation to an institution via the electronically signed consent form at the start of the interview. As communicated to the participants, participation in the research is completely voluntary and participants could opt out at any moment.

3.6.1. Interviews round 1

The interview template that was used for the first round of interviews has been pre-approved by the UCT Faculty of Science Ethics Committee and can be found in Appendix B. As the research follows the DSR method, the main purpose of the interviews is to go into depth on the lived experiences of users and consequently get an understanding of the problem. A total of 12 interviews have been performed and interviews lasted 32 minutes on average.

In the first part, respondents are asked general questions addressing demographic characteristics, namely age, gender, race, housing status, place of residence, job status and employment location, work-home travel method, income, access to mobile device and access to the Internet.

Thereafter, the research is focused on gathering individuals' perception of crime threat, perceived safety in the neighbourhood, trust in local crime prevention authorities, and degree of neighbourhood integration. Participants are encouraged to openly share their experiences with regards to feelings of safety and security in the city and their neighbourhood. The purpose of this section is to explore the problems faced by participants in relation to safety and security and which factors influence these.

In the second part of the interview, participants are informed about the proposed design of a mobile application prototype and its function as a smart city application that is focused on enhancing feelings of safety and security of Cape Town citizens. The notion of a smart city is explained in the interview. Participants are asked to share their wishes and needs when it comes to enhancing feelings of safety and security through mobile application prototype features and requirements. Particularly, the participants are asked to translate their experiences with regards to safety and security threats as identified earlier in the interview and fit them within a set of requirements in order to enhance their feelings of safety and security. Additionally, participants are asked how they believe community engagement could have an impact on feelings of safety and security. This is also done in the context of a smart mobile application prototype.

Lastly, participants are asked how they foresee the success of a prototype with the purpose of enhancing citizens' feelings of safety and security, and if and which potential drawbacks could be identified.

3.6.2. Interviews round 2

Following the DSR method, a second round of interviews was performed during evaluation stage. The purpose of the second round of interviews, which are held in the evaluation phase, is to gather feedback from participants on the developed prototype and to what degree it conforms to the participants' expectations with regards to feeling safe and secure in their neighbourhoods in Cape Town as set out in the initial round of interviews. A total of four participants from the first round of interviewees were interviewed with the purpose of evaluating the artifact. The in-depth interviews provided rich insight in the perceived usefulness and ease of use of the artifact. Furthermore, because of the structure and determined content of the interview protocol, saturation of knowledge could be reached after these interviews. The composition of the pool of interviewees can be found in section 3.6.1.

The mobile application prototype was made available on Sketch cloud. The participants interviewed for the in-depth evaluation were sent an open link to the prototype on sketch cloud which can be accessed here (<https://www.sketch.com/s/8be43c80-e2fc-4381-bc57-64b8d7f98b64>) on both mobile and desktop devices. The prototype was made available to interviewees just before the start of the interview. Participants were asked to open the link on their mobile device to have the best mobile application prototype experience, while keeping the interview call on loudspeaker.

The interview protocol can be found in Appendix C. During the first part of the interview, which lasted approximately 5 minutes, participants were given the opportunity to explore the different screens in order to get an impression of the general look and feel of the prototype as well as the available screens and menu options. Participants are asked to provide comments on their first impression.

During the second part of the interview, which lasted approximately 25 minutes on average, participants were requested to perform a set of six tasks derived from the main use case descriptions as set out in section 4.3.2. The protocol for the task assessment and evaluation follows the Technology Acceptance Model as set out in methods section 3.2.5, where users are asked to assess intention to use and ease of use for each of the tasks. The six tasks are the same for each of the participants in order to facilitate comparison and implement any feedback accordingly.

In addition to commenting on the perceived usefulness of the different system functions, participants are further asked to specifically assess the perceived usefulness of the

system functions in terms of its effect on community engagement and enhancing feelings of safety and security. This brings the task of assessing the community variable to be evaluated with the following questions:

- *How easy is the system's function to use?*
- *How do you perceive the usefulness of this system function (communities) for enhancing community engagement to make you feel more safe and secure in your neighbourhood?*

3.7. Data analysis

3.7.1. Thematic analysis

All interviews were transcribed. The approach chosen for qualitative data analysis is that of *thematic analysis*. According to Braun and Clarke (2006), the goal of thematic analysis is the process of analysing data and identifying patterns (themes) emerging from the data. Thematic analysis does not necessarily have to build on a pre-existing theoretic framework but can be used to report experiences and meanings and their effects on different discourses operating in society. In this research, such experiences and discourses are concerned with perceptions and feelings of safety and security within the urban space. The goal of the interviews and subsequently the thematic analysis thereof is a method of reflecting reality and unpicking the surface of reality for the participants in the study (Braun & Clarke, 2006). A theme captures a recurring pattern within the data and relates back in some way to the research question(s).

Specifically, this research engages in inductive thematic analysis, also specified in section 3.4 on type of reasoning. As the design science research method aims to generate new knowledge, insights and explanations from the perspectives of users central to the problem, inductive thematic analysis is performed in order to refrain from fitting the data in a pre-existing frame, but rather linking the themes to the data themselves. This is done in order to unravel as much information from participants as possible and set the development stage of the application primarily from a user perspective.

3.7.2. Coding qualitative data: using NVivo

To analyse the qualitative data gathered in the interviews, a computer-assisted qualitative data analysis (CAQDAS) method was used, namely NVivo. This software was chosen because it is the most common method of qualitative data coding. The purpose of a CAQDAS is to go through a data set marking certain sequences of code and collect all sequences of text belonging to a particular code (Bryman, 2012). Coding was done through nodes, which are a collection of references (Bryman, 2012). The node trees that were used for the thematic coding of the interviews can be found in Appendix D.

Coding of the interviews was performed in two phases. The first phase includes the coding of the first half of the interview, going into challenges with regards of feeling safe and security in the neighbourhood and the city. This part is called “Perceptions of safety”. A total of 16 nodes were used to code this section, which can be visualised in appendix E.1. Nodes were subdivided into the following themes: challenges influencing safety and security, attitudes towards safety, neighbourhood development, and external factors impacting safety.

The second phase includes the coding of the second part of the interview, going into wishes and needs with regards to enhancing safety and security in the neighbourhood and the city in the context of the mobile application prototype development. This part is called “Wishes and needs”. A total of 14 nodes were used to code this section, which can be visualised in appendix E.2. Nodes were subdivided into the following themes: Application requirements, attitudes towards using the app, challenges for using the app, and factors impacting use and success of the app.

The second round of interviews, in which four participants were interviewed (see table 6) to obtain feedback on the developed mobile application prototype as a result from the requirements deriving from the first round of interviews, have been coded into a code book called “Application Evaluation”. A total of 10 nodes is used to code this section, which can be seen in appendix E.3. The number of incidences for each theme is indicated in brackets.

3.8. Ethical Consideration

This dissertation satisfies the University of Cape Town’s Policy for the Responsible Conduct of Research (2020) and The University of Cape Town Code for Research involving Human Subjects (2012). The university’s policies address important policies regarding plagiarism, research data management policy, ethics review for involvement of human participants, and scholarly responsibility, integrity, and honesty in the design and execution of the research.

As this dissertation involves the participation of human subjects, an application has been submitted to and was approved by the Faculty of Science Research Ethics Committee with approval code FSREC 027- 2020. In addition, the work set out in this dissertation is the researcher's original work, that confirms the values set out by the university's Codes of Research.

4. Findings

This section presents the research findings and places them in the context of the design science research method for developing the mobile application prototype.

4.1. Explicate Problem

This section discusses the results from the first part of the interviews with the study's participants. The findings from the interviews are related back to the first subsection as presented in the methodology posed in section 3. This sub question is proposed as:

“What are the safety and security related challenges experienced by the citizens of Cape Town?”

In addressing the sub question and analysing the interview data, the dissertation will first discuss participants' challenges with regards to their feelings of safety and security in the neighbourhood. Secondly, an overview will be presented of the effects of community engagement, living environment and law enforcement on feelings of safety and security for participants.

4.1.1. Challenges with regards to feelings of safety and security

The challenges with regards to feeling unsafe in Cape Town as identified by interviewees, which constitute the explicated problem that is central to the study according to the DSR, are grouped into five themes, which will be discussed below.

4.1.1.1. Fear of night-time

The first challenge posed by interviewees that negatively impact feelings of safety and security for participants relates to the daytime versus night-time divide. All people interviewed identify that they feel less safe or completely unsafe at night in their neighbourhood. The reasons for the feelings of unsafety at night-time range from a lack of visibility of their surroundings, streets becoming quieter and a feeling of vulnerability. These feelings can be captured in a quote from respondent 5: *“Times I feel unsafe would definitely be when it gets darker, at night time, because the roads generally do become more quite in Sea Point, so I feel more vulnerable, less safe, feel like if something happens, there is not a lot of people around that would be able to help me”*. Interestingly, some of the interviewees mention that occasionally they also feel unsafe during the day, when they are alone in combination with one or more of the challenges presented hereafter. This is captured in a quote by R6: *“I don’t feel safe any time of the day if I’m walking (...) [T]he city can be dangerous especially at night but during the day it’s not as dangerous because it is busier but in Kenilworth it’s dangerous but more quite, does that make sense?”*

In contrast, most of the men interviewed mention that they feel safe during the day in their neighbourhoods, and only sometimes unsafe at night, as opposed to the women in the study, who all feel unsafe at night and occasionally also during the day. Previous studies have identified time of day a barrier to safety and security among citizens.

4.1.1.2. Mode of transportation restrictions

The second challenge posed relates to the mode of transportation. The majority of men that were interviewed responded that in relation to the mode of transportation, the only instance where they sometimes or regularly feel unsafe is when they are walking. The remaining cases of the men interviewed do not associate modes of transportation with feeling unsafe in their neighbourhood.

All of the women interviewed, however, mention mode of transportation as a factor impacting their feelings of safety in their neighbourhood, leading to a decrease in feeling safe and secure. The respondents with access to a car stress that driving a private car gives them a safe or safer feeling because it is a personal space that is not likely to be compromised. Taxi services such as Uber are perceived somewhat safe by those respondents that address this mode

of transportation. In a few cases, these private taxi services are considered unsafe, such as stated by respondent 2, who stresses that *“I’m okay with using an Uber but there are sometimes some issues with Ubers attacking females or kidnapping people or stuff like that. So, I’d rather just use my own car most of the time”*. R6 further mentions that she is also not always comfortable taking taxi services such as Uber because of bad stories she has heard: *“Because I’m alone and I don’t know who the driver is. And there has been stories about Uber drivers and stuff like that”*. Some respondents similarly perceive the use of public transport, stating that stories have gone around making them feel less comfortable using public transport, as well as the fact that public transport limits the possibility of being in one’s own space, captured in a quote by R5: *“And I’ve obviously heard of stories, so public transport would definitely be when I feel most unsafe compared to walking even.”*

In the interviews, all of the women identify that walking decreases their feeling of safety, such as captured by respondent 9: *“Like I would walk and I would see weird people following me and I would literally have anxiety attack due to that, because I would never feel safe knowing that there is somebody potentially following me and if there is nobody in the street and then also it does really affect me when I was walking the street was empty, I felt really insecure. And unsafe. But as soon as I got a car it did really help me to feel more safe within my neighbourhood because I could obviously like lock the car and then I had like an inside parking at my place so having a car has been a huge relieve in terms of feeling safe”*. Another respondent felt comfortable walking to her work but has been made to feel less comfortable because of people approaching her to make her aware of dangers: *“I feel quite comfortable and I wear my earphones and listen to music. I like to do that, and I just keep my phone in my pocket, that’s something I always try to do. But then I have had people approaching me and say “hey, don’t show your EarPods because then they know where your phone is””*. Three female respondents furthermore mention how carrying valuables, especially when walking, gives them an increased feeling of unsafety for the reason that they are at higher risk of becoming a victim of mugging.

4.1.1.3. Feeling unsafe around strangers

The third challenge identified and mentioned by all except one of the interviewees, relates to feeling of unsafety around strangers. Feltes (2003) stresses that this fear comes from *“unfamiliar strangers behaving in an unusual way are particularly likely to trigger distrust and*

fear” (p. 24). Respondent 4 expresses something similar, saying: *“So at night when I see maybe a group of men, usually, I feel less safe. And then safer if I see couples, or groups of all kinds of different people who don’t look poor, then I feel more safe, I guess, to be honest”*. Moreover, all of the respondents mention that they feel safe(r) when there are more people around. Places mentioned which increase safety because of the people and location, include shopping centres, the Promenade, and beaches, where there are lots of people and there is good visibility. Touching upon feelings of unsafety, respondent 2 mentions the presence of beggars give her an increased feeling of unsafety: *“There is a lot of them around in the CBD area, especially by our apartment block there is a lot of people always begging and stuff. You never know their real intentions. Because some of them might want to steal but some of them might really actually be begging for food innocently”*. R1 identifies something similar when coming back and leaving her house, saying that unfamiliar people sometimes give her a feeling of unsafety: *“Nothing happened, but sometimes it’s just people trying to pretend they want to fix something in the house and then they’re next to the door asking for money and then you just never know if something can go wrong (...) It’s just like knowing, and also knowing that friends of yours or people you know have been robbed so it’s always in your head and you know it can always happen to you”*.

4.1.1.4. Street architecture and infrastructure

The fourth challenge identified by the interviewees relates to the design of the streets and overall infrastructure and was mentioned to be a factor influencing safety and security by all respondents. According to the participants’ responses, the type of street architecture, such as lighting, open spaces, and the possibility for a ‘refuge’ can have an impact on feelings of safety and security. The majority of respondents mention that a particular street architecture can impact their feelings of safety and security. These particulars include open and visible spaces, proper streetlights, greenery, the presence of bars and restaurants, and cleanliness of the area. Two respondents mention Woodstock to have a particularly high level of neighbourhood upgrade with regards to cleanliness. Respondents 7 and 8 identify that the upgrade of the area, with professional graffiti art, the renovation of buildings, the addition of markets and shops and office buildings leads to the gentrification of the area. Another participant mentions Camps Bay as an example of giving increased feelings of safety and security because of good street design: *“If you look at Camps Bay there is a lot of visibility, it’s a big suburb, there is greater*

infrastructure there and the lights and patrols are higher” (P7). The same is said about Sea Point promenade, where broad visibility enables participants to be vigilant, also because it is a place where people come for leisure purposes and exercise.

In the interviews, some responses are classified to form a challenge that is based on combining the street design challenge with feeling unsafe of night-time or feeling unsafe around strangers, such as for R11: *“I used to feel unsafe in Rondebosch because I used to live right over the railway line, if you know what I mean. So every time I would walk home from either Pick n Pay or Checkers, or anywhere on the Main Road, I would have to walk over the bridge and that was quite scary because there was always people there and they were just hanging around”*. Something similar is brought up by R9, who mentions the lack of a possibility to look far ahead as diminishing her feelings of safety: *“I feel like in Obs [Observatory] there is a lot of like, there is a main road and there is a lot of corners and as soon as I’m approaching a corner I’m always stressing out, because there is a lot of stories where people are hiding in these small streets and waiting for victims and attack them as soon as they cross the corner”*.

4.1.1.5. Lack of police support and follow-up

The fifth challenge identified by interviewees refers to the lack of police involvement and follow up. Some respondents mention the current lack of police involvement and follow up when incidents are reported, and advocate for a system that allows a better follow-up from law enforcement with regards to incidents happening. R2 stresses: *“when we had the break in, we literally investigated on our own and we found out who did it through the body corporate or sorry, the building managers, and we found pictures of the person who did it. So we literally told the police that we have pictures but they didn’t do anything with the case and didn’t get back to us like they said they would. So basically, there is a criminal on the loose and we have pictures of her but the police just don’t do their job so I think that they’re useless”*. Another participant had a similar experience where the police was present but did not act to the benefit of the citizens: *“Cause after a night out I saw someone on the floor and this was in the Waterkant by Modular and there was someone passed out on the floor and there were two police lights driving past and none of them did anything. And then on the corner of the street there were like three security guards and they were just chilling meanwhile everyone was crowded around this person”*. In a more general regard, most participants mention they do not

feel supported by the police in terms of safeguarding their feelings of safety and security within the urban spaces. This will be further addressed in section 4.2.2, in which the dissertation discussed the impact of law enforcement policies and visibility on feelings of safety and security for participants in the study.

4.1.2. Factors impacting feelings of safety and security

Below section identifies different factors that have an impact on feelings of safety and security for participants in the study. It addresses the impact of community engagement, law enforcement policies and (type of) living environment and safety measurements taken within the living environment, on feelings of safety and security.

4.1.2.1. Impact of community engagement on safety and security

During the interviews, respondents were asked how they perceive community engagement in their neighbourhood and how the level of community engagement affects their perception of safety and security. Overall, most respondents identify the level of community engagement in their neighbourhoods to be determined by the level of interaction with other residents, to what extent people within the neighbourhood look out for each other, as well as the amount and type of activities taking place within the community. Firstly, the level of interaction with other residents affects community engagement. Participants highlight that recognising and knowing people within the neighbourhood increases the perception of community engagement and provides a sense of cohesion. One participant mentions: *“People are walking around and they do know the faces around the neighbourhood, like I even know people that live outside the building”* (R7). Similarly, R8 says she feels safe recognising the faces in her neighbourhood: *“There are really nice coffee places that you can go to, and you see familiar people”*. One of the participants feels that community engagement would be better if people would interact more: *“To be honest there is no sense of community in Greenpoint. (...) At most you probably know your next-door neighbour. So it’s very limited interactions, I probably know I few people in the complex that I do engage with on a Whatsapp group”*. Secondly, participants identify that community engagement is positively affected when people in the neighbourhood actively look out for each other. According to two participants residing in Observatory, this is the case in their area. R1 stresses: *“I would say for my case within the street we are having a WhatsApp*

group with all my neighbours, and it is really nice because I will always know if there is a problem or if I need help or if I have to pay attention to like some dodgy people". The other Observatory residents adds something similar to this: *"I know in Obs I also have like a kind of community watch and they have these events where they get together and say we're going to walk together through the streets to make it more safe so I do think that if there is a strong sense of community you know that there are people who are kind of doing a neighbourhood watch it is definitely affecting safety positively".* A third factor impacting the level of community engagement according to participants has to do with the frequency and type of events organised in the area. R2 stresses that in her neighbourhood in Central Business District there is close to no form of community engagement because everyone lives within their own shell: *"I think it's different if you would work in a suburb where there would be more community engagement, there would be more things that people like to attend, like markets or where, you know".*

Eight respondents identified that they have some contact with their neighbours and feel like neighbours are looking out for each other to make sure safety is safeguarded. R6 stresses: *"knowing like your neighbourhood will definitely make me feel safer, and also as a girl I would say knowing that if I have a problem, I can always call my neighbour or ask for help. That is something that will really affect how I feel safe or not in my neighbourhood".* Similarly, R11 mentions that *"when there is someone not around the property, we know that no one is there and we need to make sure that security is on top of it, things like that. Like a sense of community is important like that".* When asked if feelings of safety and security would be enhanced if more community engagement would be present in their neighbourhood, all respondents confirm this is the case. R2, living in an apartment block in CBD, believes there is no community engagement in their building or neighbourhood and is one of the only respondents with a negative attitude towards community engagement in her neighbourhood. She stresses that a higher level of community engagement could work towards enhanced feelings of safety: *"For instance what happened with us with the break-in, if somebody would have seen somebody that looked or seemed suspicious they would have quickly notified us, but because everyone is in their own little shell and bubble they don't really know what's happening with their neighbour so they couldn't really say like "Oh, that person doesn't live here", or "there is a locksmith on our floor trying to change the keys". So, I think maybe it has a positive effect if we had better community engagement".* In conclusion, participants stress that higher level of

community engagement within neighbourhoods positively affects feelings of safety and security.

4.1.2.2. Impact of law enforcement on feelings of safety and security

During the interviews, respondents were asked questions regarding the influence of law enforcement policies and performance, on their feelings of safety and security. Specifically, the respondents were asked about their opinion regarding the level of community patrolling in the neighbourhood and security policies enforced by law enforcement in the wider city and its effect on personal feelings of safety and security. The nodes used for analysis were “neighbourhood policing and patrolling” and “policies”. When mapping both nodes against positive attitude regarding safety on the one hand, and negative attitude regarding safety on the other, most interviewees feel positive towards neighbourhood policing and patrolling, while feeling negative towards wider policies by law enforcement to ensure safety and security of citizens in the City of Cape Town. Participants living in Rondebosch, Observatory, Greenpoint and Sea Point were positive regarding the activity and frequency of neighbourhood policing and patrolling. All respondents in the study, even when not positive regarding the level and frequency of neighbourhood policing and patrolling in their neighbourhood, stress that seeing neighbourhood watch or SAPS cars drive around the neighbourhood gives them an increased feeling of safety. As R5 puts it: *“we often see a police van driving in our road and especially, like very often, maybe even twice a day in our road, so then that improves my perception of safety, because I’m like, okay there is a police present”*. The same participant mentions: *“it definitely makes me feel safer knowing that there is a presence there that has a bit more authority and power and should be installing justice”*. One of the interviewees stresses that the presence of police gives a feeling of safety, but a feeling of insecurity at the same time: *“you know you can sort of count of them, I mean you never know but... I guess it would help but I also don’t like that feeling of knowing that it needs to be there. So, for me that wouldn’t be my ideal way or feeling more secure, that would be in different ways”*. Respondents are more negative about the question of how they appreciate current crime policies in the city. The majority of the respondents feel that crime policies are not effective and are not tackling the root causes of crime. Additionally, a large proportion of respondents mentions the socio-economically skewed policies that law enforcement is pursuing to combat crime, favouring the more advantages neighbourhoods.

4.1.2.3. Impact of living environment on feelings of safety and security

All respondents point out that they feel safe inside their living environment. All interviewees touch on the fact that their living environment has one or more security measures in place, including security guards on site, burglar bars, (remote) gates, cameras, alarms or panic buttons, and off-street parking spots. Furthermore, all respondents identify that one or more of these security measures highly contributes to their feeling of safety inside of their living space. R5 describes how these security measures in her living environment increase her feeling of safety: *“We have cameras, we also have, which they check regularly, we also have three security gates you need to come through, it’s also quite a lot of old people that are around during the day and don’t necessarily work full-time jobs, so it also helps to know that there is bodies around. There is also a caretaker who lives on the property. So yes, I feel safe in my apartment, for sure. And then also I have parking inside the building which also helps”*. R7 says he enjoys living in a secured apartment building because the security measures taken give him a secured feeling: *“I feel very safe due to in the whole building having CCTV cameras in every corner without having a blind spot. I’ve got security personnel that are patrolling the front entrance, the back entrance, and they do rounds around the building itself. And the fact that other tenants don’t have access to your floor, only the people that live on the floor have access to your floor, so I feel more safer that you don’t have random people walking past your door and so forth. So yes I feel in my building I feel really safe”*. Another participant (R11) even emphasises how one was not allowed to live in her previous apartment block in Rondebosch if it did not live up to certain security standards for the protection of residents in the entire block: *“And I think they would always emphasise on people having burglars and I think you weren’t allowed to live in a block if you didn’t have burglar, so you needed some form of burglar-proof something that protects your door or entrance, so that was definitely a requirement and most people had those”*.

Two female respondents, both living in Observatory, state that coming home or leaving the house impacts their feelings of safety and security negatively. Additionally, one of them stresses to feel relatively unsafe when alone in the house, especially at night. R9 stresses: *“But to be honest, as soon as I’m outside my place, I feel unsafe. Like I have been robbed just in front of my place when I was walking one night. So, I would say like literally when I’m not inside my house, I do not feel safe”*. Similarly, R1 observes: *“I do feel safe but the part I’m*

always a bit anxious about is like leaving the house or coming back especially when it's dark you come back and the Uber drops you and they mostly wait but it's like that moment walking into your house or going out that you never know if someone could wait next to the gate and also because there is no electrical fence around my house so people could basically jump over the fence even though you first have to go through the house".

This section provided insights into the state of the problem and offered these insights based on real life experiences from participants, as well as their wishes and needs for feeling safer in their neighbourhoods. The actionable requirements constituting a possible solution can be inferred from the articulated problem and will be discussed in the next subsection, which is the second phase of the DSR method, defining the requirements.

4.2. Define Requirements

This section discusses the results from the second part of the interviews with the study's participants. The section will link the interview findings to the second sub question as presented in the methodology posed in section 3:

"Which requirements should be satisfied by the mobile application prototype in order to enhance citizens' feelings of safety and security?"

This section addresses the application requirements as proposed by the interviewees, with each requirement discussed in a different sub section linking back to the challenges with regards to feelings of safety and security for participants in the study.

During the second part of the first interview, interviewees were introduced to the topic of a smart city. Only one of the respondents identified to be familiar with the concept of a smart city, through reading and consuming information. Participants were asked to imagine a smart mobile application prototype that is aimed at enhancing their feelings of safety and security in the neighbourhood and the wider city, and which functionalities and requirements would have to be present within the application to establish this. Appendix F reflects all requirements resulting from the interviews, the specifications mentioned, and the safety and security challenges each of these requirements relates back to, as proposed in section 4.1.

4.2.1. Emergency panic button

All participants mentioned the presence of an emergency button. How this functionality should function was dependent on the respondent. Overall, most respondents conclude that the emergency panic button should be easily accessible and easy to navigate, as the respondents mention such a functionality would be ideal to use in case of emergency.

The requirement of the functionality that satisfies the possibility to access it easily is captured in a quote from R2: *“I think that I would probably at the top of my head want something like a panic button, something that I can react to really quickly in instances where I am being attacked, or somebody is trying to attack me, or somebody is trying to rape me for instances”*. With regards to the easy navigation of such a functionality because of time constraints in a situation of emergency, two participants come up with the idea of a “hot key” or “assistive touch” which sits on the screen when it is locked. This is captured in a quote from R3: *“I guess basically having an always on function to the app where it’s kind of sitting on your screen whether or not the phone is locked or unlocked so you can press it in a panic situation. Cause the way... You’re not going to have time to always like unlock your phone and you have to go search for the app and do all these things, so to kind of have a assistive touch on an iPhone, something that’s always there and you can just press on as a feature...”*. Another participant proposes a code word functionality that listens only to the person owning the device: *“So you for example choose your own code word and no one else also knows it. And then whenever you use that, or you have to say it twice so something like that, it activates”* (R8).

Among participants, there is no consensus on who should be buzzed once the emergency button has been activated. The range of options includes family members or friends, neighbourhood watch, private security companies, and local police officers. For most of the participants, the signal preferably goes out to the security (community) team nearest to the destination of where the emergency has been reported, so a fast response is guaranteed: *“Depending on which area you’re on, it sends a signal to community safety or police that are in that area, I think that would be the most valuable feature that the app would have”* (R3). R5 says something similar: *“And then also having an emergency button that like sends a signal, or like when someone presses it, they can send a signal to whoever is closest in the surrounding areas to respond”*. Some of the participants interestingly felt that they would not rely on the police to be assisting in case of emergency. The reason for this was twofold; in some cases,

participants felt the police would not have the same sense of urgency, or they felt that police reliability is often not guaranteed.

R8 shares that she also has access to a physical emergency panic button inside the house which has been installed to press in cases of emergency, as common in many houses in Cape Town. The emergency button sends a signal to the local community watch services of the registered house or apartment. The mobile app emergency button could be linked to such physical emergency buttons installed in housing, so it is accessible through the mobile device anywhere and at any moment. Such a functionality relates back to the challenge of time of day, and specifically, a fear of night-time. As discussed in the previous section, some participants mention they feel unsafe coming back to the house and leaving the house: *“But to be honest, as soon as I’m outside my place, I feel unsafe. Like I have been robbed just in front of my place when I was walking one night”* (R9). R3 experiences similar feelings towards feeling relatively unsafe around the house: *“Not closing a front door gate has now led to someone jumping over the fence and stealing the Playstation. So yes, I guess if you kind of make sure you’re properly vigilant about things then it’s safe, but then if you’re not, it’s a double-edged sword”*. In cases like these, an emergency panic button could be of use to participants, both inside and outside the house. This is captured in a quote by R9: *“If I’m thinking about it, because sometimes I just stress and then you’re just freezing so sometimes you don’t have the reflex, but I guess knowing that it is in my pocket and that it can help me I will definitely try to use it”*.

In addition, the emergency panic button solution relates back to other challenges presented by participants as well, including fear of strangers, challenges relating to certain modes of transportation, and feeling unsafe in certain streets and areas. In short, any situation that is causing feelings of unsafety or a situation of emergency caused by any of the challenges presented could be used for activation of the panic button functionality. As stressed by R10: *“If you don’t feel safe at a particular occasion, you click help and then it alerts a security team that patrols in the area to come to your location to escort you to wherever your destination that you would like to reach. So, I think that’s one of the important things”*.

4.2.2. Crime heat map

The second most mentioned requirement for the app is that of a crime heat map. A majority of respondents suggest a community-based map which enables citizens to log incidents and suggests users of the app which neighbourhood not to access and which one to access based on

previously logged information. R2 states: *“I think it would be really helpful, a crime heat map, because some instances you want to go somewhere but you are not necessarily sure what the crime rate is like there because you’ve never been there before. So, I think it would be really helpful and it wouldn’t really scare me”*. A third of participants suggest the logged incidents are filed in a database which are used to make long term algorithms available for safe route planning for citizens, as well as being able to (re)allocate law enforcement resources to those areas identified as crime hotspots in order to tackle and diffuse criminal activity.

Flowing from the idea of a crime heat map is the suggestion for a safe route planning system. Some participants indicate that planning a route in the app can be relevant to avoid certain areas that are associated with high crime and incidents. Participants would be able to enter their destination point and be directed towards their destination in the safest manner, building on logged incidents from the crime heat map.

Such a safe route planning system, building on the crime heat map, could primarily tackle the time of day and mode of transportation challenge faced by participants: *“Like maybe trends can be developed from that, so let’s say all incidents are happening between 10 at night and 2 am, then you’re kind of like it’s just not a good idea to walk at night whether you’re in a group or alone”* (R5). Similarly, R1 stresses: *“If I know if I’m walking through Obs and this one there have been more accidents happening then I would just try not to walk there so I think that’s definitely a positive thing and I think it would be nice also in terms of government data gathering just to know where something happened”*. Further building on the safety challenge relating to mode of transportation, one participant argues a crime heat map could suggest where or not it’s safe to drive and park with a car: *“I think for a long-term thing it’s definitely positive for them to track down if there has been car break in”* (R1). Another participant similarly argues that a crime heat map could tell her which access mode to call on: *“And also provide me with safety access modes to that area. So if maybe using Uber and Uber is not safe, rather just using a MyCiti bus it’s safer that way, then I would rather know”*. Lastly, the crime heat map relates back to the street design and architecture challenge, captured in a quote by R9: *“If I have to walk I would love to see on my way if there is restaurants or bars that are open because I usually prefer to cross that kind of street cause I know there is like life there”*. In summary, participants prefer to know which types of street environment are safe for movement around which they are then able to anticipate on.

The previous section touched upon the impact of community involvement on feelings of safety and security and concluded that participants in the study feel safer when there is a

high(er) level of community involvement and members of the community are looking out for each other. The crime heat map application functionality is said to promote community involvement, while community involvement, according to participants, will also be necessary for successful use and scale of the app. Some participants flag that the heat map is dependent on collecting data of community members and app users filing reports that should eventually be used for analysing large-scale crime data for developing models and algorithms for more efficiently and effectively combatting crime on the long term. As R7 stresses: *“It would also give the police data, as to where exactly to employ and what could be the cause because with the app you can pick up and pull evidence as to where the crime hotspots are, what’s the cause, and then be able to strategize as to how to defuse that situation”*. In short, the crime heat map is then dependent on the community for building a data set of crime data that enables the implementation of the crime heat map.

4.2.3. Community chat room

Relating to the abovementioned requirement is the third suggestion from participants, namely a community chat room. Five respondents mention this requirement as being a valuable addition, enabling the user to speak to people in the neighbourhood or getting updates. R6 stresses: *“People can post updates (...) or if I see something sketchy and I’m just going to ask on the app like “did anyone else see this? I would just like to clarify that wasn’t anything serious”*. R9 similarly emphasises that the use of a community chatroom would make her feel safer: *“So definitely having a chat room where you can speak with your neighbourhood or any people that are around would definitely make me feel safer”*.

As with the crime heat map functionality, the community chatroom functionality is equally dependent on the involvement of the community in order to raise awareness in the community and facilitate the community buy-in for use of the app. This is stressed by R11: *“I think the community would need to be involved in that they need to obviously have a forum to speak about these things that are happening, share information on who’s been mugged and what’s been happening. Maybe like an active forum and also people just sharing their experiences of what they’ve gone through. And not just sharing, but also just information that helps the community in a way”*.

The community chatroom functionality relates back to several challenges presented by the participants. Whether afraid of movement at night, walking alone (relating to modes of

transportation), accessing certain streets or parks, or being confronted with strangers, the application's community chatroom would function as an awareness platform to promote vigilance in the neighbourhood and look out for other members of the community. Among others, R10 stresses: *“So where community involvement comes in, is you're actually getting underground information, so first-hand, where have people actually had the experiences in which areas. So, it gives you that added information, which you usually don't get from reported crimes”*.

4.2.4. Safety resources

A fourth application requirement touches upon the availability of safety resources. Participants mention local police office numbers, rape response numbers, and other emergency contact numbers such as ambulance and police. R3 summarises the current lack of awareness regarding safety numbers availability, saying that *“It's also a typical South African problem of not knowing how to contact ambulances or police or stuff like that in times of emergency. Cause the number that we all use which is 10111 which would take you to the police dispatch is now used for something else, and it's quite confusing. So, to be in a setting where the app would be linked to a, not a distribution centre, but for a lack of better term, to a room or outpost that would then deal with your query would be a lot better”*. Summarising, participants identify that the availability of safety resources will increase the level of awareness among users of the app.

The fifth suggestion for an application requirement is that of a live police map, which is mentioned by 4 of the participants. R1 stresses: *“also obviously knowing where the security guards are positioned on the map will also make me safer because then I know if I'm using that streets like there is a security guard so then I would feel a bit safer”*. Participants here suggest that knowing where police are stationed or where police cars are driving at times of movement, allows participants to remain in the vicinity of police which increases their feelings of safety and security.

The suggestion of safety resources within the application tackle the challenge presented in the previous section of a lack of police involvement and follow-up. Often, people are unaware of the presence and location-specifics of police or channels on how to use them. As mentioned by R1: *“To see where are police stations, or where are those, cause in some areas you have those small little places where guys are sitting and they just check around. So if you walk to Waterfront for example from the city centre you have those small cars or like where*

people are sitting to check if everything is fine so I think that would be nice to see the checkpoints where you know they're safe".

4.2.5. Personal information

The last requirement brought up only by one of the respondents is to have personal information listed on the app that could be accessed in case of an accident: *"If something were to happen to the person like they've falling of their bike, I don't know, they would have all your medical requirements and yeah. And an instant list of who you are, where you are, what you do, like, yeah, and so forth"*.

Concluding this section, an overview of all requirements as resulting from the interviews can be found in Appendix F.

4.3. Design and Development of Artifact

Based on the previous section which defined the requirements for the application, the sketches and first build of the prototype are presented. In order to give a representation of the functions, a use case diagram is developed which is accompanied by use case descriptions.

4.3.1. Use Case Diagram

Based on the requirements as set out in the previous phase, a use case diagram is presented in order to lay out the main functionalities within the mobile application prototype (see figure 7). A use case describes a sequence of interactions between an actor and the system, where the user performs a certain input, and the system delivers a response (Johannesson & Perjons, 2014). An actor is an external user of the system and are not part of the system (Johannesson & Perjons, 2014). For the application presented here, the main actor is the citizen who interacts with the system but is not part of the system, hence it is visualised to be outside of the container. The citizen is considered the primary actor as it is the actor initiating a use case to which the system in turn responds.

4.3.2. Use Case Descriptions

To see how the user interacts with the artifact, use case descriptions are developed. These will later also be used during evaluation phase when the participant is asked to perform a set of tasks to complete with the mobile application prototype and share their opinions regarding perceived usefulness and ease of use of the system in accordance with the Technology Acceptance Model (TAM). The use case descriptions can be found under appendix G.

4.3.3. Sketches

The use case diagram based on participant input for the design of the application is visualised in an initial set of sketches. The sketches are visualised in sketch 1 through 11 in Appendix H. Based on the user feedback during the interviews, five categories were chosen as the main menu functionalities, which include: Safe map, communities, category weights, safety resources and settings. The icons used in the sketches are based on common icons to depict the chosen menu options.

4.3.4. Prototype design

The sketches were designed into the prototype using Sketch software. After completion of the initial prototype, the files were pushed to Sketch Cloud to make it accessible using the following link: <https://www.sketch.com/s/8be43c80-e2fc-4381-bc57-64b8d7f98b64>. Under “page 1”, a user is able to see the different screens. Under “prototype”, the user is able to access the prototype. The first screen, “intro/logo” takes the user to the first screen. Hot areas and buttons are prototyped, taking the user to the next logical screen. In case the user clicks on an area that is not prototyped, the user will be made aware and shown the hot areas they are able to click instead. The final version of the application prototype screens can be found in appendix I.

Concluding this section, the following steps have been conducted to design the artifact:

- Requirements for the design of the application have been gathered in user interviews.
- All potential requirements have been assessed which have returned a selection of requirements for implementation into the design to satisfy participant requirements for

providing a sense of safety and security for Cape Town citizens in the context of a smart city.

- From the user requirements and artifact end goal specification, a use case diagram and use case description of all possible paths around the use of the application has been set out.
- The paths as set out in the use case diagram and explained in the use case descriptions have been used for the development of a set of initial paper sketches, and thereafter used as a basis for the design of a non-coded working prototype of the artifact in Sketch software which was used for demonstrating the artifact to the participants during evaluation stage (see next section).

4.4. Demonstrate Artifact

The question central in this section is:

“How can the developed artifact be used to address the explicated problem?” (Johannesson & Perjons, 2014, p. 133)

In order to answer the above design science question, the research takes the developed prototype and applies it to user stories, using descriptive knowledge on how the artifact works. The user stories lead to the demonstration of the artifact and can be found under appendix J.

4.5. Evaluate artifact

In the previous phase, the research concluded on perceived ease of use and intention to use of the presented mobile application prototype for the participants in the study who resemble the end users of the artifact. The research sub-questions that are central in this section are:

- *Which circumstances should be satisfied for citizens to accept the use of a proposed mobile application prototype for enhancing their feelings of safety and security?*
- *How can the proposed mobile application prototype lead to greater community engagement within a smart city?*

The goal of evaluation is to formalise knowledge about the artifact and investigate unintended effects (Johannesson & Perjons, 2014).

To evaluate the artifact and give an answer to the above presented sub-questions, participants are asked to provide feedback about the artifact in accordance with the Technology Acceptance Model as described in section 3.2.5. According to this model, users are asked to assess perceived ease of use (PEU) and perceived usefulness (PU) for each of the system variables. This is accomplished through assessing the participants with a set of 6 tasks. The next subsections go into the different tasks and how participants evaluate the ease of use and usefulness of the functionalities within each task according to the TAM.

4.5.1. Create account

Generally, all participants interviewed perceived the create account flow as easy to use and user friendly. Some positive feedback points included the existence of a progress bar (screen 6-10). This can be captured in the following quote: *“It is nice to see how far I am with registering. I don’t want to have like ten pages and not know there is ten pages”* (P6). This significantly increases the ease of use, as the user of the application here believes that using the functionality would be free of effort for participants (Davis, 1989).

Other positive comments included the intuitiveness of screen design including buttons. As participant P11 stresses, *“I think everything is pretty clear, it is self-explanatory. The user journey is quite easy, especially for elderly people. Not much complicated language.”* The only feedback on the sign up task with regards to ease of use, which was mentioned by 2 of the participants, is the need for a slightly larger font size of the sign up button on the bottom of the screen (screen 2, 3). These points are gathered and attributed to ease of use feedback implementation.

4.5.2. Set category weights

Overall, participants agree that although the category weights settings are a good addition to the app in order to personalise the safe route system, it does require a couple of changes in order to increase usefulness and ease of use. As for the ease of use, one participant flags the need to change the naming convention for “I feel safe” and “I feel unsafe” in the section *Crime Category Weights* to “Less important” and “Important”, respectively (screen 56, 57). This also relates back to perceived usefulness, which, as stressed by another participant, is that rarely anyone would feel safe with personal crime. This is captured in the following quote from the

interview with P8: *“The first thing is that I see murder, assault, rape, pickpocketing. I would guess I would have to tell the app what makes me feel safe and unsafe and how much. My first thought that comes to mind is I don’t feel safe with any of those things so... But I do understand why you have to slide the button but I don’t think anyone would feel safe.”* This leads to a negative feeling towards perceived usefulness, as participants would likely mark all categories as “feeling unsafe”.

With regards to the Movement Weights, all participants see the significance for setting these categories in order to plan a personalised safe route (screen 57). A few tweaks are suggested, which includes the need for more transport subcategories.

4.5.3. Start safe route

Perceived ease of use is satisfied amongst participants because of the intuitiveness of the user interface as it resembles the look of google maps (screen 25 – 28). This is summarised in quotes by P8 and P11: *“It looks organised, it looks like a good map, it looks a bit like a city explorer app”* and *“the steps were easy, it is like a normal GPS”*. In order to improve ease of use, one of the participants suggests changing the wording of the Safe Map for users that are not familiar with the pin icon resembling a map or routing system: *“So I suggest maybe tweaking the turn, “start safe route”. Maybe Start Route or Start Safe Map, something very, yeah. Because I am just trying to think for someone that is not quite familiar with the icon... doesn’t know what safe map means”* (screen 25 – 31).

With regards to perceived usefulness, one of the participants notes that *“I would mainly use it at home or when I am in a bar or anything like that. Just to check the areas a bit, I am not sure I would actually use it in a situation where I am unsafe, or if I think I might get robbed or if I’m in a street where I think people might rob, because I don’t want my phone to get stolen”* (P8). Later on in the interview, the same participants notes that *“I think I could use it but just to plan routes maybe... It depends where I am going, if for example I am out on my bicycle and it is getting dark or becoming a little bit more dark and I think I could cycle home, then I think I would use it. Or if someone asks me about it “do you think it’s safe there” then I would say well you can also use this app.”* Summarising these quotes, the usefulness of the application when in situations of danger is addressed. The above quotes from participant 8 indicate that users are not yet sure whether they will use the application in situations of danger. This is also highly related to the easy access to the panic button as will be described in

subsection 4.5.7. Regardless, users are positive regarding the usefulness of the app as an exploration method, when investigating the safety in a neighbourhood and communicating to co-community members, friends or family about it.

4.5.4. File and search incident reports

4.5.4.1. Filing incident reports

All participants perceived the ease of use and usefulness of the filing an incident report to be a positive experience (screen 20 – 24). Participants feel that all important fields are covered in order to file a complete report (20 – 22). One participant (P8) mentions the ease of use of the location functionality, where the user is able to pin the exact location without having to know the address of where the incident happened, which the participant stresses would be a common situation.

In order to further increase usefulness, participants mention it would be beneficial to have the option of requesting psychological assistance after having filed an incident report would be beneficial (screen 24): *“What I also think would be nice now is if the makers of the app can contact you to ask questions about the report or if there is an option if you want to talk about it and you can see numbers to call (...) and just like a check like someone can really be not okay, or someone could be like yes I just saw someone pickpocketing and I’m fine”* (P8).

4.5.4.2. Searching incident reports

Participants were also asked to evaluate the incident reports available on the safe map. Overall, all users perceive the incident reports on the map to be self-explanatory and easy to navigate (screen 14 – 16). In order to increase ease of use, one participant (P11) suggests changing the colour of the pin and the layout of the incident report box from purple to red, as red signifies danger: *“Not the whole box but the actual icon, where the pins are, because it signifies danger, something like that. Yes also in line with the SOS. And also make the outline, the actual box, red, maybe. I don’t know, just a suggestion, the incident in red”* (screen 14). Another user suggests to add a headline to each report with “keep aware”, making sure users are aware of the incident ahead.

Increasing perceived usefulness could be realised, according to participants, by adding a filter on date, so only recent reports can be filtered (screen 16). This would also make sure that users are not constantly reminded of crime. This is noted by participant P8: *“I think seeing all the crime for myself would also not make me feel so much more safe so I would try to check it out but if I would notice I am avoiding streets because of the number of crime that happened then I don’t know if I would continue using it in that way. Then I would just have it to file an incidence.”*

4.5.5. Accessing (new) communities

During the first round of interviews, where participants were asked to share their experiences with regards to feeling safe and secure in their neighbourhoods and coming up with mobile app requirements to increase those feelings, communities were a central topic in influencing these feelings of safety. Within the application, communities take on a central role, and different functionalities available in the app relate back to the communities overview.

In terms of perceived ease of use, two participants suggest the need for adding a date filter for filtering out more recent reports, instead of trying to find recent reports by manually having to go through them (screen 45 – 50).

In evaluating the communities functionalities within the prototype, participants are asked to assess the perceived usefulness of the communities section for the benefit of increasing community engagement. Screen 35 to 51 are evaluated. Participant P11 notes: *“I think it is great because you have people who are actually living in the community and it gives you a general feel of which places to go and which places are safer because sometimes reports might not necessary be reported on the actual app, but someone who is part of the community is generally like this and that in this area so look out, basically.”* Hence, this participant notes the benefit for community engagement from the use of the application. Another participant (P4) notes: *“If you sell it in the Atlantic Sea Board and stuff, rich people will buy that. They would want to have it in their communities, you know. As an extra safety measure. Because it could be so far away from anything and you just want to click the nearest person. When there is a robbery in your house and stuff, you know, those are like quick and easy apps to have and it alerts everyone in the neighbourhood of what is going on. Maybe someone that is next door could be a police man or a doctor, so it is kind of cool like that. A community-based app.”* One of the other participants notes that the application could replace the general neighbourhood

WhatsApp groups: *“Yes, it would be good for the neighbourhood, because not everyone gets added to the neighbourhood group, or not everyone has a neighbourhood group, it is just good to see what’s happening around you and if you are safe where you are staying or not. It is very user friendly, I think it would help a lot more. Especially with the safe routes when you are walking. I don’t want to walk into a crime scene”* (P6). When asked to elaborate on the usefulness of the app in relation to community engagement, the participant notes: *“If something does happen in the neighbourhood, you can post it in the group and say “keep an eye out for this guy, he stole my phone.””* (P6). The participant links the community function in the app to the emergency signal and notes: *“With the chat room you will get to know everyone, and maybe someone will help you if you’re in the area. And they will be faster response than the cops, especially in South Africa”* (P6). One participant shares a negative note on perceived usefulness which relates to anonymity of profiles within the community and levels of trust. She notes: *“If I am talking in my community chat what if someone has a fake profile and is just checking out what people are saying?”* (P8). A suggestion mentioned is the need for a new user profile scan by the app administrators. Alternatively, profiles could be linked to other social media profiles of a user to ensure the profile is real.

4.5.6. Add and dial safety resources

For both perceived ease of use and usefulness, participants mostly gave positive feedback. In terms of ease of use, points brought up include the significance of a personal safety resources folder and an instant dialling option (screen 32 – 34). Furthermore, one participant notes that the colour of the safety pins being green is a good pick and user friendly, as it signifies safety (screen 32, 33). For increasing usefulness, participants suggest an option to receive tips on how to feel more safe and secure in the neighbourhood (screen 39 – 41). This is supported by the following quote: *“I find the longer I have stayed in Cape Town the more safer I feel, because I get to know Cape Town, I get to know myself in Cape Town so like I felt more unsafe first because people told me it is dangerous, but now it feels more at home and I know the unwritten rules, be confident when you walk, keep your phone close to you. How do I say it... sometimes if someone approaches you, you don’t have to stop, just cross the street or... I feel also, I don’t think about the crime as much anymore because I feel more safe and that is because of the people that I know that live here. So I think some general tips on how to be more safe would really help as well because I think that would be very important”* (P8).

4.5.7. Send emergency signal

As discussed in the define requirements stage of the design method, the application would facilitate a quick access emergency button, with which a user can send an emergency signal while the mobile device is in a locked stage. During the evaluation interviews, participants were made aware of this, as such functionality cannot be presented in the prototype.

Participants reacted positive to the emergency button options (screen 14, 59). One of the participants notes: *“I am clicking the SOS icon, you’re about to send an emergency signal. Send to all current users in the neighbourhood and the fastest respondents... send signal. Yes. It is good to send before it sends out you have a prompt, your pop up notification that you have right now. To confirm”* (P11). On the contrary, another participant notes they would not read the prompt when in an emergency situation so suggest to instead tell users to hold the emergency button for 5 consecutive seconds.

Summarising, this final subsection of the results section takes the most important feedback points from the participant evaluation interviews and uses these for implementing changes to the mobile application prototype to satisfy the user needs as presented in the above subsection 4.5.2. An overview of the feedback points, applied to Davis’ Technology Acceptance Model from figure 6, can be found in table 8. The feedback changes applied to the prototype can be accessed through the following link to the Sketch Cloud: <https://sketch.cloud/s/e38530a1-9847-40c0-adc6-c6e428643fa7> as well as in Appendix I. In addition, table 9 offers insight into the proposed application prototype functionalities comparing them to functionalities in existing mobile apps with a similar purpose of enhancing perceived feelings of personal safety.

SYSTEM VARIABLES	PERCEIVED EASE OF USE	PERCEIVED USEFULNESS
Accounts	- Increase font size of sign-up button	
Category weights	- Change naming convention on slide bar ends	- Remove crime category weights from view - Add more subcategories to movement weights - Add a user explanation as an introduction
Safe routes and crime map	- Amend the menu wording - Change the colour of the pins to red	

Incident reports	<ul style="list-style-type: none"> - Change the colour of the pins to red - Add a filter for finding recent reports 	<ul style="list-style-type: none"> - Add the option to upload picture in incident report - Add follow up button options after submitted report - Add a date filter to minimise exposure to previous crime reports
Communities	<ul style="list-style-type: none"> - Add filter for finding recent reports 	<ul style="list-style-type: none"> - Add “report user” option - Add scan profile functionality for new profiles
Safety resources		<ul style="list-style-type: none"> - Add “tips and tricks” section for feeling safer - Start personal chat with community user
Emergency buttons		<ul style="list-style-type: none"> - Offline emergency signal option

Table 8: Application feedback according to Technology Acceptance Model

Feature/Use Case	Research App	Namola	MySAPS	Life360	BullHorns	Safe Community App	MySOS	bSafe
Log in/sign up	✓	✓	✓	✓	✓	✓	✓	
Log Incident	✓		✓		✓	✓		
Safe Route	✓							
Personal Safety Resources	✓		✓					
Community Room	✓					✓		
Emergency Signal	✓	✓		✓	✓	✓	✓	✓
Private Armed Response	✓	✓			✓	✓	✓	
Response from community members	✓					✓		
Response from trusted friends/family	✓	✓		✓	✓	✓	✓	✓
Live GPS tracking and sharing	✓	✓		✓		✓	✓	✓
Ambulance Services		✓						
Live streaming of incident								✓

Table 9: Application prototype functionalities compared to existing personal safety apps in South Africa

Section 4 addressed this dissertation’s findings. Using the Design Science method, the research found user insights through user interviews and designed a solution based on the findings. It first gathered information on the needs and values of users, after which the research clearly defined the objectives. Continuing, different ideas were gathered through user interviews after which the feasible and viable ideas were filtered out for development and testing. Through an iterative approach, the artifact was reviewed, refined and retested as a last step in the DSR process.

Concluding the research, it must be compared with existing literature and theories in order to generalise an outcome that could be shared with relevant audiences. This will be done in the next section, in which the proposed artifact is evaluated in the context of previously discussed existing literature, and compared with existing artifacts of a similar nature.

5. Discussion

This study obtained insights on how participants in the study perceive the prototype to be able to address their perceived fear of crime or how the prototype is likely to assist them in their personal safety. Previous research has shown that issues relating to safety and security and fear of crime negatively impact urban life for citizens, and several studies suggest that improving the social engagement within communities might alleviate such issues (Blom et al., 2010; Kadar et al., 2016). To strive towards a city that is perceived safer by citizens, this research offered an alternative perspective that takes on a user-driven approach for developing a smart mobile application prototype according to the Design Science Research method with the aim of increasing feelings of safety and security. The study taps into Cape Town's high mobile phone penetration rate and existing local government's initiatives for building on smart pillars by proposing a mobile application prototype for citizen use. In doing this, the study places participants, who are in turn Cape Town citizens, at the front of the analysis and development process.

5.1. Addressing the sub-questions

The secondary research questions as presented in the methodology are used to structure the discussion section and give answer to main research question which will be addressed in the conclusion in section 6. The next subsections link each of the secondary research questions to existing literature in order to uncover how the use of a 'smart' community-based and crime-focused mobile application prototype can influence feelings of safety and security for Cape Town citizens.

5.1.1. Safety and security-related challenges

The design science research method used in this study aimed to address the explicated problem of participants experiencing challenges with regards to feeling safe and secure in the city. With the first sub-question posed in the study, the study aimed to explore the reasons for the existence of explicated problem. The sub question to address is “what are the safety and security related challenges experienced by the citizens of Cape Town?” The research found that participants feel unsafe in various situations and circumstances.

Firstly, the study found that interviewees feel more unsafe during night time. This is due to a lack of visibility, quitter surroundings and an increased feeling of vulnerability. This finding is supported by existing literature which have addressed the increased fear among citizens during the night. Most of cases are paired with situations in which the citizen is a pedestrian and female (Blom et al., 2010; Bennet et al., 2007). In addition, fear of night time is induced when combined with fear of strangers, quite places and traveling by foot. This research found the same, which is addressed in the below paragraphs.

Secondly, the study found that participants feel more unsafe when walking, because personal space can be compromised and there is an increased feeling of becoming a victim of attack or mugging. For women, the study found that walking lessens the feeling of safety, both during day and night time, because of the fear of potential crimes that could be committed against them. Literature supports these findings, revealing that women experience a higher victimisation risk than men for rape and sexual assault-related crimes, leading to increased fear of crime among women in urban spaces (Tandogan & Ilhan, 2016; Snedker, 2015). Walking is especially perceived unsafe when done at night, which can be seen across various cities worldwide where safety for women is compromised during night hours (see Tandogan & Ilhan, 2016).

In addition, the study found that the use of public transport or taxi services can also be a factor contributing to feeling unsafe, especially when traveling alone and traveling at night. Citizens are forced to walk or use public transport when not in possession of a car. South Africa has reported having 165 car owners per 1000 citizens, bringing car ownership in the country to be relatively low (Registered vehicles data by country, 2020). In effect, citizens are increasingly forced to find other modes of transportation such as walking or the use of public transport, which feed into increased feelings of unsafety as explained above.

Thirdly, participants highlighted fear of strangers in contributing to their challenges towards feeling safe and secure. The study found that this fear of strangers is partly fed by negative stories around crimes committed to citizens by strangers and the knowledge regarding

high urban crime rates in Cape Town. In addition, the study revealed that female participants stressed the fear of (groups of) men when walking alone because of an increased feeling of vulnerability and powerlessness. The findings mentioned above are supported by literature. Feltes (2003) stresses that this fear comes from “unfamiliar strangers behaving in an unusual way [who] are particularly likely to trigger distrust and fear” (p. 24). Blom et al.’s research found that the presence of a male that is not known to the citizen drives a strong fear due to the senses being invasive (2010). Snedker notes females experience increased fear of crime when encountering men in groups (2015). Lastly, research shows that women seem to feel increasingly unsafe around male strangers because of their reduced possibility of being able to defend themselves (Chui, Cheng & Wong, 2012).

Fourthly, this study revealed that participants feel unsafe in spaces where there is a decreased possibility for refuge, such as when navigating through narrow streets. They stress that open and visible areas, greenery, cleanliness of streets and spaces and sufficient artificial lighting contribute to a feeling of safety. This finding is backed up by several studies, such as one conducted by Tandogan and Ilhan (2016), who stress that especially women feel the most unsafe when they are alone at night, in isolated and quiet streets, dark subways, empty parks, poorly kept urban spaces and when wearing short skirts and décolleté. As a suggestion for addressing such safety challenges, previous literature on smart cities found that the use of artificial lighting and cameras on the street, as well as the presence of restaurants and bars contribute to a feeling of safety (Tegenlicht, 2016).

Lastly, the study unravelled that there is a lack of trust among participants in the police system. Participants experience a lack of police follow up after incident reports have been filed. Furthermore, the participants feel their safety and security is not safeguarded enough in the city, because in many neighbourhoods there is a lack of police presence and police patrolling. The study’s findings into the lack of participant trust in the police system could not be linked to existing literature as this is currently an under researched topic, though very important to get a better understanding of the needs of citizens with regards to police action towards combating crime. As discussed in the literature review in section 2, Cape Town is home to 7 out of 10 worst performing SAPS stations in the country, begging for more research into the effectiveness of policing in the city which could ultimately contribute to increased feeling of safety and security among participants. As a first step towards more research into policing policy effectiveness, the study found that participants are concerned with the socio-economically skewed law enforcement policies in place in Cape Town. They voice that police-

presence is guided by privilege, pointing to a presence of police and private security in upper to middle class suburbs and a lack of presence in lower income areas like the township areas. Literature supports this finding. An annual report by Social Justice Coalition from 2015-2016 shows that imbalanced resourcing in Cape Town is indeed evident, showing that within the 5 best police resourced precincts in Cape Town there are less than 400 murders per 100,000 citizens over 4 years, compared to 1800 murders in the 5 worst police resourced precincts (Social Justice Coalition, 2016). Concluding, more research must be conducted into the trust in the police system in Cape Town from the perspective of citizens, to move towards a mutual beneficial smart and safe city that is built on urban technologies and human experience.

5.1.2. Requirements for enhancing safety and security

The second sub-question to address is “which requirements should be satisfied by a mobile application prototype in order to enhance citizens’ feelings of safety and security?” The requirements proposed by participants have been uncovered in the first round of interviews and give an answer to how the explicated problem can be addressed through implementing these features in the mobile application prototype. This study aimed to place citizens, the participants in the study, at the front of requirement analysis and development process, in order to drive a smart city application that focuses on citizen engagement and social innovation.

The study found that the most important requirement for the application as voiced by participants is the presence of an emergency button that can be quickly and easily accessed. This finding is supported by literature, as various studies touch upon the use of mobile services in harnessing safety and the importance of a silent signal to be sent out to police, which is one of the most echoed wishes (Blom et al., 2010). Such signals should be easily accessible, as phone calls are argued to be too obvious and take more time, hence sending a signal with GPS location to authority is a widely proposed solution (Blythe et al., 2004; Yu, Lymberopoulos, Teixeira & Savvides, 2008). Existing personal safety apps as presented in table 9 show that most apps focused on personal safety also include the option for sending an emergency signal. In all but one case this is done using the application. In one case, this is done using an external device. In this respect, the application prototype follows existing applications.

This study provided more insights into this by revealing that ideally, the panic button should be accessible when the phone is locked which can be accomplished when the prototype is built into a working mobile application.

In terms of the destination of the signal, various literature suggests the signal to be sent to community members or family and friends (Yu et al., 2008). Existing personal safety applications mostly use trusted family and friends from an “inner circle” to be the destination of the emergency signal (table 9). This research carefully evaluated the destination of the GPS emergency signal based on user interviews, and proposed something similar, where community members take on a central role as the first point of contact for emergencies in the community-based application. Interviewees stress the importance of having the community engaged in the mobile application prototype, because the success of the mobile application is dependent on community buy-in. This finding finds support in other studies, such as the study by Ariffin et al. (2014) which observes that communities actively use online platforms to share information with co-members with a similar interest, with crime being one of those popular conversational topics. Looking at the existing personal safety apps, it is seen that only one other app from the comparison list in table 9 put the community in the centre of the application by allowing users to chat to community members. This is the Safe Community App. This prototype takes it one step further, by enabling the possibility to look up safety tips, view logged incidents and submit their own incident reports. What must be considered here however are the ethical implications for filing incident reports directly to law enforcement. The implications of such a functionality must be discussed with local and national law enforcement as well as researched extensively which could be a suggestion for future research.

Additionally, the study found that for the application to be successful, an important requirement is the implementation of a crime heat map from which users can view previously logged incident reports on a live map and start a safe route based on their personal wishes and needs. The safe route is calculated based on previously logged incidents on the route in combination with the personal category weights set by the users. The finding presented here is used only to a limited extent across similar personal safety mobile apps. Table 9 shows that only the Life360 app offers the possibility to plan a safe route based on previously reported crimes in the neighbourhood, and in this respect the prototype from this dissertation is again close to unique, as with the community-focused aspect presented above.

The study addresses a logging incident system as another unmissable feature according to participants. The incident reports are mapped for use of the safe route functionality, and additionally available in the crime heat map and communities maps. Apart from logging and accessing previous reports on community crime, this study did not further research the possibility of filing app-based incident reports directly to official instances like Cape Town

police services. Half of mobile applications from table 9 also include the possibility to log incidents. Several participants interviewed in the study noted the possibility for interlinking incident logs with police crime data but also voiced their lack of trust in the police system and doubted whether their personal data about crimes would be safe. Literature suggest that keeping citizens informed about crime incidents will provide them with knowledge to be more careful navigating through their neighbourhoods (Ariffin et al., 2014). Literature into different smart crime-based mobile apps has found that a functionality where users are can request help from police by filing an official report after the application incident report has been submitted has proven successful (Ariffin et al., 2014). If used carefully, the available data could then be used to analyse city crime data over longer time periods and create algorithms for the benefit of predicting and diverting crime (Wallace, 2009). This could potentially be relevant for the case of Cape Town, as Cape Town is currently the homicide capital of South Africa, with a homicide rate that is six times higher than the global average (Jabar et al., 2019). As previously noted, Western Cape crime rates are among the worst in the country and continue to have the fastest growing crime rates when it comes to murder, assault and property crime (STATSSA, 2018). A better crime data analysis system could aid Cape Town authority and police departments to better tackle crime which could ultimately give citizens increased feeling of safety and security. As participants in this study stress their lack of trust in the police system and whether their personal crime data would be safe, we suggest more research to be conducted in researching the effectiveness of current policing in Cape Town as well as citizen's (lack of) trust in police bodies in order to get an understanding of the wishes, needs and possibilities of more effective policing for the benefit of citizens.

5.1.3. Acceptance of the mobile application prototype

The second sub-question to address is “Which circumstances should be satisfied for citizens to accept the use of a proposed mobile application prototype for enhancing their feelings of safety and security?” The evaluation of the artifact phase aimed to uncover participants’ willingness to use the proposed mobile application prototype. The study found that participants predominantly believe that they would use the mobile app in real-life situations as it would most likely increase their feelings of safety and security. Participants stress the willingness to use the application because it is built on data from community input. Literature recognises this notion which has become known as crowdsourcing, where information gathering is now done

by people sharing their knowledge and information on the internet with the help of technologies, as opposed to the traditional method where information was gathered by organisations and professionals (Ariffin et al., 2014). Crowdsourcing efforts in the context of crime-based mobile applications have proven successful in increased feelings of safety and reducing crime (Mancini & O'reilly, 2013). The study further found that participants would be even more inclined to use the application if there is a possibility for police follow up and psychological assistance after serious crimes. However, they also primarily stress their current concerns with regards to the lack of police follow up after an official incident had been reported. Therefore, future research could be conducted into bridging this gap between citizens' wishes and police system processes, which will be further addressed in section 6.3.

Looking again at table 9 presented earlier in this study, the prototype offers a combination of capabilities that are unique compared to the current availability of personal safety apps in South Africa, while keeping user friendly and easy to use according to participants. Looking at table 9, this prototype offers functionalities that are rarely seen in other applications, including the possibility to add personal resources, plan a safe route based on previously filed crime reports, and the focus on community involvement and crowdsourcing. The latter is considered an important requirement by the participants in this study for the application to be successful. The possibility to engage with community members, share knowledge and call out community members during emergency is what separates this application from others in the field.

The study identified several use and access constraints of the mobile application prototype emerging from the results of the stakeholder interviews, which have implications for the acceptance of the mobile application prototype. These constraints are summarised in table 10. Firstly, the study identifies access constraints, including a lack of data, connection issues, age gaps and application cost implications. Several of these constraints are echoed by existing literature. For example, Odendaal (2006) explains the broadband connectivity in South Africa is limited in many neighbourhoods, especially towards the outskirts of the city. In effect, it could be difficult to propose the use of the mobile application prototype at hand to citizens from the wider areas of Cape Town. Although this implies a reduced acceptance of the mobile application prototype, existing literature also stresses that increasing effort has been going into ensuring connectivity in all parts of the cities in South Africa at more affordable rates (Odendaal, 2006).

Another type of constraint with an implication for the acceptance of the application relates to use constraints. An important one here is that accessing the panic button inside the mobile application prototype might not be top of mind in a situation of emergency. Several studies have researched the use and application of an emergency access button, both in private sphere and the health care sector such as hospitals. Ride-hailing company Uber, for example, introduced an emergency button within their app which riders could easily access to automatically send the rider's information and location to 911 dispatchers (Snider, 2018). Although this could not be prototyped, the artifact presented in this study aims to have the emergency button additionally available when the mobile phone is locked to make sure this constraint is properly addressed, and the panic button is always accessible to users.

The last type of constraint with potential negative effects on the acceptance of the application are constraints that compromise user profiles. Interviewees have voiced concern regarding the trustworthiness of co-users of the app and possible bad intentions some people might hold. To tackle this constraint, the study suggests that when building the actual mobile application prototype, user profiles are linked to existing social media profiles to ensure the profile is real.

CONSTRAINTS	CONSTRAINTS SUMMARISED
Use constraints	<ul style="list-style-type: none"> • Phone might be the thing in danger of being stolen in a situation of emergency • Getting phone to access app is not top of mind in a situation of emergency • Application would require sensitive personal information • The application would only work if there is a high community buy-in
Lack of access	<ul style="list-style-type: none"> • Connectivity issues • Lack of availability of people during outgoing emergency call • Lower income communities might not have access to smartphones or data • Lack of space for downloading an application • Older generations have limited access to smartphones and apps
User compromise	<ul style="list-style-type: none"> • Safeguarding access to the app is difficult to control and criminals could mislead the app and data available on it to their advantage • Corrupt police could use the data available on the app wrongly

Table 10: Constraints to the mobile application prototype voiced by participants

5.1.4. Community engagement because of a smart mobile application prototype

The fourth and final sub-question to address is “how can the proposed mobile application prototype lead to greater community engagement within the smart city?” Answer to this question is given based on the provided information from participants during the first and second round of interviews. The study found that participants feel most confident about co-members of the community assisting in the case of an emergency as opposed to the police or friends, because there is a lack of trust in the police and friends or family contacts could likely not be in the neighbourhood. Provided there is a large community buy-in, the app would be used by a large number of people and in effect, the likelihood of an active community member being in close vicinity of where an emergency signal is being sent is also high. The research further found that participants believe community engagement and social cohesion within the neighbourhood have a positive effect on feelings of safety in the neighbourhood because it shows a member can rely on the neighbourhood and to help you when in need. The community chat room is necessary here to play a central role in facilitating communication and awareness between community members.

How, then, can the proposed mobile application prototype lead to greater community engagement within the smart city? Previous research has shown that crowdsourcing, where information gathering through the internet is done by individuals, is often very successful because technologies that are based on crowdsourcing show to have an overwhelming participatory crowd (Domdousis et al., 2016; Ariffin et al., 2014; Mancini & O’reilly, 2013). Studies in Latin America and Brasil have shown that mobile applications using crowdsourcing related to crime prove successful in reducing the number of crimes in those areas (Mancini & O’reilly, 2013). The applications addressed here use a similar functionality where incidents are alerted to co-community members in the near vicinity (Mancini & O’reilly, 2013). This study’s proposed mobile application prototype makes use of the same crowd-sourcing methods for collecting crime-based data. Community members in the research have addressed their confidence in a large community buy in which could lead to the use of the mobile application prototype having a snowball effect for participation, for the purpose of feeling more safe and secure in the neighbourhood with the help of the community, and therefore the dissertation concludes that the smart mobile application will have a positive effect on community engagement.

6. Conclusion

The final section summarises the concluding statements and gives answer to the main research question. Thereafter, the limitations of the study are discussed and suggestions for future research are made.

6.1. Addressing the research question

This study attempted to address the following research question: *“How can a ‘smart’ community-based crime-focused mobile application prototype influence feelings of safety and security for Cape Town citizens?”*

The purpose of this research was to take a narrow look at smart-community developments of a city that is marked by high urbanisation rates, high crimes rates and a history of colonisation and apartheid legacies. Given these characteristics, there is a need to look at ways of growth which include facilitating a safe and secure city for citizens. This study took Cape Town as its case study. Cape Town local governments and private companies have been deploying smart city initiatives as part of the City Development Strategy and the Integrated Development Plan. However, crime is persisting at alarmingly high levels and substantial effort needs to be put into Cape Town smart and safe city planning (Loideain, 2017). The study aims to contribute to research by sharing results that are relevant to apply to cities on the continent with similar urban characteristics and developmental traits to expand knowledge on smart city developments across the African continent. In doing so, this research took on a user-centric approach aiming at addressing, understanding, and detailing the needs and wishes of citizens with regards to fear of crime and feelings of safety and security in the context of a smart city.

Addressing the research question involves several aspects. Citizens must actively be involved in addressing smart-community solutions for the benefit of increasing the quality of life for citizens, which is one of the main objectives of the smart city (Albino et al., 2015; Alam & Porras, 2018; Kloppers, 2016). This research accomplished this, giving citizens a central role in the problem description, requirement analysis and evaluation of the mobile app.

The research found that the development of a smart community-based crime-focused mobile application prototype has a serious potential of positively influencing feelings of safety and security of citizens in the city. The application should make it possible to send emergency signals to community members when help is required and have safety resources available to

make calls in several situations. As community members often already use Whatsapp groups for communication, and community members further voice that a feeling of cohesion within the community enhanced feelings of safety and security in the neighbourhood, the application could further benefit from a community chat room and access to crowd-sourced crime-related information on previously logged incident reports in the area. Before suggesting such prototype functionalities, however, law enforcement must be interviewed and included in the requirement engineering before such implementations can be made. Additionally, requirements include the addition of a map and planning service that is customisable for each user which can be used to explore different neighbourhoods in a city and suggest levels of safety in each of them.

For the application to be successful, there is a need for community buy-in on a large scale, as the application is only argued to work when there is a large group of users to rely on for building a crime database and helping community members when in need. The application should be easily accessible, both in terms of quick access to the emergency signal as well as accessibility in terms of pricing, data, and connectivity, so it can be used by members from all types of communities in the City of Cape Town.

However, most importantly, this research found that facilitating more safety and security for Cape Town citizens through the mobile application prototype is a first step in aiding citizens in being more informed on the levels of crime in the neighbourhood and share thoughts with different members related to safety. To further build on a smart and safe city, the research found that more attention must be paid to tackling crime, researching the police systems in the city, and investigating the nature of the lack of trust in the local police systems by participants in this study. Existing literature shows, which is backed up by ideas from participants central in this study, that the crowd-sourcing mobile application prototype solution could be used for wider analysis of large-scale crime data for crime detection and prevention. This could lead to trust-building between community members and the policing system. Research further shows that involving citizens in effective policing efforts is assumed to be socially beneficial and leads to better social service transparency (Karreth, 2019). This research accomplished to investigate opportunities for community-based efforts that use crowdsourcing and sharing crime-related information with citizens to reduce fear of crime and enhance feelings of safety and security.

6.2. Limitations

The research identified a few research limitations. Firstly, due to time and resource constraints the mobile application prototype could not be built into an actual working software application. The implication of this limitation is that testing the different functionalities of the application and its effects on promoting safety and security in the city are less reaching. Secondly, again due to time and resource constraints, the study only included neighbourhoods from the inner parts of Cape Town in its case study for research and analysis and excluded the wider areas of Cape Town which include the Klipfontein District, Helderberg, Northern Suburbs and the South Peninsula. Additionally, the number of interviewees interviewed in this study is considered a research limitation, as it does not reflect the city of Cape Town's population, and the research could have benefitted from a larger pool of interviewees if resources and time would have allowed it. Furthermore, law enforcement and government representatives were not interviewed for this study due to scope limitation in which the research only chose to focus on the citizens, who are the end user of the prototype. This is mentioned as a limitation, because conducting these interviews with additional stakeholders would allow to get a full understanding of the smart-city ecosystem. Lastly, a limitation of the study can be identified relating to data connectivity and accessibility. Although mobile phone penetration is high across the continent and access to Internet is rapidly expanding, also in Cape Town, citizens are currently dealing with limited access to data because of the high costs as well as connectivity issues, especially in the outskirts of the city. This reduces the availability of the application to all citizens in the city and has a negative effect on large-scale community buy-in, one of the requirements of success for the application.

6.3. Suggestions for future research

Emerging from the first limitation addressed in the previous subsection, future research could focus conducting large-scale interviews with citizens from all suburbs and neighbourhoods in Cape Town, to get an understanding of their wishes and needs. In addition, future research on the topic could focus on performing interviews with all smart city stakeholders including local government and municipalities, to get an understanding of the smart city plans with regards to a safe and secure city. Results of these interviews should focus on alignment between citizen wishes and needs and municipal and local government plans to identify the gap between

stakeholder interests. This will drive a mutual beneficial smart and safe city that is built on urban technologies and human experience. Future research should furthermore focus on linking logged incidents to law enforcement crime databases to analyse large scale crime data and tackle crime issues more efficiently going forward. However, research must look into the ethical implications of citizens filing their own crime reports and how the data that is transferred to law enforcement must be handled. Lastly, as participants voiced their concern with regards to the police services and trust in the system, wider stakeholder interviews with local government, municipalities and law enforcement are advised. Lastly, further research on this mobile application prototype in the context of the safe and smart cities should focus on building the app, so it can be tested on a large scale.

7. References

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8. Appendices

Appendix A: Current mobile applications safety apps in South Africa

APP	URL	DESCRIPTION
Namola	https://www.namola.com/	A mobile application allowing users to track their GPS signal and send their live location to friends/family. People can research smart alerts when a loved one starts or ends a trip and monitor the trip. When response is requested through sending a signal, Namola calls to confirm details and dispatch help through the Namola community, private response or Emergency Services.
My SAPS	https://apps.apple.com/za/app/my-saps/id1478487910	My SAPS is a mobile application developed by the South African Police Services and allows users to anonymously report suspicious behaviour or crime, as well as finding near police stations and contact SAPS through social media. The app aims to facilitate easier communication between law enforcement and citizens.
Life 360	https://www.life360.com/intl/	Mobile application that allows users to create a private Circle, add most visited locations by members in this Circle, and get notifications when the members leave or arrive at these locations. App also offers easy navigation to Circle members location and receiving driver reports.
Bull Horns	https://bullhornsapp.com/	Panic button app allows users to notify personal contacts and private security company services and receive call-out response instantly and silently. The application further allows to report crimes in the user's neighbourhood.
Safe Community App	https://www.safecommunity.co.za/	An application that allows users to communicate with inner circle and community members active on the app, as well as participate in Community Police Forums, Neighbourhood Watches. And private security companies. Users can report neighbourhood crimes, chat with members, activate S.O.S. response, and customise notifications in their personal center.
MySOS South Africa	https://mysos.co.za/index.php	Mobile application accompanied by a wearable panic button that allows to send signals and notify emergency contacts of live location. Allows users to choose the nature of the emergency.
bSafe	https://www.getbsafe.com/	Mobile application that allows user to activate S.O.S. signal using only their voice and sending radio alarm with live GPS location to friends or family. The friends and family can follow what happens through real-time live streaming

Appendix B: Interview Protocol – Interview Round 1

INTRODUCTION	
<p><i>Goal:</i> Gain an understanding of participants experiences, wishes and needs with regards to feelings of safety and security in the city and how they could be enhanced through the development of a prototype.</p> <p><i>Recording:</i> Audio-recorded for the purpose of the study</p> <p><i>Informed Consent:</i> Interviewees signed consent form prior to the start of the interview</p>	
PART 1: GENERAL INFORMATION	
Questions	<ul style="list-style-type: none"> • What is your name? • What is your age? • What sex do you consider yourself? • What is your self-declared race? • Which citizenship status do you hold? • In which neighbourhood do you live? • What is your employment status? • Where do you work? • How do you travel from home to work? • How long does it take you generally to travel from home to work? • Do you have access to a private mobile phone? • Do you have access to the Internet?
PART 2: EXPERIENCES	
<p><i>Goal:</i> Identify the lived experiences with regards to feelings of safety and security in the city and/or neighbourhood</p>	
Spatial	<ul style="list-style-type: none"> • When do you feel safe or unsafe in your neighbourhood? • What make you feel more or less safe? • Which challenges do you face in relation to safety and security? • When assessing safety, what connection do you make with your own living environment? • How do you perceive community engagement in your neighbourhood? • How could community engagement affect your perception of safety and security in the neighbourhood? • How do you value the safety in your neighbourhood compared to other neighbourhoods in the city?
Temporal	<ul style="list-style-type: none"> • How do you consider the development of safety and security in your neighbourhood over time?
Political	<ul style="list-style-type: none"> • How do you appreciate current crime policies? • How do you assess policing in your neighbourhood?
PART 3: WISHES AND NEEDS	
<p>Participants are introduced to smart cities. A smart city is an urban area that uses information and communication technologies to make the city “smarter”, e.g. better manageable for authorities and better liveable for citizens. The smart city aims to attract new business and investments, while maintaining sustainability. For a smart city to be successful, it is heavily dependent on its citizens for translating wishes and needs into implementable applications. The aim of this study is to create a</p>	

smart city artifact that is aimed at enhancing feelings of safety and security for Cape Town citizens, as the city is marked by high crime rates and high inequality. The artifact constitutes a mobile application prototype.

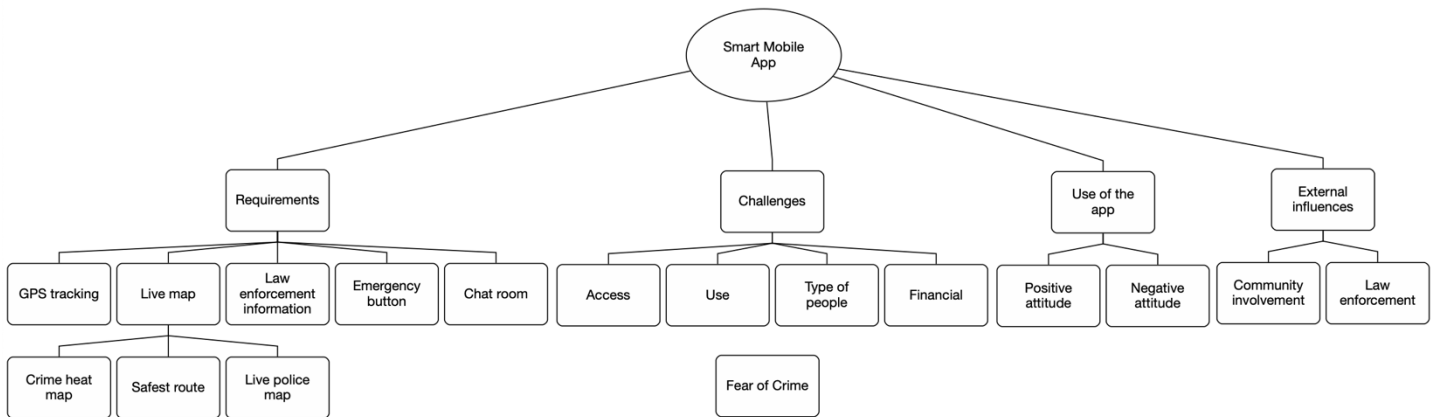
Goal: Identify wishes and needs for enhancing feelings of safety and security in the context of a mobile application prototype.

General	<ul style="list-style-type: none"> • How familiar are you with smart cities?
Application	<ul style="list-style-type: none"> • What would you like to see in the mobile application prototype in order to enhance your feelings of safety and security? • Can you specify any requirements? • Which requirements would you find most important?
Community	<ul style="list-style-type: none"> • How do you rate the importance of community involvement when considering the development of a mobile app?
Personal	<ul style="list-style-type: none"> • How do you believe a mobile application prototype could influence your feelings of safety and security? • Would you use the app in cases of stress/emergency/feeling unsafe? • How do you rate the value of a mobile application prototype for law enforcement purposes?
Constraints	<ul style="list-style-type: none"> • Which constraints do you foresee resulting from a mobile application prototype?
PART 4: ROUNDING UP THE INTERVIEW	
	<ul style="list-style-type: none"> • Is there anything else you could tell about your feelings regarding safety and security in the neighbourhood and how those feelings could be enhanced to make you feel safer? • Any other topic that you think is relevant here?

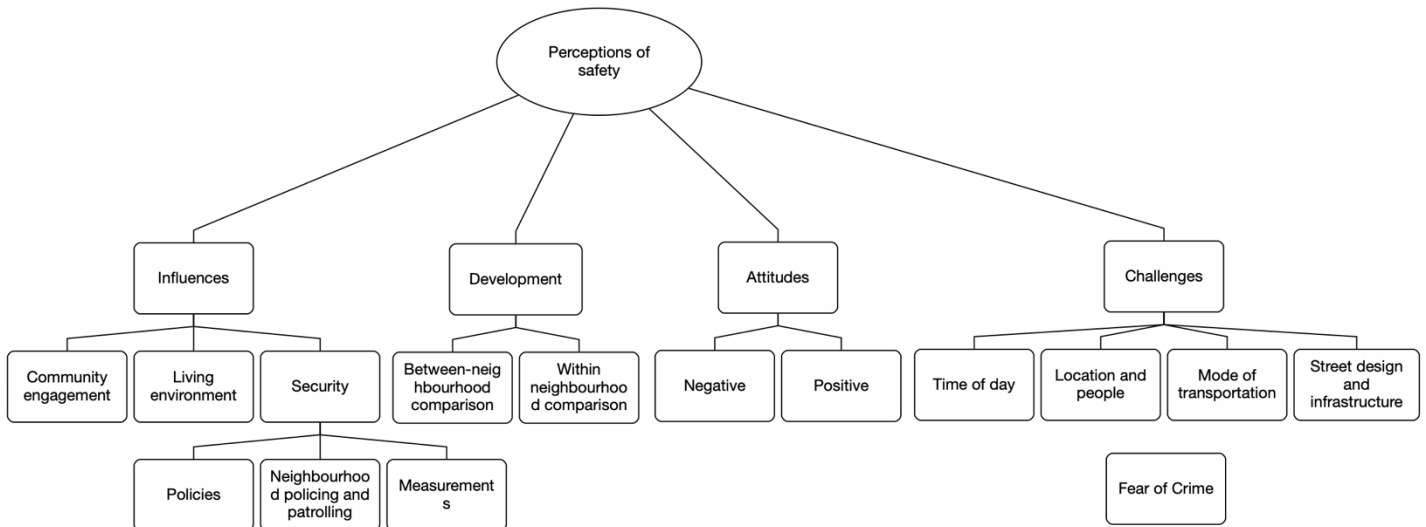
Appendix C: Interview Protocol – Interview Round 2

INTRODUCTION: GENERAL INFORMATION	
Goal	Present the mobile application prototype to participants and understand their feedback on the system in terms of usefulness and ease of use, and to what extent it ... the participants' intention to use in order to tackle issues of safety and security in the city.
Recording	Audio-recorded for the purpose of the study
Informed Consent	Interviewees signed consent form prior to the start of the interview
Questions	<ul style="list-style-type: none"> • What is your name? • Can you confirm you have previously been interviewed for the same research?
PART 1: SCREEN EXPLORATION	
Goal	Give the participant the opportunity to explore the different screens available and get a general look and feel of the system
Questions	<ul style="list-style-type: none"> • What is your first impression of the system?
PART 2: TASK ASSESSMENT	
Goal	Assess the ease with which participants are able to complete different task paths within the system and their satisfaction with using and completing the tasks and appropriate functionalities within the task paths. Participants are asked to describe what they are doing while completing the task.
Task 1: Create a new account and log in	<ul style="list-style-type: none"> • How do you perceive the ease of use of this system function presented in this task? • How do you perceive the usefulness of this system function presented in this task?
Task 2: Set the category weights and start a safe route	<ul style="list-style-type: none"> • How do you perceive the ease of use of this system function presented in this task? • How do you perceive the usefulness of this system function presented in this task?
Task 3: File an incident report	<ul style="list-style-type: none"> • How do you perceive the ease of use of this system function presented in this task? • How do you perceive the usefulness of this system function presented in this task?
Task 4: Become member of a community	<ul style="list-style-type: none"> • How do you perceive the ease of use of this system function presented in this task? • How do you perceive the usefulness of this system function presented in this task? • How do you perceive the usefulness of this system function for enhancing community engagement in order to make you feel more safe and secure in your neighbourhood?
Task 5: Add a safety resource to your folder	<ul style="list-style-type: none"> • How do you perceive the ease of use of this system function presented in this task? • How do you perceive the usefulness of this system function presented in this task?

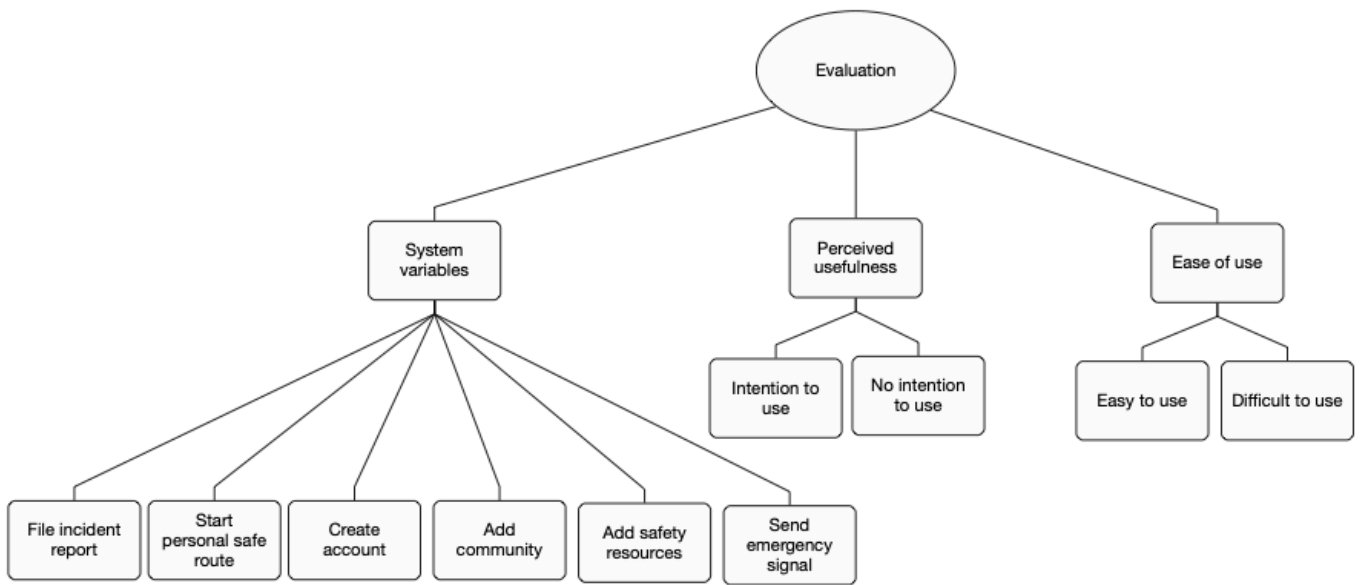
Appendix D: Node Trees (Thematic Analysis)



Appendix D.1: Perceptions of Safety Node Tree



Appendix D.2: Smart Mobile Application prototype Requirements Node Tree



Appendix D.3: Smart Mobile Application prototype Review Node Tree

Appendix E: Coding Book

THEME	SUBTHEME	INSTANCE	
Challenges influencing safety and security	Fear of night-time (23)		
	Fear of strangers (22)		
	Fear related to mode of transportation (30)	Walking (11)	
		Public transport (6)	
		Taxi services (5)	
		Driving (8)	
Feeling unsafe of certain streets (26)			
Lack of police involvement and follow up (23)			
Attitudes towards safety	Feeling safe (92)		
	Feeling unsafe (69)		
Neighbourhood development	Comparing between-neighbourhood factors (24)		
	Comparing within-neighbourhood factors (10)		
External factors impacting safety and security	Perception towards levels of community engagement (35)		
	Feeling of safety in living environment (19)		
	Perception towards security (60)	Attitude towards law enforcement crime policies (23)	
		Level and presence of neighbourhood policing (29)	
	Presence of general safety measurements (8)		

Appendix E.1: Perceptions of Safety Coding Book

THEME	SUBTHEME	INSTANCE	
Application requirements	Emergency panic button (18)		
	Community chat room (5)		
	Live map (17)	Crime heat map	
		Safest route planner	
		Police movement map	
	Law enforcement information (6)		
Personal information (1)			
Attitudes towards using the app	Positive feeling (30)		
	Negative feeling (14)		
Challenges for using the app	Lack of access (11)		
	User compromise (5)		
	Use constraints (11)		
Factors impacting use and success of the app	Involvement of the community (17)		
	Involvement of law enforcement (15)		

Appendix E.2: “Wishes and needs” coding book

THEME	SUBTHEME
Application features	Sign up (11)
	Category weights (7)
	Safe route (4)
	Incidence reports (17)

	Communities (16)
	Emergency button (8)
Perceived ease of use	Easy to use (31)
	To improve (29)
Perceived intention to use	Intention to use (15)
	To improve (6)

Appendix E.3: Prototype evaluation coding book

Appendix F: Application Requirements

REQUIREMENT	# CASES	REQUIREMENT SPECIFICS	ADDRESSES SAFETY CHALLENGE ASPECT
Emergency button	11	<ul style="list-style-type: none"> - Speed dial call going out to law enforcement, family/friend (top speed dial contact list), community - “Assistive touch” functionality or “hot key” on unlocked phone screen - Code word emergency button activation - GPS signal sending out whereabouts 	<ul style="list-style-type: none"> - Afraid of night-time - Fear around strangers - Mode of transportation - Street design and infrastructure
Crime map	10	<ul style="list-style-type: none"> - Live crime heat map, alerting safe and unsafe areas in the city - Safety access transport modes alerting system - Community incident logging system - Auto-case opening system after incident log - Safe-route planning and assistive system 	<ul style="list-style-type: none"> - Lack of community involvement - Afraid of night-time - Mode of transportation - Street design and infrastructure
Safety resources and live police map	5	<ul style="list-style-type: none"> - Emergency contact numbers list - Neighbourhood police station numbers - Emergency numbers outpost centre - Overview of security guards positioning - Live police patrolling map - Map of police stations 	<ul style="list-style-type: none"> - Lack of police involvement and follow up
Chat room	5	<ul style="list-style-type: none"> - Community interaction room - Community centralised updates 	<ul style="list-style-type: none"> - Lack of community involvement - Fear around strangers - Afraid of night-time
Personal information	1	<ul style="list-style-type: none"> - Emergency contacts - Medical requirements 	<ul style="list-style-type: none"> - Lack of community involvement - Lack of police involvement and follow up

Appendix G: Use Case Descriptions

Use case name: Log in

Summary: User logs in to the application with existing user credentials

Actors: Citizen

Preconditions: The user has selected they want to log in with existing user credentials and has previously created an account.

Description of main sequence:

1. User adds email address and password.
2. System checks if combination of email address and password are recognised by the system and match.
3. User is directed to application main menu.

Description of alternative sequences:

Step 2: If user password is incorrect for the given email address or email address if not recognised by the system, user displays corresponding error message and asks user to try again.

Postcondition: User has logged in and is redirected to main page for completing profile.

Use case name: Sign up

Summary: User signs up to the application by creating an account in order to proceed with using all application's functionalities.

Actors: Citizen

Preconditions: The user has selected they want to create a new account instead of logging in with existing credentials.

Description of main sequence:

1. User adds first name, last name, email and phone number.
2. System checks if email and phone number adhere to the input rules and if these are existing inputs.
3. User inputs new password and repeats password.
4. System checks if passwords match and if password adheres to strong rule requirement.
5. User sets notification requirements.
6. User finishes creating account and is redirected to the main page for completing the account.

Description of alternative sequences:

Step 4: If user passwords are not identical or password does not adhere to strong rule requirement, system gives password error output message and asks user to input again.

Postcondition: User has created account and is redirected to main page for completing profile.

Use case name: Log Incident

Summary: User logs incident after a crime has occurred in a specific community after which the incident is logged in that respective community.

Actors: Citizen

Preconditions: The user is currently active on the crime heat map in order to select the log incident button as an option.

Description of main sequence:

1. User has the crime heat map opened and their current location is detected by the GPS.
2. User initiates to log incident.
3. User selects the type of report.
4. User enters the location of the crime, date of the crime, time of the crime, travel method and a comment.
5. User files the report and goes back to the crime heat map.

Description of alternative sequences:

Step 1: User selects an existing incident and examines the details of the logged incident. User may vote the logged incident up or down.

Step 4: User may change the type of report which was initially inputted under step 3.

Step 5: User alternatively goes to My Communities where incidents are listed in the specific community.

Postcondition: User has filed a report which is logged to the community's incident reports.

Use case name: Start Safe Route

Summary: User plans a route that directs the user from point A to point B using a maps functionality that plans the safest route according to the category weights set by the user in Settings.

Actors: Citizen

Preconditions: The user has set category weights in settings and is currently active in Crime Heat Map.

Description of main sequence:

1. User is in Crime Heat Map and clicks button Start Route.
2. User selects a starting point and destination point.
3. User views suggested route and starts suggested Safe Route.
4. User follows route planner until destination is reached.

Description of alternative sequences:

Step 3: User may choose to go with Fastest Route instead of Safest Route.

Step 4: User is able to send emergency signal pressing S.O.S. button on the safe route in case of dangerous situation. User confirms sending emergency signal.

Step 4: User selects incident report while on route in order to investigate previously reported incidents in vicinity of current route.

Postcondition: User has completed route and reached final destination. User is returned to Crime Heat Map.

Use case name: Add Safety Resource

Summary: User adds a safety resource to their personal database which can be called at any time.

Actors: Citizen

Preconditions: None.

Description of main sequence:

1. User stays on current GPS location on map or navigates towards specific location.
2. User finds safety resource depicted by green safety icon and clicks icon.
3. User adds safety resources to personal safety resources.

Description of alternative sequences:

Step 3: User goes to My Resources and views, edits or calls resource.

Postcondition: User has added new safety resource to personal safety resources folder.

Use case name: Become member of community

Summary: User becomes member of one or more communities to receive incident updates, respond to emergency requests from community members and chat to members.

Actors: Citizen

Preconditions: None.

Description of main sequence:

1. User uses main menu to navigate to communities.
2. User adds new community and searches for location on the map.
3. User submits request and enters community page.
4. User views all previously logged incidences in community.
5. User enters community chat room and sends messages in chat.

Description of alternative sequences:

Step 3: User goes back to communities and adds another community to their folder.

Step 4: User uses filters to customise community incidents overview or dates added.

Step 5: User starts personal chat with one of the community users.

Postcondition: User has added new community to personal communities folder.

Use case name: Send emergency signal

Summary: User sends emergency signal using the red S.O.S. button and gets assistance from community members responding positively to the call-out through a GPS system.

Actors: Citizen

Preconditions: Other citizens have become part of same community to database for call-out participants is >1.

Description of main sequence:

1. User is on map view and clicks red S.O.S. button.
2. Call-out request is sent to active community members.
3. Call-out request is completed with notification after 2 members have accepted call-out.
4. Call-out members complete request when they have arrived at the GPS destination.

Description of alternative sequences:

Step 1: User has phone locked and presses quick emergency sequence buttons.

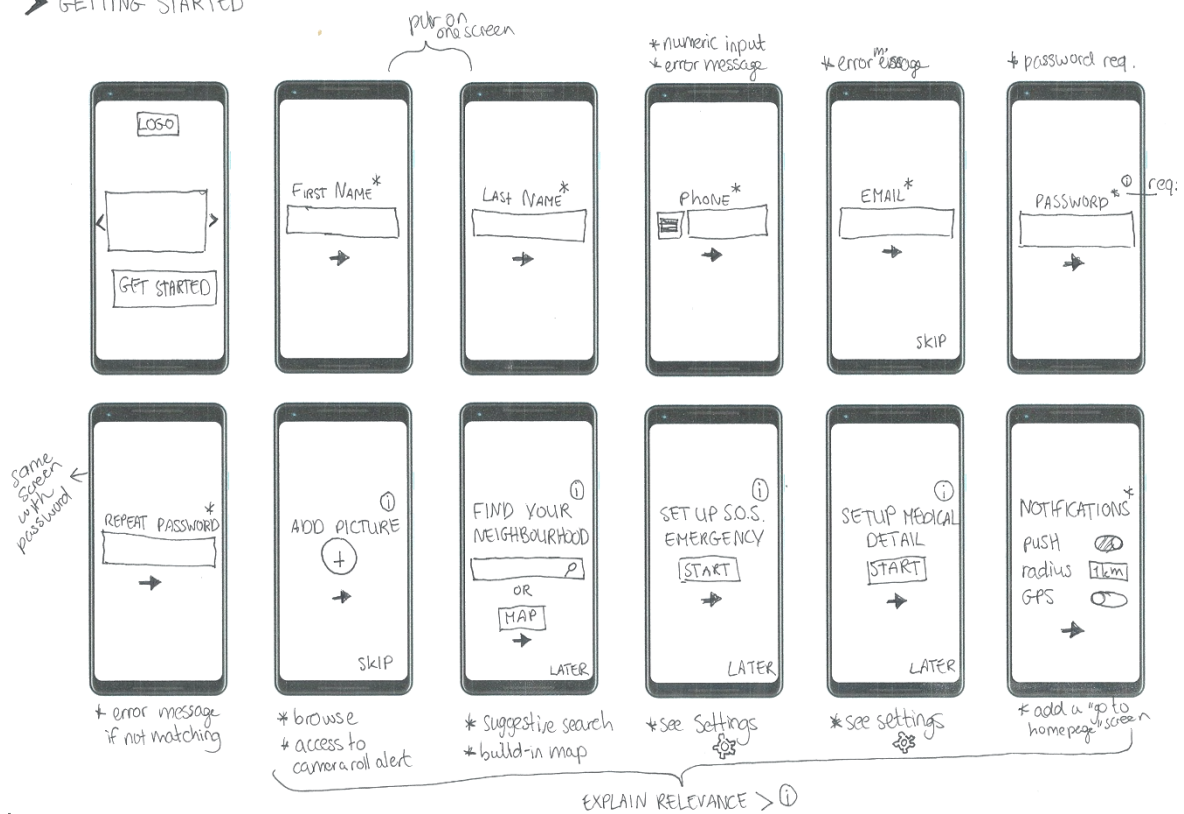
Step 4: User uses filters to customise community incidents overview or dates added.

Step 5: User starts personal chat with one of the community users.

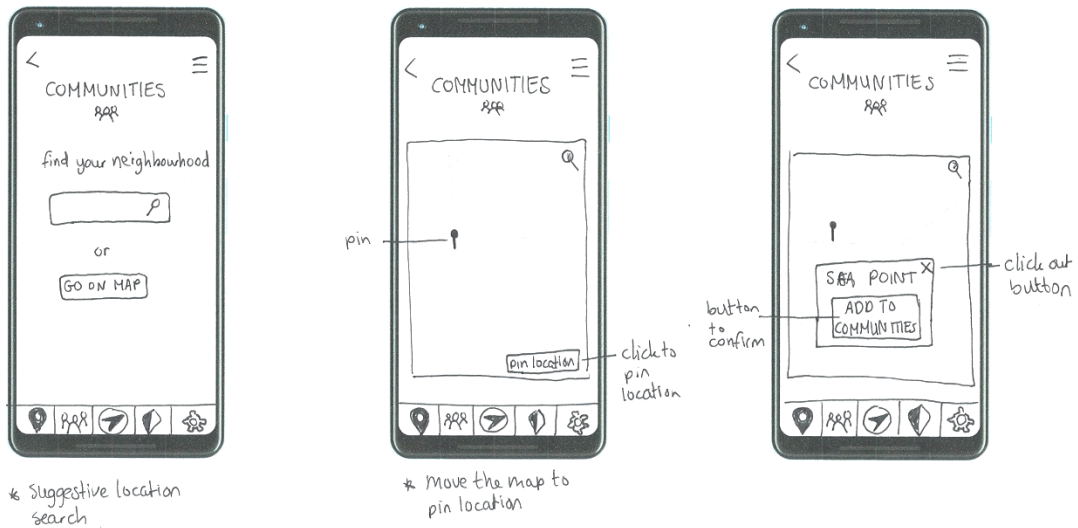
Postcondition: User has sent an emergency signal and 2 community members have reached GPS destination of reporter.

Appendix H: Application Sketches

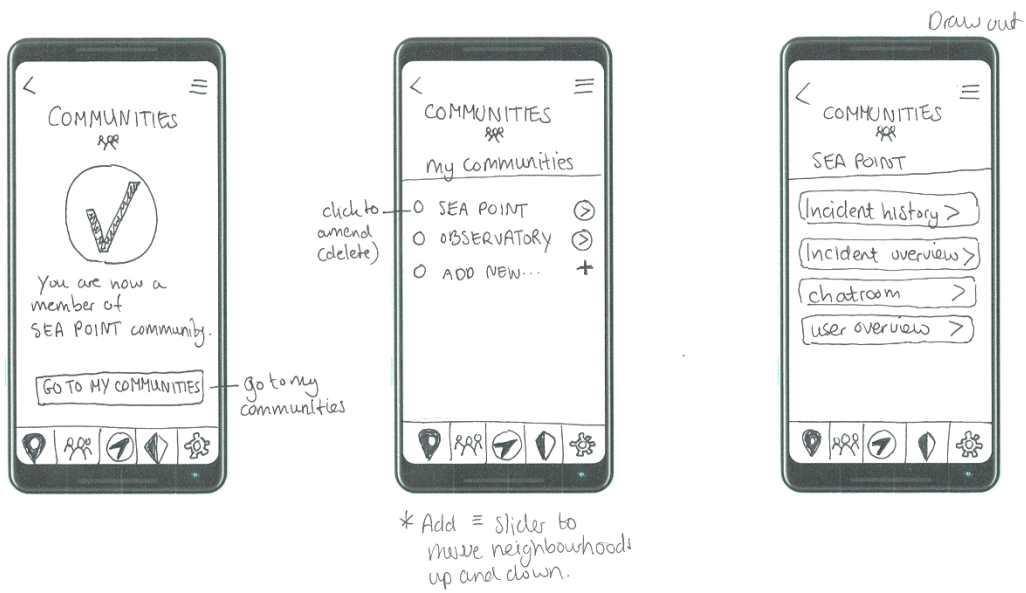
➤ GETTING STARTED



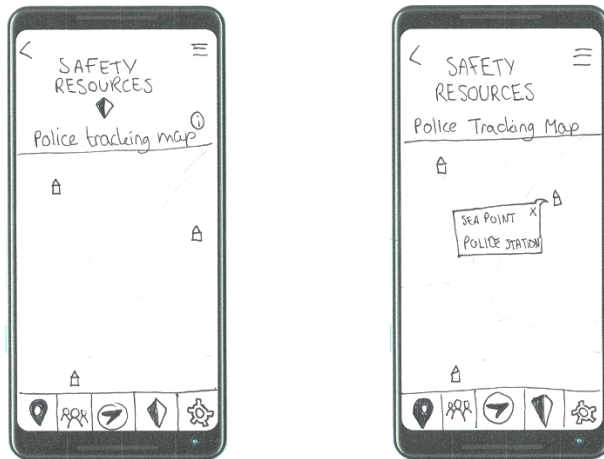
Sketch 1: Mobile Application prototype Sketch "Getting Started"



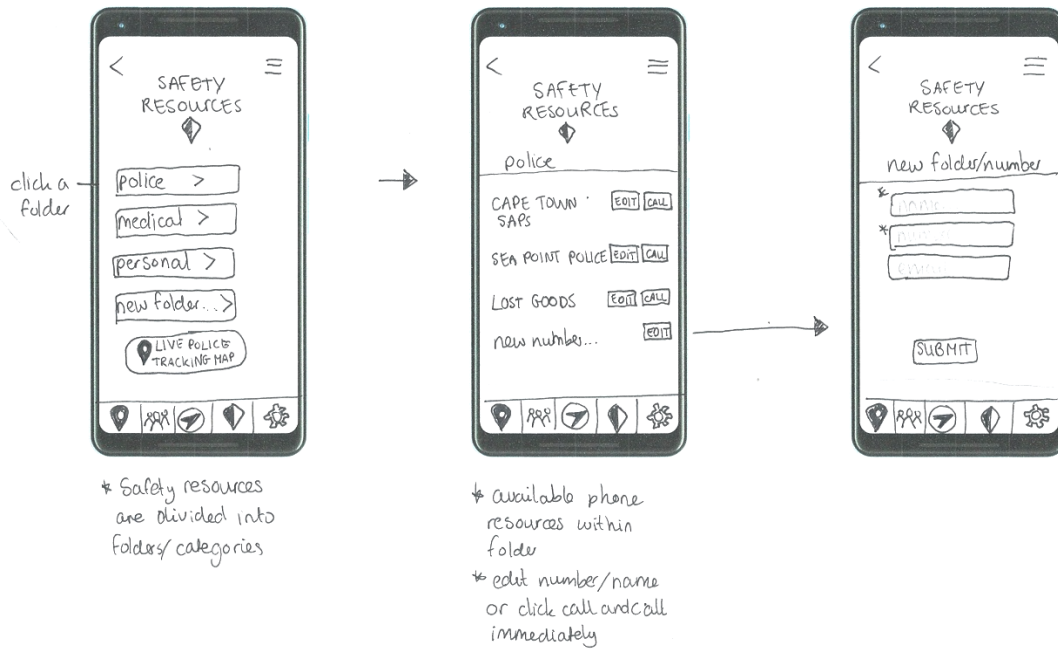
Sketch 2, 3, 4: Mobile Application prototype Sketch "Community"



Sketch 5, 6, 7: Mobile Application prototype Sketch "Community"



Sketch 8, 9, 10: Mobile Application prototype Sketch "Safety Resources"



Sketch 11, 12, 13: Mobile Application prototype Sketch "Safety Resources"



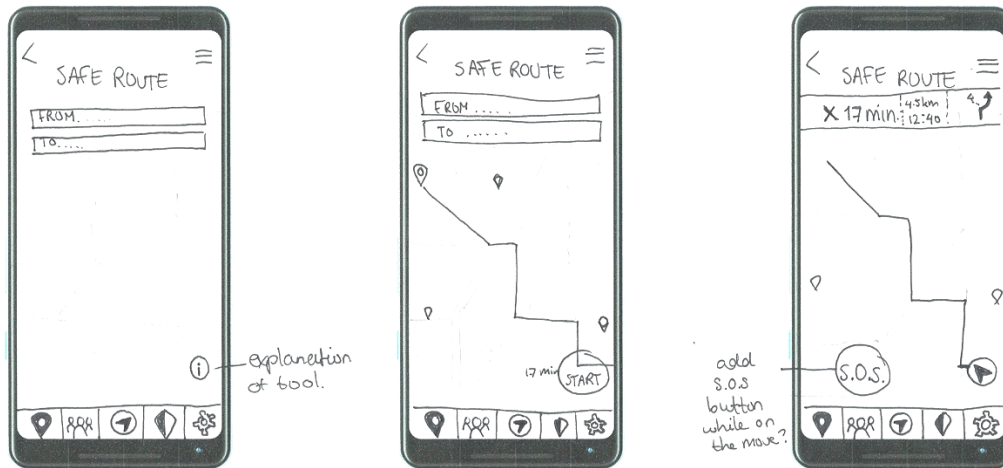
Sketch 14, 15, 16: Mobile Application prototype Sketch "Risk Map"



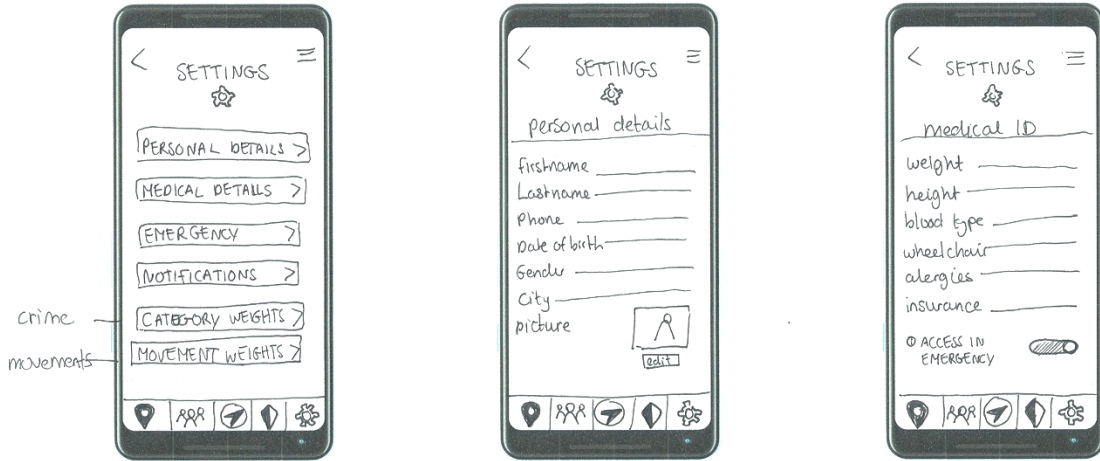
Sketch 17, 18: Mobile Application prototype Sketch "Risk Map"

SAFE ROUTE

update → add safe route as part of crime map.
only added functionality will be "plan safe route" option.



Sketch 19, 20, 21: Mobile Application prototype Sketch "Safe Route"

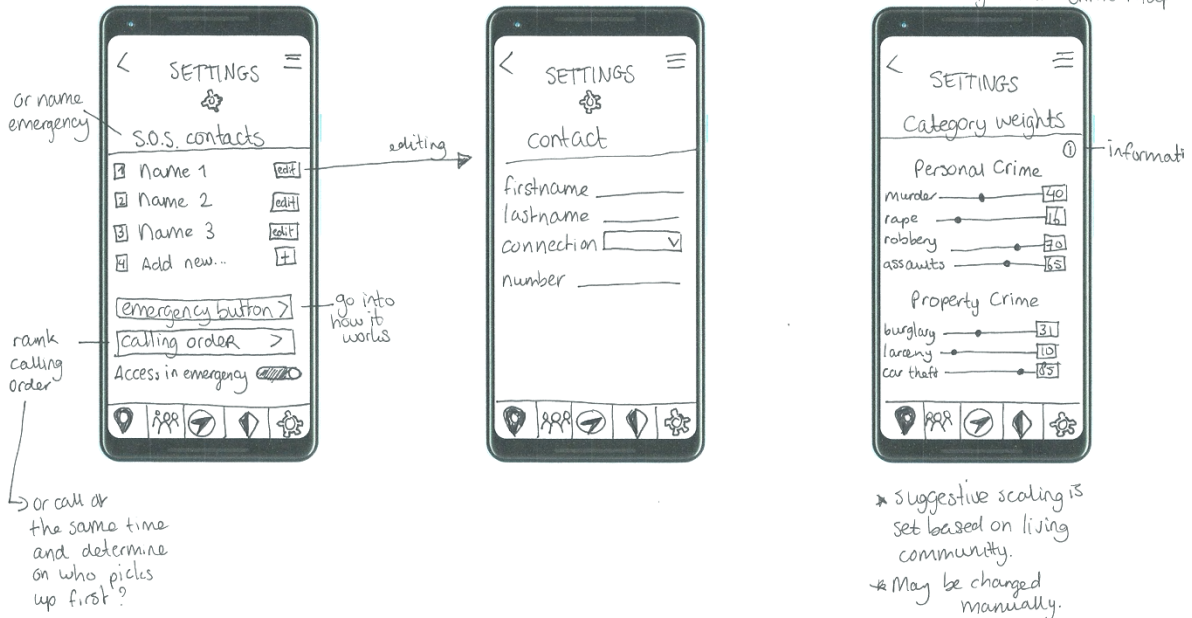


Sketch 22, 23, 24: Mobile Application prototype Sketch "Settings"

SETTINGS

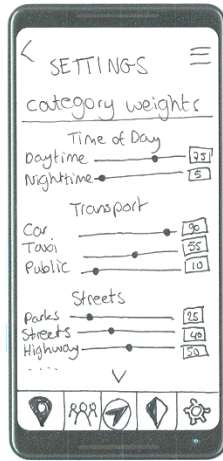
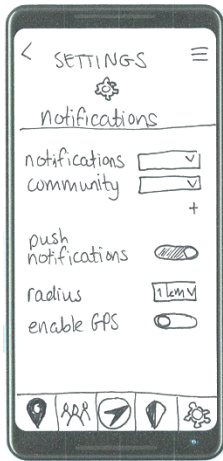


Make category weights a separate menu bar icon. Instead of 'safe route' as merged with crime map



* Suggestive scaling is set based on living community.
* May be changed manually.

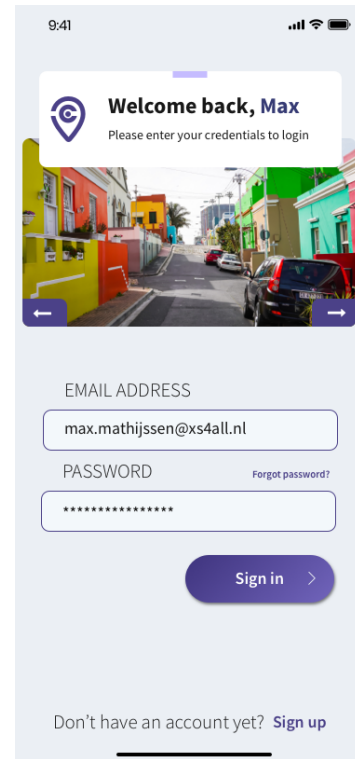
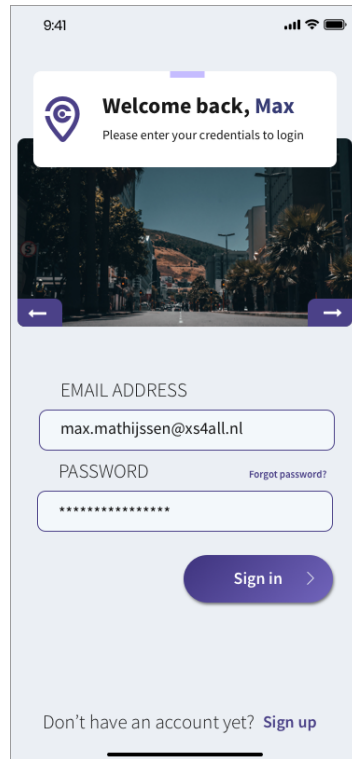
Sketch 25 26, 27: Mobile Application prototype Sketch "Settings"



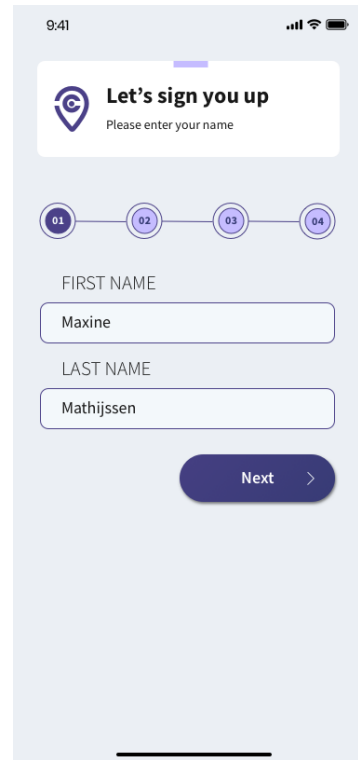
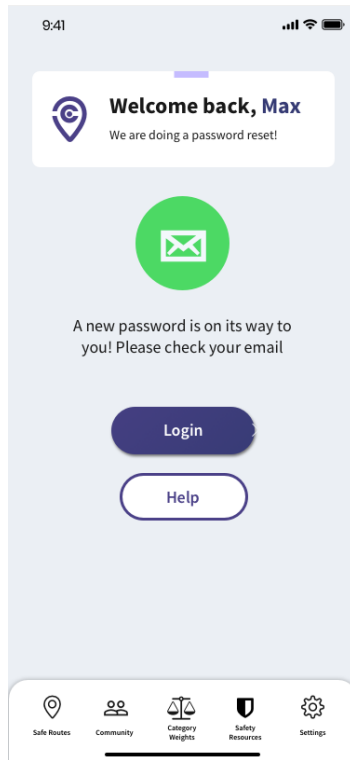
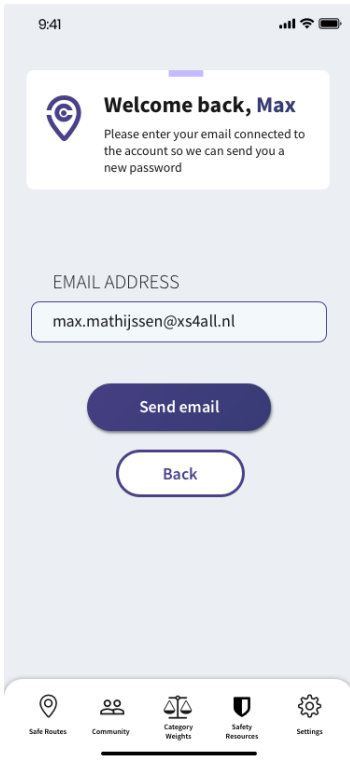
Sketch 28, 29: Mobile Application prototype Sketch "Settings"

Appendix I: Application Prototype

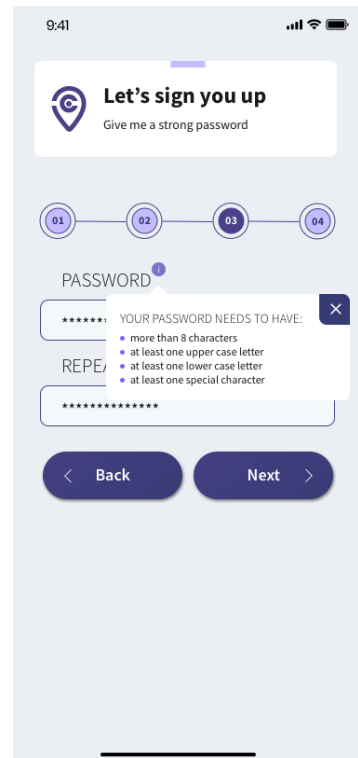
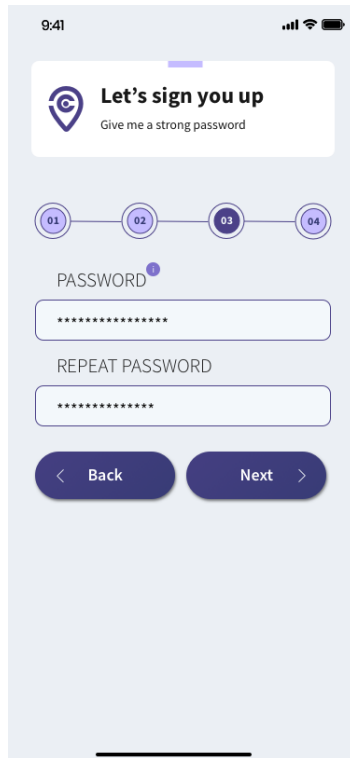
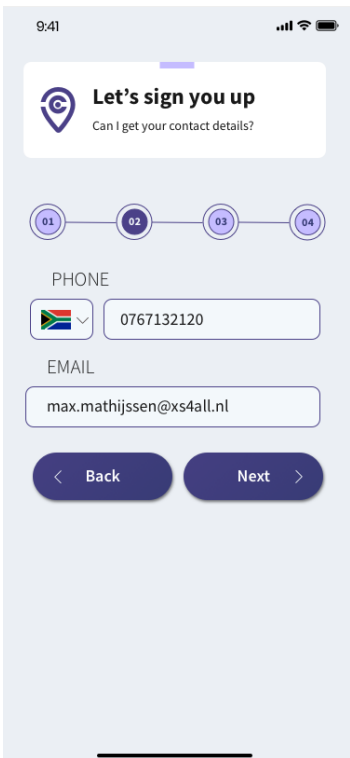
- Initial design accessible online: <https://www.sketch.com/s/8be43c80-e2fc-4381-bc57-64b8d7f98b64>
- Design after feedback implementation accessible online: <https://sketch.cloud/s/e38530a1-9847-40c0-adc6-c6e428643fa7>



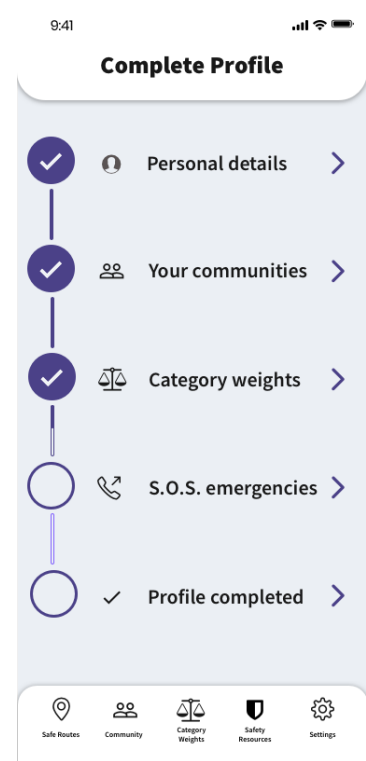
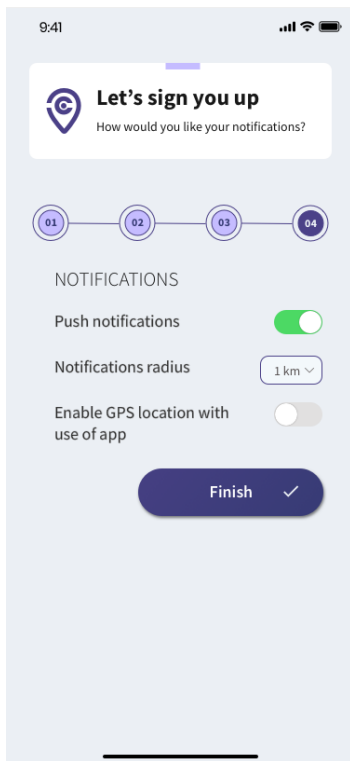
Screen 1, screen 2, screen 3



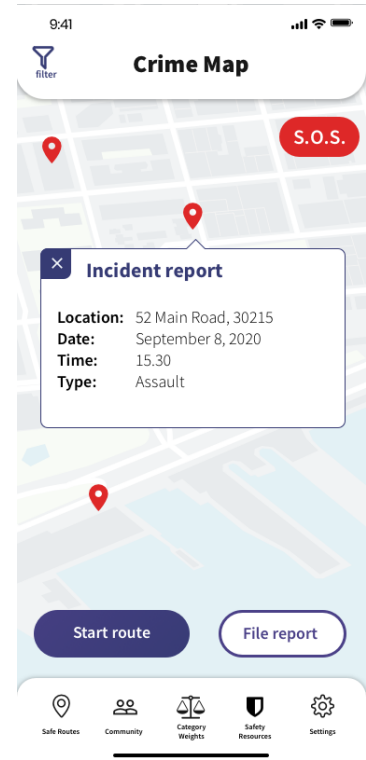
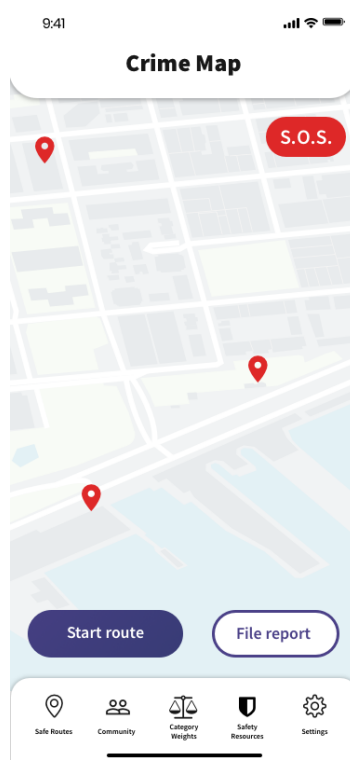
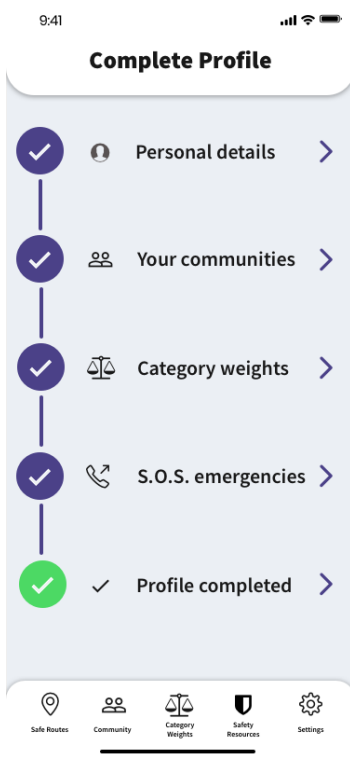
Screen 4, screen 5, screen 6



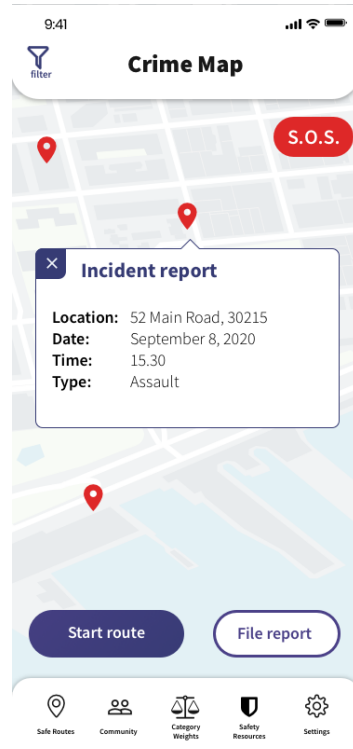
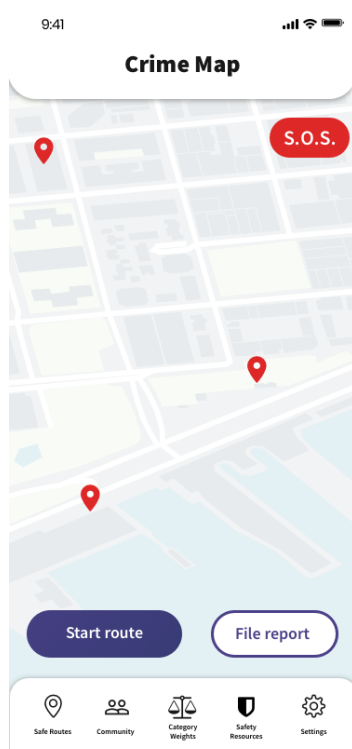
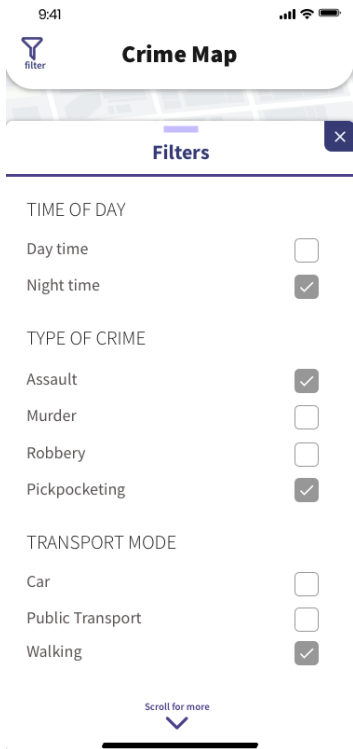
Screen 7, screen 8, screen 9



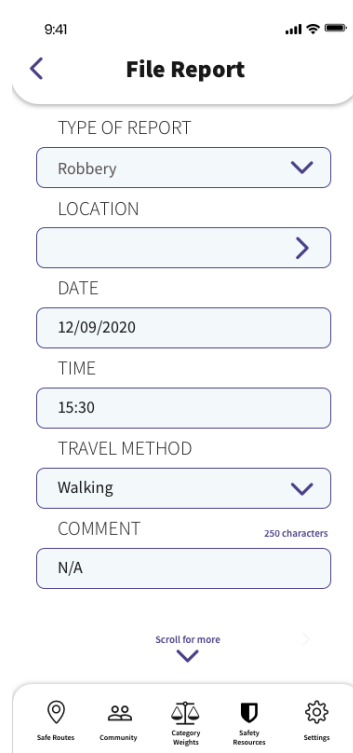
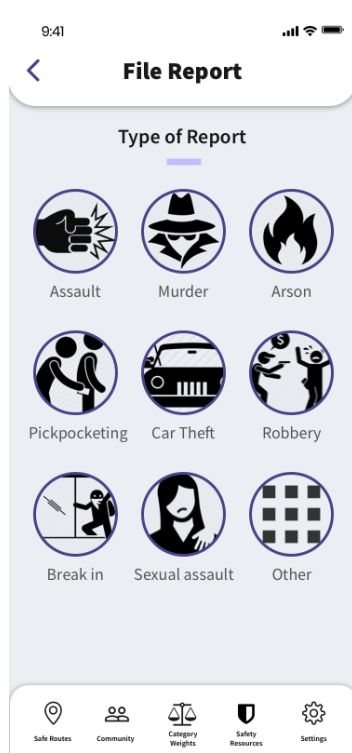
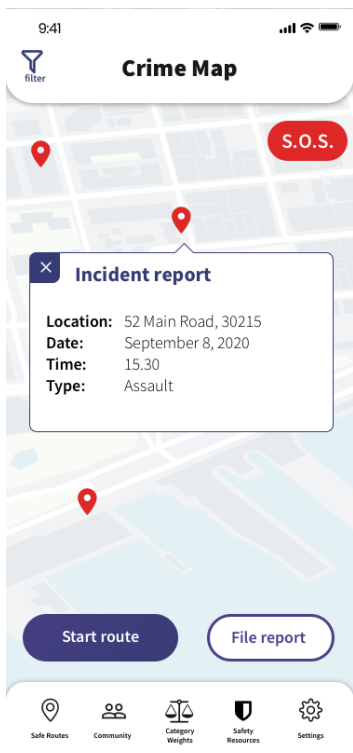
Screen 10, screen 11, screen 12



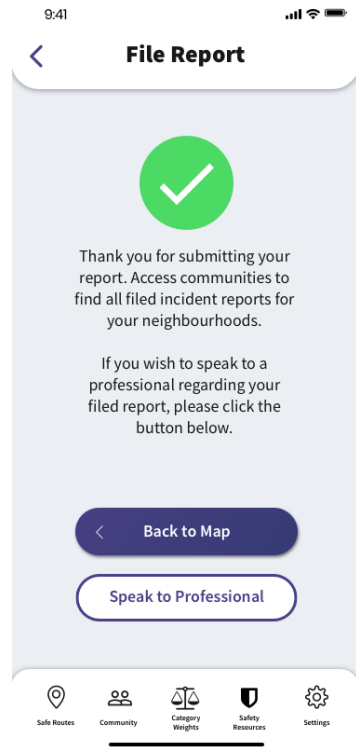
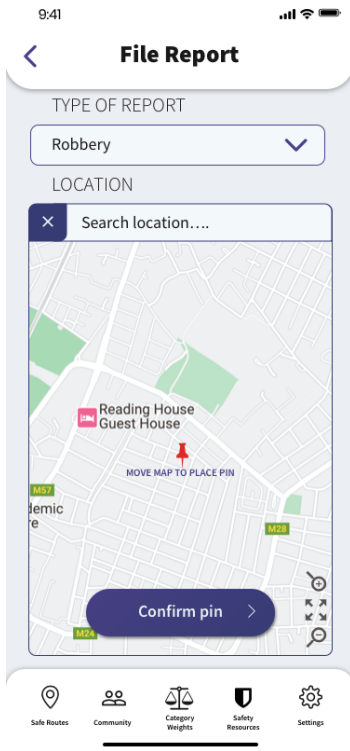
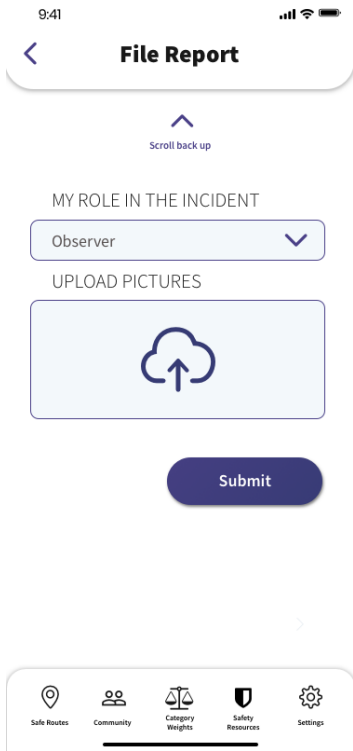
Screen 13, screen 14, screen 15



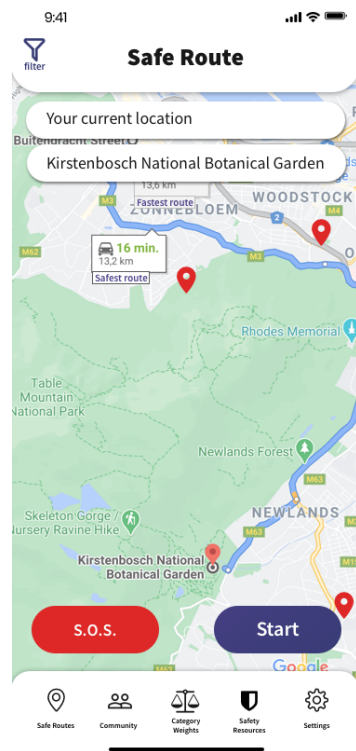
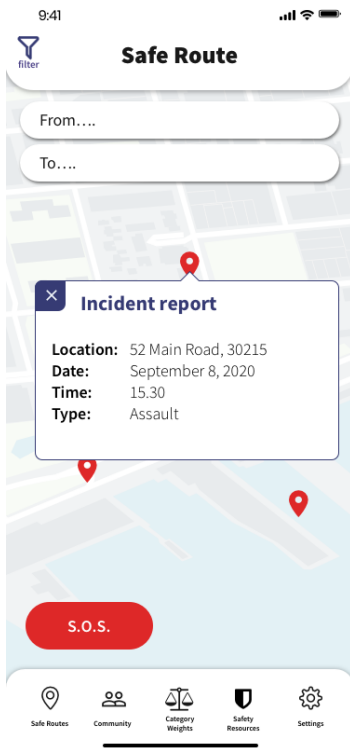
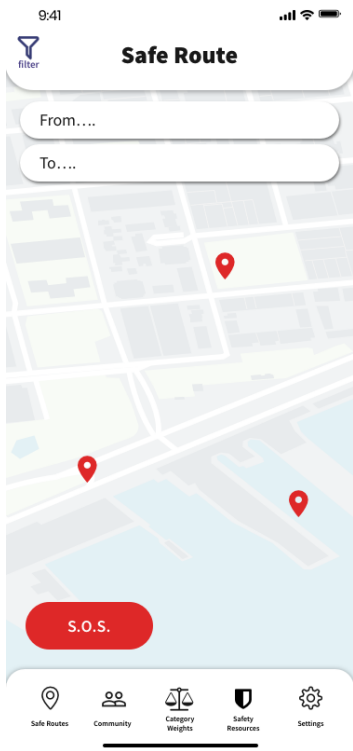
Screen 16, screen 17, screen 18



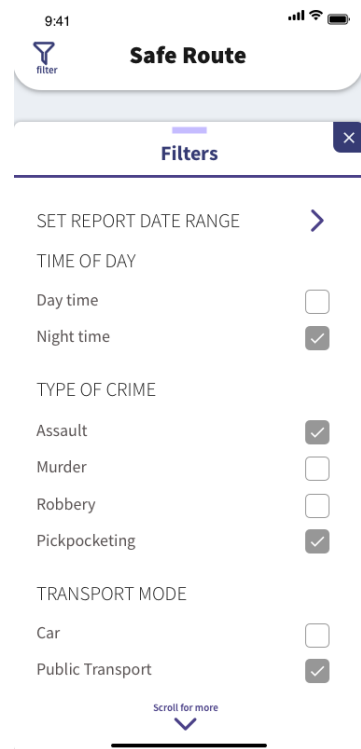
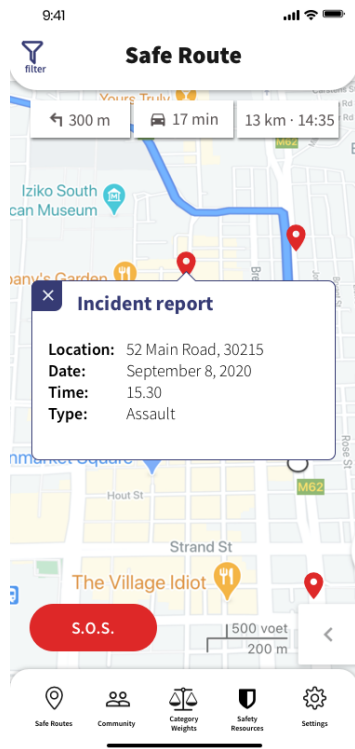
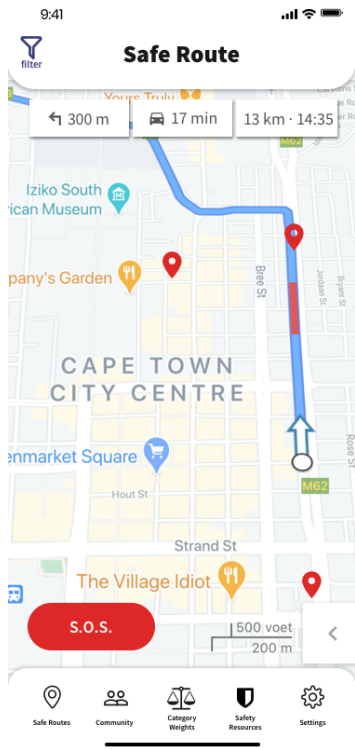
Screen 19, screen 20, screen 21



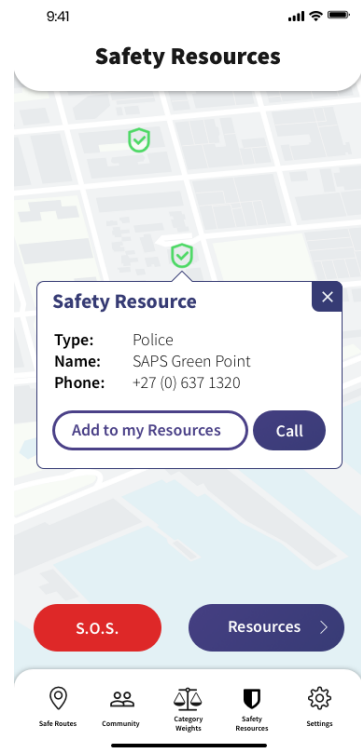
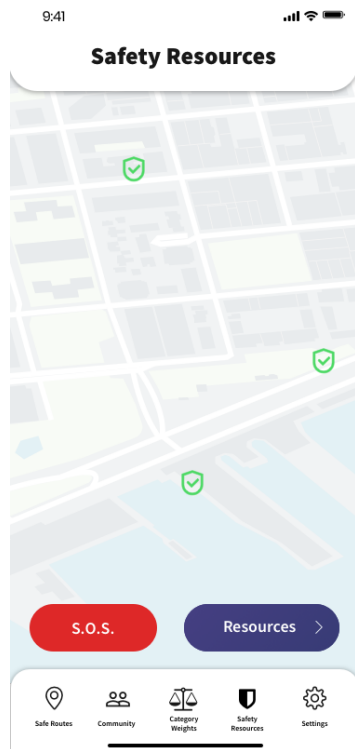
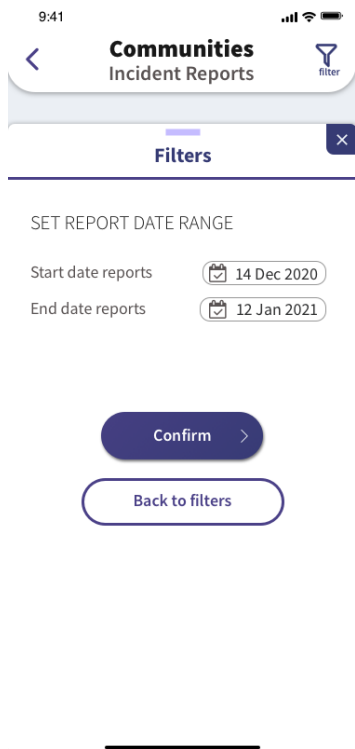
Screen 22, screen 23, screen 24



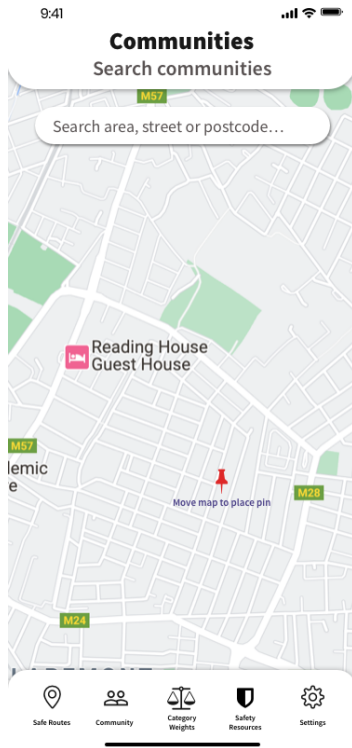
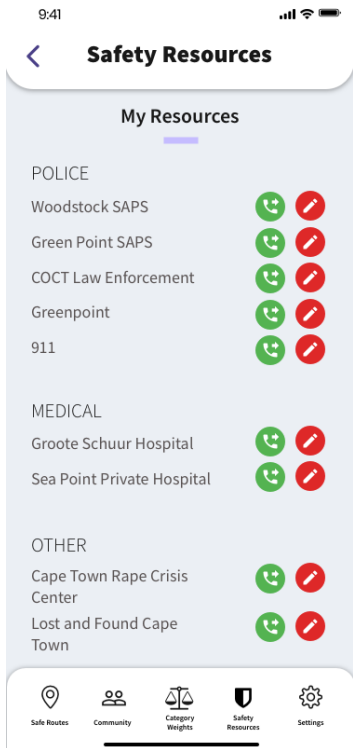
Screen 25, screen 26, screen 27



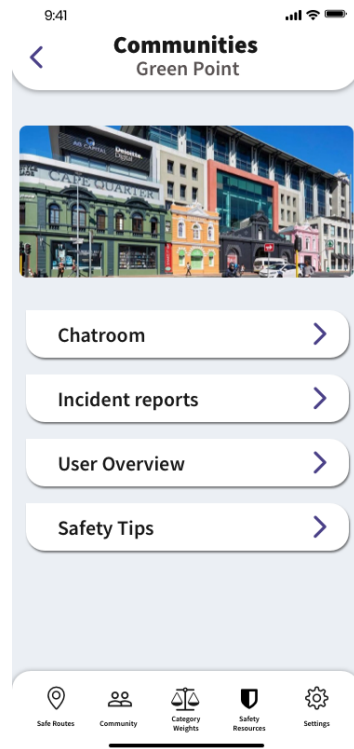
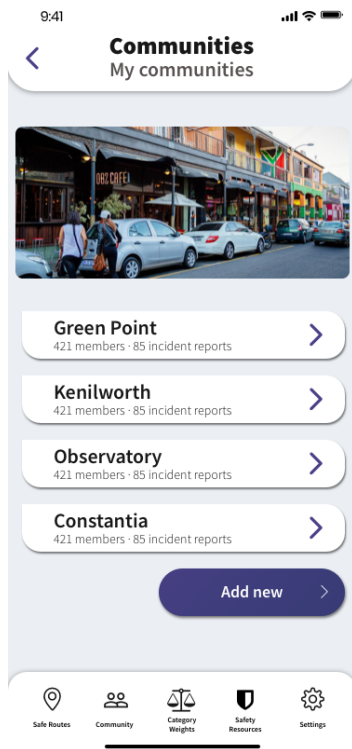
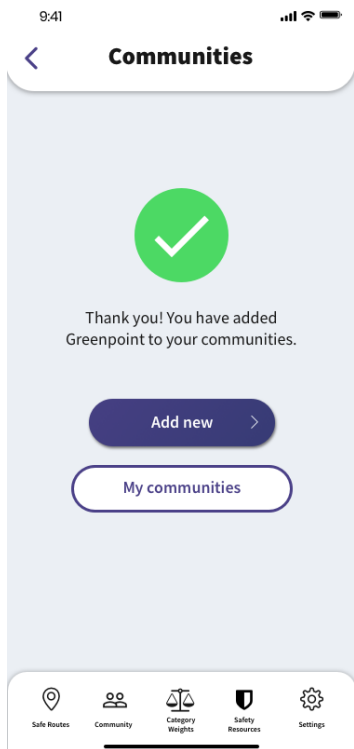
Screen 28, screen 29, screen 30



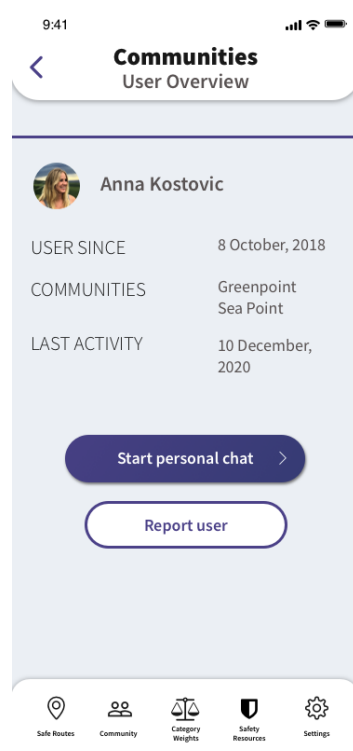
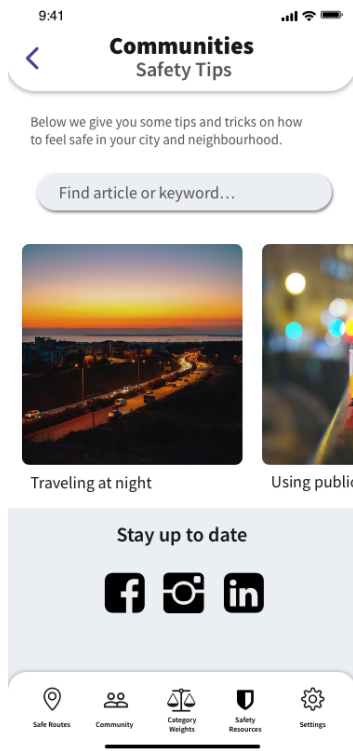
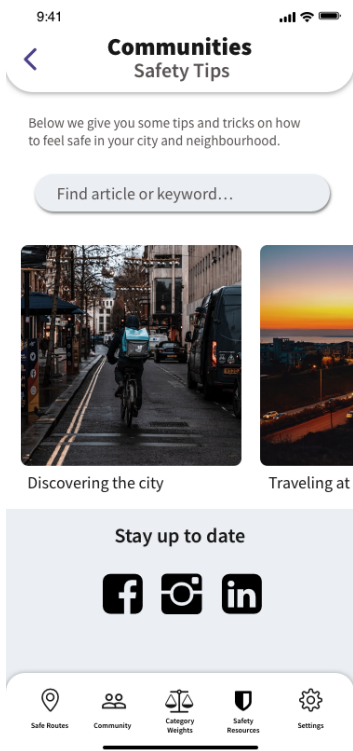
Screen 31, screen 32, screen 33



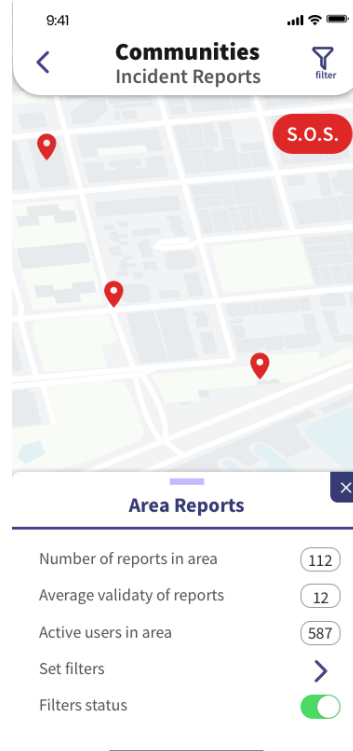
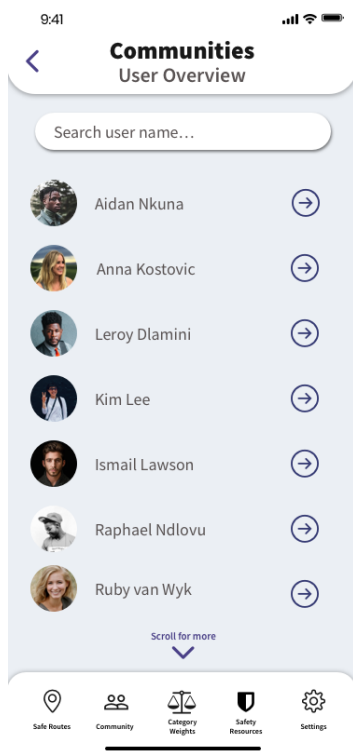
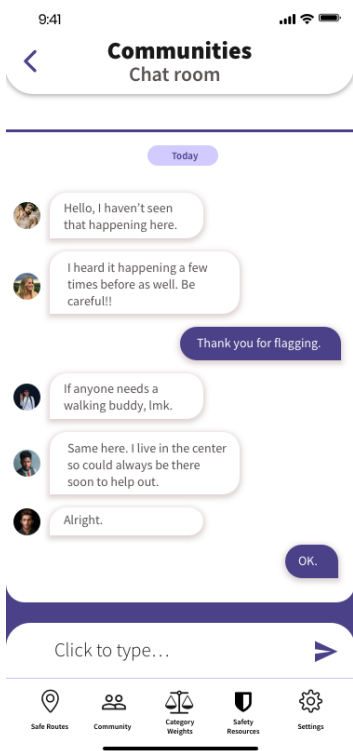
Screen 34, screen 35, screen 36



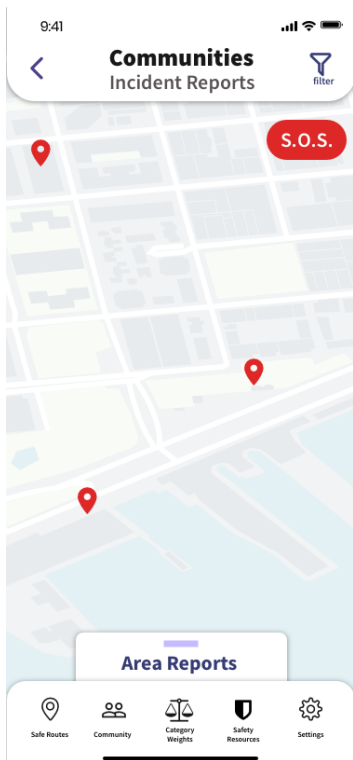
Screen 37, screen 38, screen 39



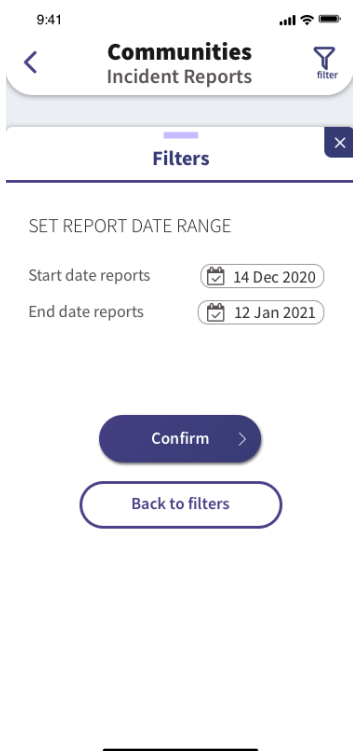
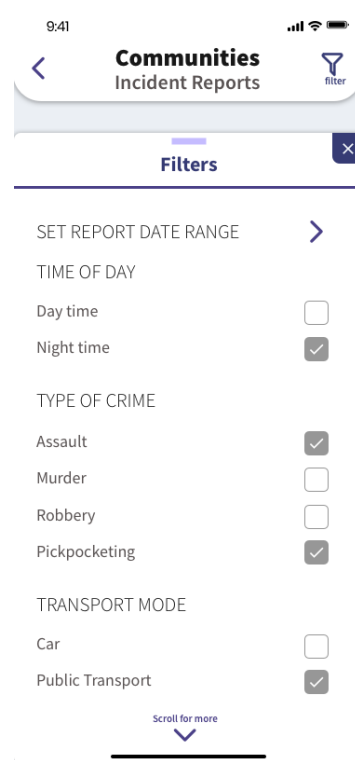
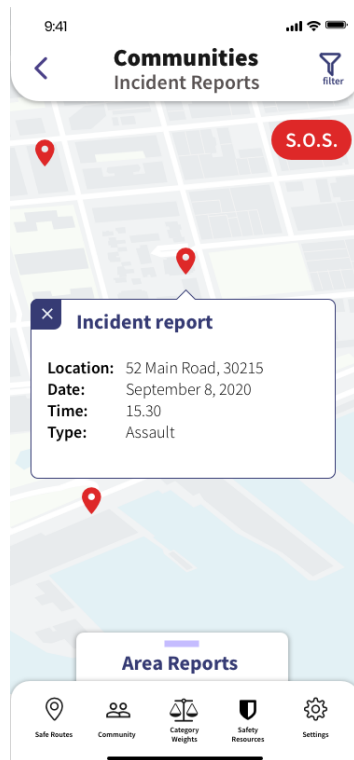
Screen 40, screen 41, screen 42



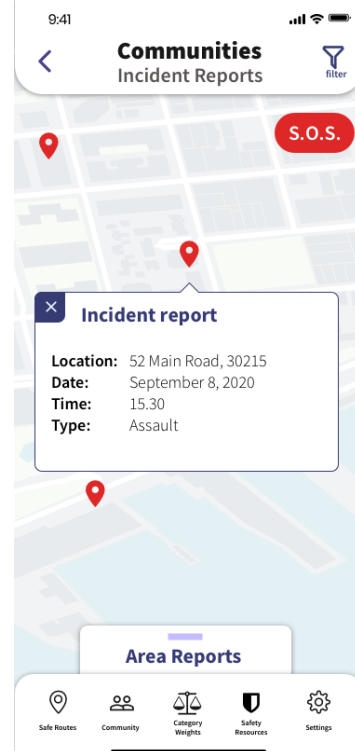
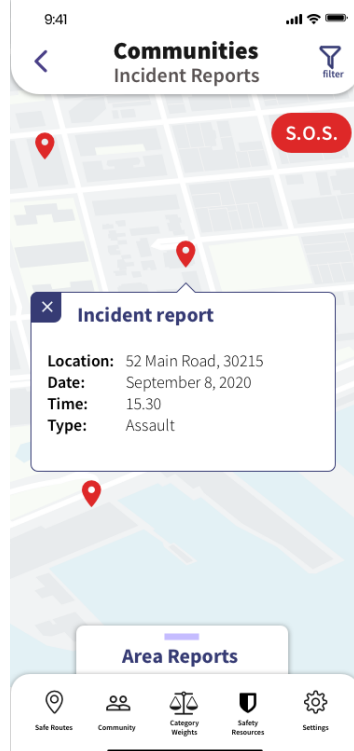
Screen 43, screen 44, screen 45

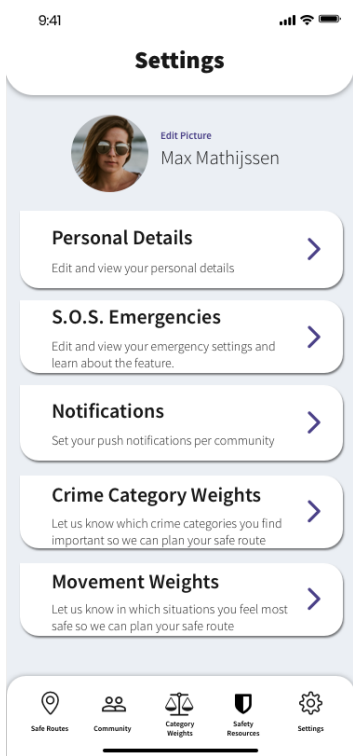


Screen 46, screen 47, screen 48

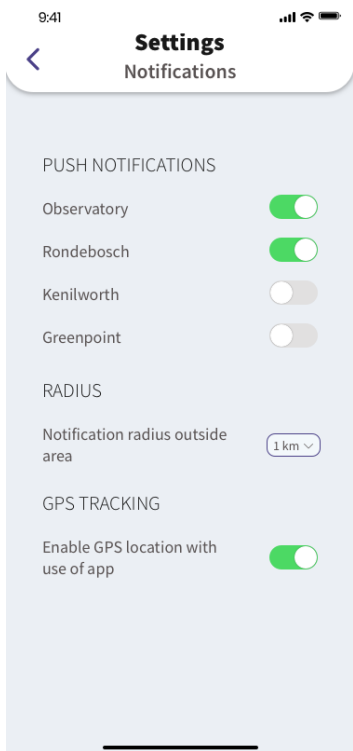
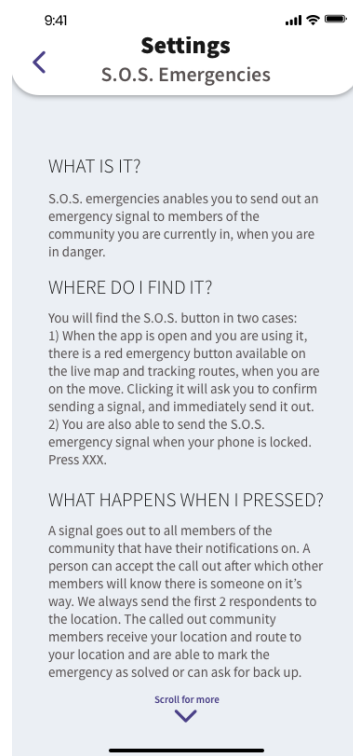
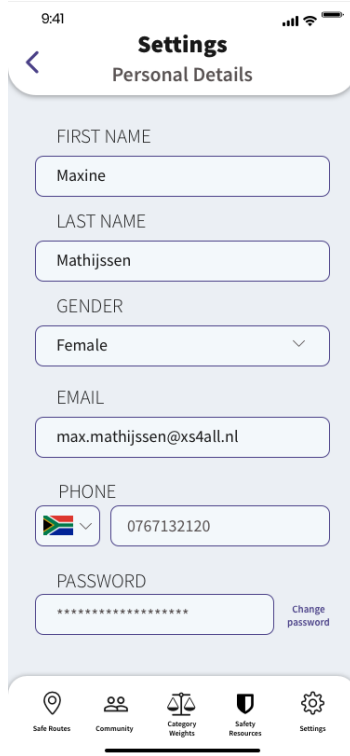


Screen 49, screen 50, screen 51

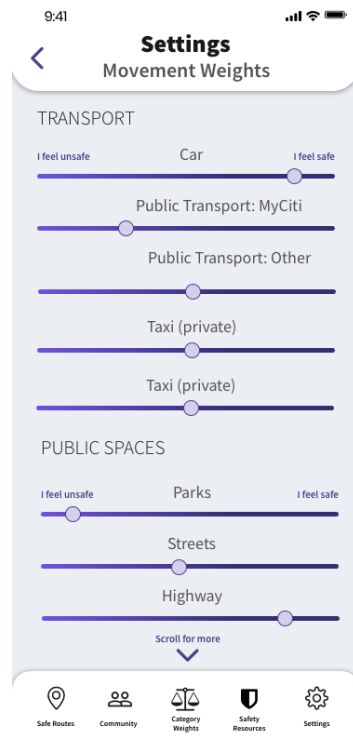
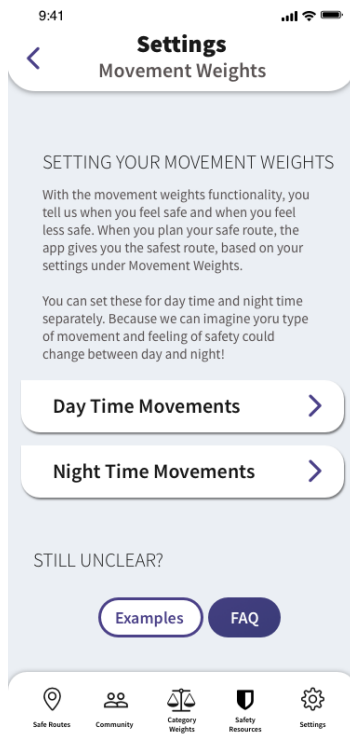


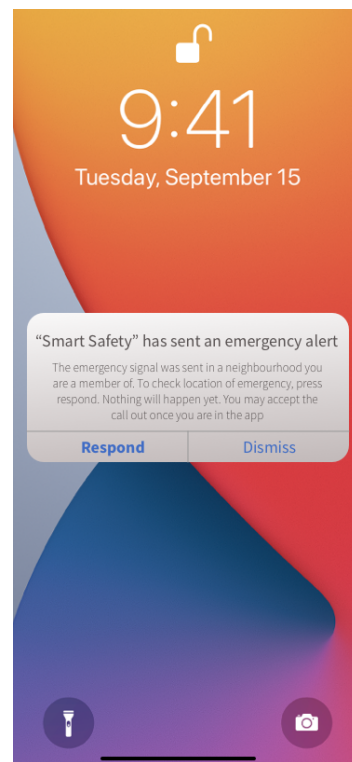
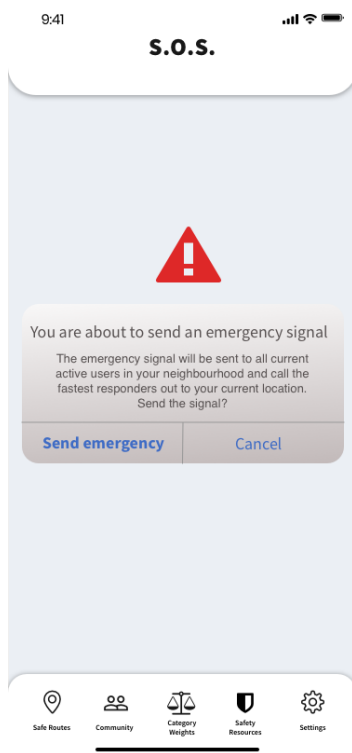
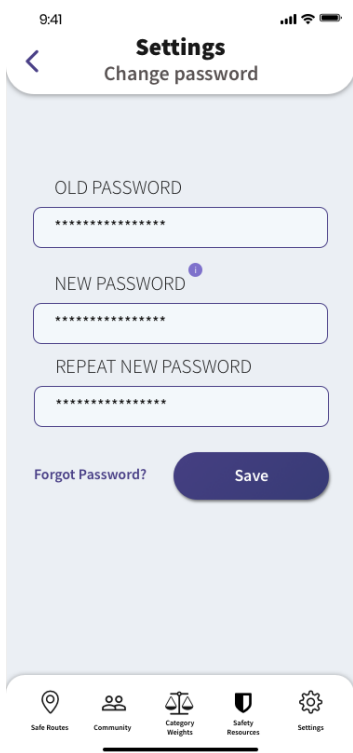


Screen 52, screen 53, screen 54

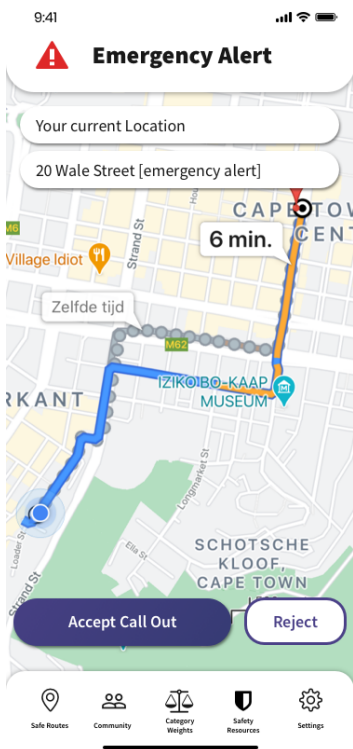


Screen 55, screen 56, screen 57





Screen 58, screen 59, screen 60



Screen 61

Appendix J: User Stories

USER STORY	ACCEPTANCE CRITERIA	SCREEN REFERENCE(S)
I would like to sign into my account so that I can access my personal app.	Given that I am a returning user, when I open the app, I expect to be able to log in with my email and password credentials, so that I can access my personal app.	1 – 3
I would like to reset my password so that I can log in to my account even if I forgot my password.	Given that I am a returning user, when I try to log in but cannot remember my password, I expect to reset my password, so that I can log in.	3 – 5
I would like to create a new account so that I can use the app when I am a new user.	Given that I am a new user, when I am a new user, I expect to have a clearly visible “sign up” button at the bottom of the screen so that I can create a new account.	2, 3
I would like to see the progress of my sign up so that I am not discouraged to use the app.	Given that I am a new user, when I sign up, I expect to see a progress bar. Given that I am a new user, when I finalise my account setup, I expect to not have to do everything before I am able to use the app.	6 – 10 11 – 13
I would like to see previous incidents on a map so that I can explore the safety in different neighbourhoods.	Given that I am a user, when I go on the Safe Map, I expect to see pins indicating a previously reported incident. Given that I am a user, when I click on a pin on the map, I expect to get an incident report pop up with information about the report. Given that I am a user, when I search previous incidents on the map, I expect to apply filters so that I am not taken aback by the number of incidents.	14 15 16
I would like to log my own incident report so that I can report a crime and help other neighbourhood members stay vigilant.	Given that I am a user, when I am on the Safe Map, I expect to be able to click a button to file an incident. Given that I am a user, when I click on the file report button, I expect to get an overview of types of crimes and enter all relevant details about the crime including type, location, time, my transport, comments, pictures. Given that I am a user, when I have submitted an incident report, I expect to get a success message and option to return to the map or speak to a professional in case I have gone through something traumatic.	17 18 – 23 24
I would like to start a route planner so that I can navigate from point A to point B in the safest way	Given that I am a user, when I am on the Safe Map, I expect to start a Safe Route by clicking a Safe Route button that is clearly visible.	17

possible according to my personal values.	Given that I am a user, when I start a Safe Route, I expect to get a choice between the fastest and safest route options.	25 – 27
	Given that I am a user, when I start a Safe Route, I expect to get an easy-to-navigate and recognisable map similar to Google Maps.	27 – 31
	Given that I am a user, when I plan a Safe Route, I expect the navigation planner to reroute me if I have deviated from the initial route.	N/A
	Given that I am a user, I expect to set my personal category weights in different sections which the route planner depends on.	56 – 57
I would like to have easily accessible safety resources so that I can call them if I need assistance.	Given that I am a user, when I am on the Safety Resources map, I expect to add a safety resource to my personal safety resources folder.	32 – 34
	Given that I am a user, when I found a safety resource, I expect to click it and receive a pop up with the details of the safety resource.	32 – 34
	Given that I am a user, when I want to add a safety resource to my personal folder, I expect to click “Add to personal folder” or “Call” when I have a pop up open of a safety resource.	32 – 34
I would like to become a member of a community so that I can see community-logged incidents and view and chat with other members of my community.	Given that I am a user, when I navigate to “communities” in the main menu, I expect to see my personal communities or add a new one.	38
	Given that I am a user, when I add a new community, I expect to set the location pin so that it recognises the community the location belongs to.	35 – 37
	Given that I am a user, when I go to one of my communities, I expect to see a community map with previously logged incidents which I can apply filters to.	45 – 51
	Given that I am a user, when I go to one of my communities, I expect to enter the community chat room and chat with co-members or start a personal chat.	42, 43
	Given that I am a user, when I go to one of my communities, I expect to see a user overview and report a user in case I don’t trust the user.	42, 44
	Given that I am a user, when I go to one of my communities, I expect to find tips and tricks on how to feel more safe in my community/neighbourhood.	39 – 41

<p>I would like to have an overview of my settings so that I can edit and set personal account details</p>	<p>Given that I am a user, when I go to settings I expect to see an overview of settings options in a listing view.</p> <p>Given that I am a user, when I go to edit details I expect to see and amend my personal details and reset my password.</p> <p>When I go to settings, I expect to find more information about the emergency button.</p> <p>When I go to settings, I expect to be able to set push notifications per community I am part of and set the notification radius.</p> <p>When I go to settings, I expect to be able to switch on and off my GPS location.</p> <p>When I go to setting, I expect to be able to set my movement weights per day and night time separately and have an explanation of how it works.</p>	<p>52</p> <p>53, 58</p> <p>54</p> <p>55</p> <p>55</p> <p>56, 57</p>
<p>I would like to have an S.O.S. button in the map section which I can click to send an emergency signal.</p>	<p>When I click on the S.O.S. red button, I expect to get a push notification with the choice of sending the emergency signal or cancelling the action.</p>	<p>59</p>
<p>I would like to be able to respond to an emergency request to help a co-community member.</p>	<p>When I am a member of a community, I would like to get a pop up when a user within my community sends an emergency signal and have the option to respond or decline it.</p> <p>When I accept an emergency request, I expect to get the route to the emergency request sender with the use of a GPS tracker.</p>	<p>60</p> <p>61</p>