MSc Programme in Urban Management and Development

Rotterdam, the Netherlands

September 2020

The influence of physical built environment and socio-economic characteristics on walkability in saburtalo district of Tbilisi

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Country: Georgia

Report number: 1375

UMD 16

IHS Making cities work Erasmus

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Summary

Academic and popular literature widely argues about the importance of sustainable urban development and how transportation has a tremendous role in it. A growing number of cities worldwide tries to improve the sustainability of the transportation system by promoting the usage of non-motorized transport modes such as walking and cycling on short distances. Mostly, because of the health, social and economic benefits that compact cities create (Oriol et al., 2014). Similarly, Tbilisi tries to shift the paradigm and promote sustainable modes of transportation to tackle the aforementioned problems by putting a pedestrian on the top of the priority pyramid.

While walking is one of the common modes of transportation, it is one of the most sensitive modes to external elements also. Therefore, it is crucial to understand how the physical built environment and socio-economic characteristics hinder the citizens of Tbilisi from walking. By explaining how the physical built environment and socio-economic characteristics affect the walkability in Tbilisi, this research could contribute to the further development of the pedestrian-friendly policy. It can also guide intentions to create strategy document concerning pedestrians. Thus, the practical relevance of the study is increasing. Thus, the research's objective is to determine these effects influence. This is possible by comparing subjective and objective data that was obtained by both primary and secondary sources. The objective will be attained by conducting explanatory research.

The study is based on the theory of the built environment, the theory of travel behaviour and walkability concept.

This research uses one of the most prevalent research instruments a questionnaire. Besides the questionnaire data, spatial data (secondary data) including objective elements of the physical built environment were collected from various sources. The primary data were analysed using descriptive statistical methods and inferential statistics. As for the secondary data, network analysis, density and proximity analysis were used, in the GIS environment.

With regards to the main research question, the study explored the walkability index measured by survey and by spatial analysis. Walkability index was defined as the dependent variable, while physical built environment and socio-economic characteristics were represented as independent variables.

The research is the initial effort to explore characteristics influencing walkability in Saburtalo districts. The research findings show that there is a need for a wider variable range, for example, education level, relief and weather.

To conclude, as the interpretation of analysis suggests subjective indicators play a lesser role in walkability determination rather than the objective ones in Saburtalo district. In other words, analysis has shown that mixed land use, presence of streetlight and trees have a more significant position in determining walkability in Saburtalo district than age, gender or vehicle ownership, for example.

Keywords

Walkability, Built Environment, Socio-economic characteristics, Saburtalo district, Tbilisi, Walkability Index

Acknowledgements

First and foremost, I would like to express my appreciation to my supervisor Dr Taslim Alade for the continuous support, patience and motivation in the process of creating this work.

I would also like to thank Julia Skinner for being the second reader, for reviewing the thesis, for the insights and recommendations.

I should like to express special appreciation to the faculty members, staff and my friends from UMD16 who created unforgettable experience even though the unexpected appearance of the pandemic cut our time together in half.

My gratitude to Sandro Mikadze, Giorgi Todadze, Elene Mikadze, Davit Daiauri whose support was invaluable.

Last but not list, special thanks and love to my family and my husband Davit Adeishvili for their unconditional love and support.

Abbreviations

BE	Built environment
GEL	Georgian Lari
HHS	Household Survey
IHS	Institute for Housing and Urban Development Studies
PA	Physical activity
TPB	Theory of Planned Behaviour
WI	Walkability Index

Table of Contents

List of Figures

List of Tables

List of Formulae

Chapter 1: Introduction

This chapter introduces to the reader the background and the problem statement of the study. Relevance and the research objective of the study is also presented in the chapter, alongside with the main and sub-research questions.

1.1 Background Information

Walking is basic, the most elementary form of transportation. Thus, every human has a right to walk safely and comfortably despite the gender, sex, physical ability and living location.

High share of walking in a city's modal split has been affiliated to clean air, solving traffic congestion, reducing health issues, increasing economic activity, socialization within a neighbourhood and general liveability of a city.

As John Butcher (para.1, 1999) stated:

> *"Walking is the first thing an infant wants to do and the last thing an old person wants to give up. Walking is the exercise that does not need a gym. It is the prescription without medicine, the weight control without diet, and the cosmetic that can't be found in a chemist. It is the tranquilliser without a pill, the therapy without a psychoanalyst, and the holiday that does not cost a penny. What's more, it does not pollute, consumes few natural resources and is highly efficient. Walking is convenient, it needs no special equipment, is self-regulating and inherently safe. Walking is as natural as breathing".*

Academic and popular literature widely argues about the importance of sustainable urban development and how transportation has a tremendous role in it. From an ecological point of view, the significance of sustainable transportation in climate change adaptation and mitigation is widely recognized (Banister, 2011) as the transportation sector is responsible for 20.4% of CO2 emission from fuel combustion (World Bank, 2014). From a health perspective, according to the World Health Organization (2018), road traffic-related deaths remain consistently high as 1.35 million people die globally each year. From an economic standpoint, congestion is one of the issues (Litman and Burwell, 2006) as the level is continuously increasing especially in cities. Time spent in congestion is steadily rising that affects the level of activities engaged by the people during the workday. According to INRIX Global Traffic Scorecard (2019), citizens of the eight most congested cities spent from 149 to 191 hours in congestion. Thus, congestion develops into "economic tax on cities". Moreover, transportation is one of the substantial items of a household budget and in car-dependent cities underdeveloped opportunities for other modes, other than a private vehicle, social exclusion increases (Leveraging Urban Mobility Disruptions to Create Better Cities, 2020).

Academics and professionals worldwide have been looking for solutions to all these problems for a long time. It is not surprising that active transportation modes, being walking and cycling, have been confirmed to be the remedy for abovementioned troubles as the multidimensional characteristic of active travel enables cities to alleviate all problems discussed earlier in this paragraph. Besides, academic, as well as empirical, evidence exists as proof that active transportation not only loosens problems but also creates financial, health and environmental benefits. By promoting walking and cycling health of an individual can be improved; as fewer people are likely to use private vehicles noise and air pollution can be reduced, which contributes

to less congestion; an increase of the liveability and overall quality of life can also be achieved. With such advantages, the question to ask is how to encourage walking. Among academics, several ways have evolved to encourage people to walk, one of which is altering the physical built environment (BE) features (Vale et al., 2016).

A multidisciplinary approach – Sustainable Urban Development is determined by three pillars: environment, social and economic development. These pillars are interconnected and none of them exists without others. Promoting and creating equal opportunity for active transportation modes (walking and cycling) is one of the working solutions to sustainable urban development issues many researcher, professionals or advocates have confirmed (Litman and Burwell, 2006; Speck, 2020). Walking naturally is considered as a social activity and walkable neighbourhoods benefit to the area by enriched social capital, decreased traffic pollution and improved economic sustainability (Kim et al., 2019). Many researchers have confirmed strong relation between socio-economic characteristics and walkability of a neighbourhood.

Tbilisi, the capital city of Georgia, with 1,2 million inhabitants, also suffers from traffic-related problems that are repercussions of car-oriented development rooting from the Soviet Era. Rapid industrialization directed the city's early development alongside the river Mtkvari (Kura) that could be one of the causes of current transportation problems (Gonçalves et al., 2016). Besides, after the collapse of the Soviet Union (1991) Tbilisi faced the civil war, increasing the number of crimes, financial crisis, constant power cuts and failure of public transportation (Salukvadze and Golubchikov, 2016). Moreover, after the Rose Revolution, in 2003, so-called "investor urbanism" flourished neglecting the city's long-term development strategies (Van Assche and Salukvadze, 2012). Thus, the city's development path for the last few decades contributed to soaring car ownership and car usage. According to the Ministry of Internal Affairs, the number of registered cars in Tbilisi has increased from 413,414 (2016) to 481,888 (2018).

The situation affects the city on an environmental, economic and social level. In addition, air pollution is above the critical point, and GHG emission from transportation accounts for 71% (State Audit Office, 2018). The household survey (HHS) that was conducted in 2016, by the municipality of Tbilisi and the French consultancy company shows the modal share of Tbilisi (Figure 1).

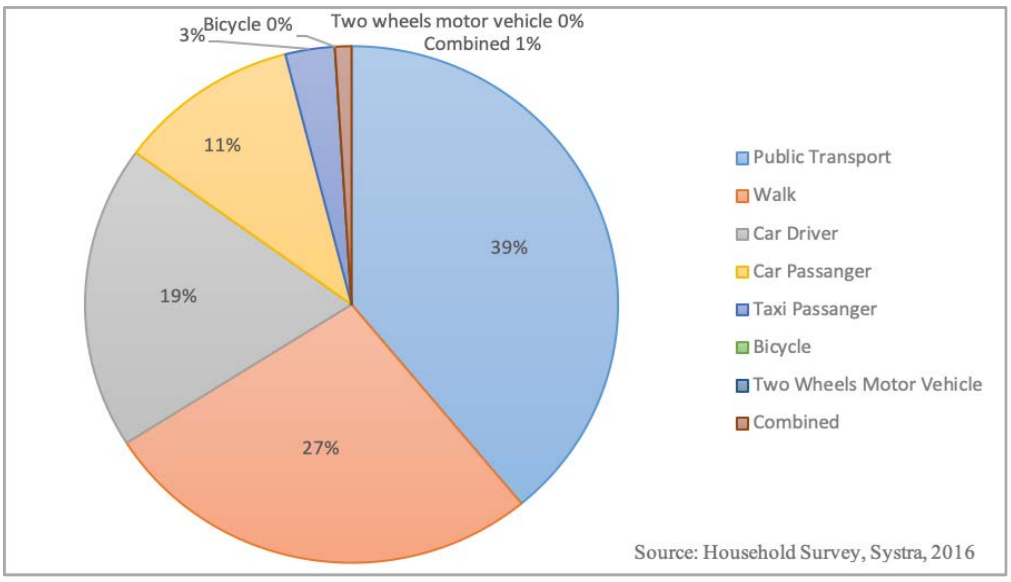
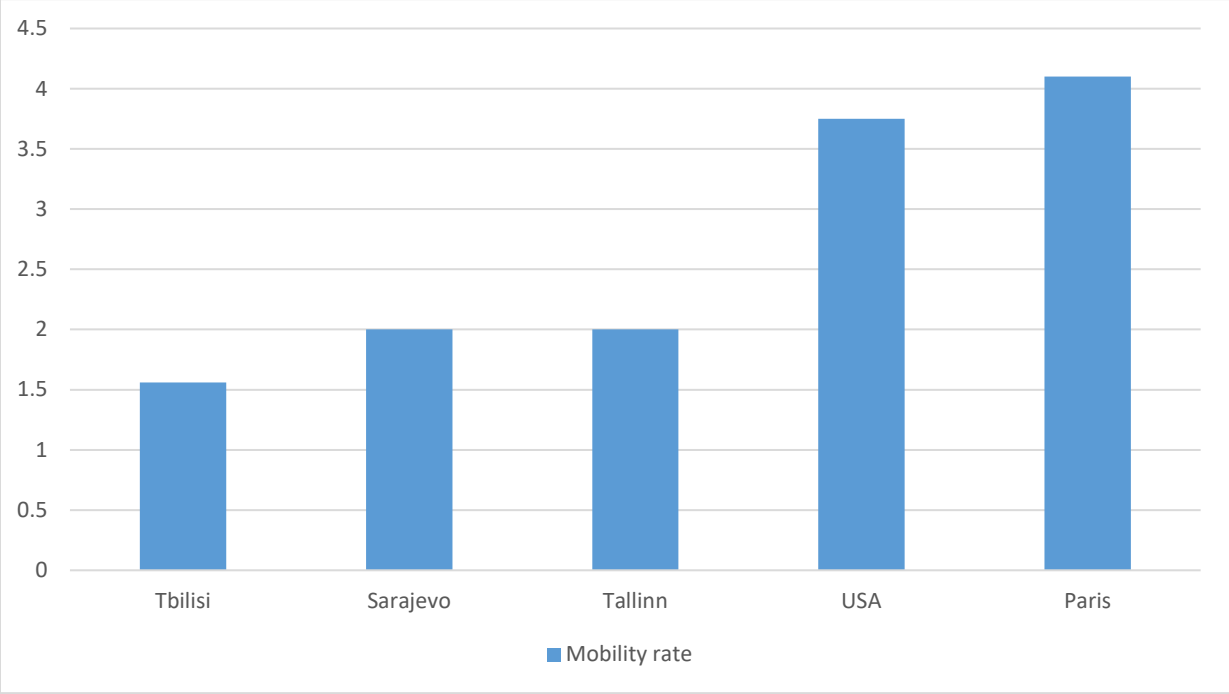


Figure 1. The modal share of Tbilisi

According to the household survey, the most popular mode of transportation is public transport with a share of 39%. If we combine trips performed by private vehicles, proportions of car driver, car passenger and taxi passenger, they together contribute to a share of 33%. Accordingly, walking stands as the 3rd most popular mode with a proportion of 27%. Tbilisi's modal share may seem balanced. However, the city still suffers from congestion, air pollution and other urban problems. Besides, the HHS shows a growing trend of motorization rate that increased by 30% between 2011 and 2016. The non-motorized mobility rate stands at 0.42 trips per day, while the number of motorized trip rate stands at 1.14 meaning that people in Tbilisi prefer to use vehicles as a daily mode more than twice than walk or cycle, for example. Moreover, mobility rate (meaning how many trips person performs on a daily basis) for Tbilisi is 1.56 trips. On an international scale this rate stands on the low end as in Sarajevo the mobility rate stands at 2.0, in Tallinn – at 2.4, in the USA - at 3.75 and in Paris – at 4.1 (see Graph 1).



Graph 1. Mobility rate on international scale, source: HHS, 2016

Moreover, in Tbilisi car trips on the distance smaller than 1.5 km contribute to the share of 20% (SYSTRA, 2016). This trend contributes to detrimental impacts on urban environment such as injuries, deaths, health issues and pollution. Thus, it is necessary to increase the share of walking.

1.2 Problem statement

A growing number of cities worldwide tries to improve the sustainability of the transportation system by promoting the usage of non-motorized transport modes such as walking and cycling on short distances. Mostly, because of the health, social and economic benefits that compact cities create (Oriol et al., 2014). Similarly, Tbilisi tries to shift the paradigm and promote sustainable modes of transportation to tackle the aforementioned problems. Therefore, according to the city's transportation policy, a pedestrian is on the top of the priority pyramid. However, the non-motorized mobility rate is remarkably low (SYSTRA, 2016) in Tbilisi. Besides, non-motorized

transportation plan or strategy does not exist (Giely, 2015) that would concern improving and promoting active transportation modes based on the complete and thorough research. Even though, the city government tries to prioritize pedestrian mobility, the pedestrian infrastructure and the physical built environment does not have an adequate quality in Tbilisi. The primary problems exist with regard to sidewalks as in most cases they are not present along streets. Blocked sidewalks with cars and construction fences also are the concern of residents (Babunashvili, 2018). Besides, because of the inadequate pedestrian infrastructure, walking to the destination is not comfortable, therefore, destination located objectively on shorter distance from origin is perceived relatively far away (Kankia, 2019). Moreover, the traffic accident statistic is really high, in Georgia. According to the Ministry of Internal Affairs, in 2019 only pedestrian number of deaths in traffic accidents accounted for total of 100 people. The fact obviously serves as an impeding factor for walking.

On the Tbilisi online forum, citizens of Tbilisi city are talking about how insufficient pedestrian infrastructure and inadequate walking accessibility hinders safe and comfortable walking experience in Saburtalo district of Tbilisi:

> *"Sidewalks are very narrow… people are stepping on each other… new ground-level sidewalks should be constructed, pedestrian islands and public spaces too" (Sopromadze, 2020).*

> *"This city is not oriented to pedestrians. It is necessary to improve pedestrian infrastructure" (Siradze, 2020).*

> *"Sidewalk occupation continues, parking entrance at newly rehabilitated street inhibits pedestrian movement" (Arabuli, 2020).*

While walking is one of the common modes of transportation, it is one of the most sensitive modes to external elements also. Therefore, it is crucial to understand how the physical built environment and socio-economic characteristics hinder the citizens of Tbilisi from walking. The previous studies concluded that individual mode choice is a relative, complex and individual decision-making process and is affected by several elements (De Witte et al., 2013; Guinn and Stangl, 2014). A vast academic literature focuses on factors influencing walkability. According to the literature review the physical built environment and socio-economic characteristics (such as gender, age, income, car ownership and household composition) have been confirmed to be some of the greatest influencers of walkability (Sundquist et al., 2011; Cervero and Kockelman, 1997; Frank et al., 2010; Forsyth et al., 2008; Aziz et al., 2018; Clifton et al, 2016; Riggs and Sethi, 2020).

Physical built infrastructure such as sidewalk, trees, crosswalks and streetlights have enormous impact on walkability. Sidewalk presence creates comfort for pedestrians, the adequate width of a sidewalk encourages walking within the neighbourhoods as they enable users to walk at their pace, socialize and stand without impeding other users' walking experience (Wicramasinghe and Dissanayake, 2017; Institute of Urban Studies, 2016). Besides, trees and their canopies shelter pedestrians from the hot weather (Maco and Mcpherson, 2003). Similarly, presence of streetlights

spawns the feeling of safety and, thus, increase the walkability (Peña-García et al., 2015; Sallis et al., 2015; Vich et al., 2018).

Land use explains diversity of the neighbourhood, Land use mix and percentage of walking are positively correlated (Frank and Pivo, 1994). Concentrating diverse land uses in a particular area creates cluster of activities that also contributes to increased accessibility (Naess, 2004). Numerous studies have found positive relations between intersection density and willingness to walk. Highly interconnected street network creates short distances, is less suitable for car traffic and therefore facilitates more PA (Carlson et al., 2015; Koohsari et al., 2016).

All abovementioned factors influence pedestrian mobility. Among others low speed and low traffic areas create sense of safety, while tree shelter provide shade from the sun and presence of greeneries is also positively perceived by the pedestrians. Short distances create possibility for pedestrians to often opt for walking as the main mode. Moreover, pedestrians tend to be very sensitive, long routes inhibit walking. Additionally, interesting scenery could be the source of entertainment and facilitate social walking (Arellana et al., 2020; Zuniga-Teran et al., 2019; D'Orso and Migliore, 2019).

Apart from already mentioned elements, socio-economic characteristics like age, gender, income, car ownership and household composition (having children) have been found to influence walkability (Schneider, 2013; Clifton et al, 2016). Clifton et al. (2016) found an evidence that pedestrians' will to walk is strongly influenced by socio-economic characteristics such as car ownership and children in household (household composition). Schneider, (2013), on the other hand, adds to the group of characteristics age, gender and income as significant influencers. Moreover, sense of safety has also been found to be one of the influencers (Peña-García et al., 2015).

1.3 Relevance of the research topic

There is a vast academic literature covering factors influencing walkability. However, there are few academic studies in Georgia, addressing neighbourhood walkability such as one conducted in 2019 by the NGO "Walk". This fact increases the scientific relevance of the study, as the context and location, where the study is conducted, is one of the significant affecting factors on mode choice (Sundquist et al., 2011).

Moreover, by explaining how the physical built environment affects the walkability in Tbilisi, this research could contribute to the further development of the pedestrian-friendly policy. It can also guide intentions to create strategy document concerning pedestrians. Thus, the practical relevance of the study is increasing. In addition, understanding the impact of the physical built environment and social economic characteristics on walkability and targeting those impacts to promote walking can also contribute to alleviating congestion issues (Oriol et al., 2014). Besides, as the urban space is assorted and not every social group uses the space similarly. Thus, understanding which socio-economic characteristics determine walkability is one of the prime points in developing the adequate transportation policy (Oriol et al., 2014). Furthermore, results from this research can support the use of walkonomics in Tbilisi, Georgia. Walkonomics is an app developed to help pedestrians find the most beautiful tree-filled route to the destination, rather than just the fastest one. Such apps aid and promote pedestrian friendly movement (Vivion, 2013).

1.4 Research objective

The objective of the research is to explain how the physical built environment and socio-economic characteristics influence the walkability in Saburtalo district of Tbilisi. The objective will be attained by conducting an explanatory research.

1.5 Main research question and research sub-questions

The main question this research is aiming to answer is:

How does the **physical built environment** and **socio-economic characteristics** influence **walkability** in Saburtalo district of Tbilisi?

Following sub-questions have been formulated to answer the main question:

1 How does the physical built environment influence walkability in Saburtalo district of Tbilisi?

2 How does the socio-economic characteristics influence walkability in Saburtalo district of Tbilisi?

Based on the main research question following independent and dependent variables are derived:

IV: Physical built environment (Independent variable)

Sub-variables

- Physical Characteristics of streets
- Land-use mix
- Street connectivity

IV: Socio-economic characteristics (Independent variable)

Sub-variables

- Age
- Gender
- Income
- Vehicle ownership
- Household composition
- Perceived safety

DV: Walkability (Dependent variable)

Sub-variables

- Walkability index
- Pedestrian walkability

1.6 Scope of the research

The study is located in Tbilisi, the capital city of Georgia, study area is delimited as one of the districts of Tbilisi – Saburtalo district. The area of Saburtalo district is 4.9 square kilometres and population is 47,368 people that is 4% of Tbilisi population. Saburtalo district with diverse public,

private and educational facilities, workplaces and recreational areas, is traversed with two main arterial avenues, each one serving one-directional mixed traffic. Due to restricted timeframe and pandemic constraints the research area included only the sub-district of Saburtalo district. In and effort of this study this sub-district is also called “Saburtalo”, as there is no name corresponding the area. Additionally, neighbourhoods are not delimited by the administrative boundaries in Georgia. Hence, the study area is determined in accordance with the area used in census by the National Statistics Office of Georgia and there is data available of land uses and population.

As already mentioned, the objective of the research is to explain how the physical built environment and socio-economic characteristics influence the walkability in Saburtalo district of Tbilisi. This is possible by comparing subjective and objective data that was obtained by both primary and secondary sources.

Chapter 2: Literature review/theory

This chapter includes the literature review that concerns the state-of-the-art theories and concepts. It also discusses the concept of walkability, walkability and strong determinants of mode choices. It also presents the conceptual framework that was formed based on the comprehensive literature review, related to the physical built environment, socio-economic characteristics and walkability.

2.1 State-of-the-art of the theories/concepts of the study

Increasing mobility demand, leading a car as a dominant mode of transportation, raised a concern about managing mobility and its adverse side effects in a sustainable manner (De Witte et al., 2013). Due to its social, economic and environmental benefits, non-motorized transportation has been confirmed to be a sustainable mode of transportation (Litman, 2017). Therefore, numerous concepts and movements have emerged regarding sustainable transport development. These diverse concepts and movements may differ in terms of concern areas; however, they all share aspiration towards increasing the proportion of non-motorised transportation. One of the common, basic and inexpensive type of non-motorised transportation is walking. Besides, a large portion of literature in health has documented the health benefits associated to it (Frank et al., 2006). Thus, walking as a form of transportation or recreation has advance effects on the three pillars of sustainability and diverse fields advocate for increasing share of walking in daily life. However, while we live in automobile-dominant cities, it is not easy to change peoples' behaviour from sedentary to an active lifestyle. The motivation of walking behaviour, and in general physical activity (PA), is influenced by several factors (Sundquist et al., 2011). Next sub chapters discuss the theories and factors influencing walkability. (In this study, terms *walking*, and *physical activity* are used interchangeably).

2.1.1 Theory of the built environment (BE)

The extensive academic literature review recognises the concept of the built environment as an excessively diverse and vast. The built environment is a concept that describes manmade structure in a broader sense including cities, buildings, streets, shelters, practically any artificial modification of the nature (Moffatt and Kohler, 2008; Sallis, 2009). The built environment is considered to be one of the strongest determinants of human behaviour and there is a defined close relationship between the physical built environment and physical activity (PA). This relationship is connected to the walkability. Factors include presence of sidewalk, land use mix, comfortable walking distance between destinations and individuals perceived safety. Studies have identified statistically significant associations between small sized neighbourhoods and increased walkability, as shorter distance encourage daily physical activities without using motorized transportation. Moreover, pleasant sceneries and well-lit environment facilitate more on-foot activity (Renalds et al., 2010). There is a belief, based on empirical research, that "if you build it, they will come", presuming that if adequate built environment exists, people will employ it (Root et al., 2017).

Besides, one of the most common troubles urban population face are mental health issues. Disorders such as depression, anxiety, stress, "psychological vulnerability", etc. are widely associated with the living environment (Zhang et al., 2020). Socioecological model posits that mental health is affected by the various factors which include environmental effects as well. Neighbourhood-level studies examine BE and its effect on mental health and vast number of

studies has proved association between increased risk of mental health problems and deprived living environment (Tao et al., 2019).

Various theories have been established on the concept of "environment". For example, the Social Cognitive Theory postulates that human behaviour is impacted by the environment. Environment can have different notions; it can be physical (e.g., built environment) and social (e.g., social norms and beliefs), also subjective (perceived) and objective (existing). Besides, significant relationship exists between BE and PA that is expressed with "individual-level perceptions". According, to social cognitive models, individual's perception of the BE determines and creates "basis of social cognitive factors" that in turn affects the PA. For example, BE that is characterized with poor connections and low level of accessibility is likely to form negative assumptions about oneself and attitudes towards PA itself. "Mediation models suggest that this pathway is known as ab, where path a is the effect of the built environment on social cognition, path b is the effect of social cognition on PA, and ab is the mediated relationship between the built environment and PA via social cognition" (Rhodes et al., 2020, p. 496).

Another theory considering the physical built environment as a behaviour determinant is the Behaviour Model of the Environment. The model, form socio-ecological standpoint, postulates that among social, physical environment features also have "power" to change and explain individuals' behaviour (Vale et al., 2016).

The BE's multidimensional nature imposes challenges to measure it (Glanz and Kegler, 2009). Besides, different facets of BE affects the quality of measures, while it is crucially important to produce high-quality one. Yet, consensus is not achieved. Brownson et al. (2009) defines three categories of the BE measures that are being commonly used:

1. The first category studies the perceptions of individuals to land-use, transportation and recreational environments via self-administered questionnaires or interviews.
2. The second category includes observational method or audits.
3. The third one uses existing spatial data sets commonly analysed using GIS.

Several broadly defined fields like health, behaviour science, transportation, urban design and leisure studies developed measurements of the physical built environment that is directly relevant to the physical activity. For example, for city planning fields, relation between design and travel behaviour has been a great interest since "at least the 1980s". They have developed theories of built environment. "Of special relevance to physical activity, planners created conceptualizations of community design such as walkability, or ability of people to walk to nearby destinations" (Sallis, 2009, p. 89).

Frequently, physical built environment includes the spatial characteristics of the area such as proximity and accessibility, sidewalks, streetlights and aesthetic qualities (trees, parks) (Vale et al., 2016; Dovey and Pafka, 2018). These factors have been found to strongly contribute to walkability. Different functions concentrated in close proximity encourages walking. Moreover, the presence of sidewalk is also very widely recognized factor promoting walkability. The adequate conditions of sidewalks enhance the walking experience. In her iconic book The Death and Life of Great American Cities, Jane Jacobs dedicated not only one, but three chapters to the importance of sidewalks and their contribution to safe, vital and socially inclusive neighbourhoods. In addition, well-lit streets develop the sense of safety and presence of the greenery creates visually aesthetic environment that contributes to increased willingness to walk.

2.1.2 Theory of travel behaviour

The concept of travel behaviour is multidimensional. There are several other elements but most prominent among them is a choice of transportation mode. And for the scope of the research focus is on walking. Generally, the mode choice refers to the individuals' choice of different transportation modes (walking, cycling, car, public transport, taxi) for daily activities.

The researchers of the various fields try to identify what influences on peoples' preferences while choosing a particular mode. However, mode choice is a complex decision-making process and is influenced by various of factors. Researchers categorise these factors into "hard factors" and "soft factors". "Hard factors" include cost, time and effort associated with the mode. While "soft factors" include individuals' perceptions and attitudes. Studies using utility theories are focused on "hard factors", for example. Utility theories suggest that individuals make their mode choices by analysing different aspects of alternatives such as "time, cost and effort". However, these theories cannot explain why "individuals in similar situations with corresponding socioeconomic characteristics" make different choices (Heinen, 2016). In oppose of utility theories, cognitive theories try to explain these differences. Studies using cognitive theory assume that individuals might "form different mental map of the same built environment", that is the reason why different choices are made per individuals (Ma and Cao, 2019).

A plethora of studies have used the theory of planned behaviour (TPB) (Ajzen, 1991) to forecast individuals' choice of mode. The conclusion drawn based on the studies is that mode choice is depended on "attitudes and perceived barriers to behaviour", so called "soft factors". In oppose to other theories, TPB posits, in case of alternative, choice is depended on the intentions' strength to "perform the behaviour" (Bamberg et al., 2011). However, some studies have reported some inconsistency between attitudes and behaviour. The TPB explains these discrepancies by underlining that "attitudes do not influence behaviour directly but indirectly". Also, two additional important determinants are identified: "perceived social stress" and "perceived ability to perform behaviour". However, past actions and behaviour is also identified as strong determinant (Van de Coevering, P et al., 2016). Moreover, a vast number of studies suggest that travel mode choice is a result of habits and is no more a conscious decision (Anable, 2005). For example, theory of interpersonal behaviour shows that when behaviour is performed daily over the long period of time "initiation of behaviour is no longer guided by behaviour intentions" (Gardner and Abraham, 2008, p. 301).

Another construct that tries to explain travel behaviour is personal identity. Identity theory postulates that individuals may possess several identities; and identities are linked to "culture and social structure", examples may be being a father, teacher, being male, etc. However, there is transport identities, self-identities and place identities also, examples are driver, cyclist, being environmentally friendly. These identities are associated to have effect on travel behaviour, however more empirical evidence is needed (Heinen, 2016).

As Götschi et al. (2017) state, Alfonzo develops ranking of "walking needs" found on the Maslow's theory of motivation. Here, travel behaviour of human is based, firstly, on feasibility, then "accessibility, safety, comfort and pleasurability". Other factors also play roles of determinants, such as climate, culture, psychology, etc.

2.1.3 Socio-economic component of travel behaviour

Socio-economic frameworks are prevalently used in the recent studies as one of the main determinants of people's behaviour and lifestyle. According to Van Acker and Witlox (2009)

Ganzeboom developed a thought that peoples' behaviour is result of their lifestyle. Based on lifestyle peoples' preferences determine how they introduce themselves socially. These choices are influenced by "available opportunities and constraints" and are resulted in "actual behaviour". Individuals' lifestyle is connected to their socio-economic characteristics. For Ganzeboom lifestyle is perceived as a continuum that is determined by three dimensions and thus, he distinguishes fixed (e.g., gender) and varying (e.g., household composition) socio-economic characteristics, that influence behaviour.

Based on the above, socio-economic component of travel behaviour includes the socio-economic characteristics such as car ownership, income, age, household composition and gender.

Some researchers suggest potential social environment constrains to walking like presence of aggressive dogs, high level of crime, "lack of social cohesion" (Adkins et al., 2017b). However, some authors suggest that neighbourhoods with socially disadvantaged population possess built environment with higher street connectivity and mixed land use (Loh et al., 2019).

Clifton et al. (2016) found an evidence that pedestrians' will to walk is strongly influenced by socio-economic characteristics such as car ownership and children in household (household composition). Further, studies have shown strong negative correlation between households with children and choosing walking as a mode (Forsyth et al., 2008; Clifton et al, 2016; Riggs and Sethi, 2020). Some researchers have found characteristic that negatively influences walking is car ownership. Households with availability of alternative modes are prone to walk less as they are more sensitive to their environment (Koh and Wong, 2013; Guinn and Stangl, 2014; Aziz et al., 2018; Clifton et al, 2016).

Schneider, (2013), on the other hand, adds to the group of characteristics age, gender and income as significant influencers. As the age increases the willingness to walk decreases (Aziz et al., 2018). As for gender, the results are inconsistent - some researchers indicate that women tend to walk less compared to men (Owen et al., 2007; Aziz et al., 2018). Others', systematic review of studies shows that more women walk for leisure than man, and there was no gender difference detected in walk generally. However, a study conducted in Czech Republic show that women walk considerably more than men (Pollard and Wagnild, 2017). As for the income, higher the household income, lower the likelihood choosing walking as a mode (Guinn and Stangl, 2014; Aziz et al., 2018; Buehler, 2011). However, other studies found inconsistency in correlation between income and walking. Aziz et al. (2018) notes positive correlation between walking and income for New York city and Baltimore and negative correlation for Portland.

Moreover, sense of safety has also been found to be one of the influencers (Peña-García et al., 2015). Different solutions for increasing the level of safety within the neighbourhood boundaries have been suggested, such as "reducing traffic speed and volume", "separating sidewalks and vehicle lines with curbs and trees" (Dörrzapf et al., 2019; Kockelman et al., 2013).

2.1.4 Concept of Walkability

Walkability is a prevalent term; however, the concept remains somewhat ambiguous. Dictionaries do not (very rarely) define the term, while there is inconsistency in existing definitions (Dörrzapf et al., 2019).

As Rafiemanzelat et al. (2017) say, walking has been studied from diverse disciplines and each perspective defines walking individually. Accordingly, the literature review confirms much research have proved that walking has environmental, social and economic advantages (Turoń et

al., 2017). For example, for urban planners walking is a means to alleviate urban sprawl, reduce level of greenhouse gas emission, level of car usage and, thus, congestion. Besides, from the health perspective, walking is defined as one of the major factors in lowering the rate of obesity, cardiovascular and other chronic illnesses. This complies with the postulate of the famous Danish architect and urban designer Jan Gehl - "there is more to walking than walking" (2011). As Turoń et al. (2017) posit popularity of walkability concept stemmed from the fact that city governments often neglect other users' right to the streets. However, lately focus has been changed from automobiles to human.

The very first identification of the concept of walkability in scientific field dates back to late twentieth century. It referred to the built environment and other factors concerning walkability. Walkability can be defined in numerous ways; it is connected to physical and non-physical elements that contribute to the "quality of walking environment" (Rafiemanzelat et al., 2017). Moreover, walkability captures capacity of the built environment "to be walkable" and the "ability" to reach destinations "on foot" (Vale et al., 2016). Besides, the concept of walkability has a prominent place in response to the adverse effect automobile-oriented cities bring to cities and public spaces.

2.1.4.4 How to measure walkability

Walkability can be assessed by different methods and there is no consensus on a specific tool on measuring walkability. Ellis et al. (2015) suggests Brownson et al's (2009) categorization of walkability measures into: subjective measures based on peoples' perceptions, observed measures based on audits and objective measures based on the analysis of spatial data using Geographic Information Systems (GIS).

Measure type	Methods of measurement	Unit	Example
Objective	GIS	Area, Segment	Land-use, intersections, street
Subjective	Survey	Individual respondent	Perceptions, attitudes

Table 1. Measurements profile

As already mentioned, indices are broad and various researchers have tried to create index that consistently measures the walkability. One of the most prevalent indices are discussed in the following paragraphs:

3Ds - A monumental study by Cervero and Kockelman (1997) which was conducted in San Francisco Bay Area introduced the concept of 3Ds: Density, Diversity and Design. The study resulted in conclusion that higher population density (ratio of residents to an area), diverse land-use mix (even distribution of land uses), and higher intersection density (ratio of intersections to sq. km) promoted physical activity. Thus, the concept of 3Ds measures the walkability of an area. These elements have been confirmed to have strong influence on walking by other studies as well (Sundquist et al., 2011; Glazier et al., 2015; Clifton et al., 2016; Van Dender, 2007; Guinn and Stangl, 2014; Clark et al., 2014; Frank et al., 2010; Forsyth et al., 2008).

Walk Score - One of the widely used measures is Walk Score. This is the index assessing the walkability of an area involving shortest distance to the destinations, the length of blocks and the intersection density. Walk Score combines gravity-based and topological accessibility and produces the score of the area (ranged 0-100). Even though various studies have validated the

score, critique is concerned about the exclusion of one of the crucial elements - subjective factors (Hall and Ram, 2018).

Walkability index – This index was originally developed by Frank (Frank et al, 2005). The original index was calculated using the following formula:

$$WI = 6 \times (z.score)\ Land\ Use\ Mix) + (z.score) Net\ Residential\ Density + (z.score) Intersection\ Density$$

Formula 1. How to calculate WI

Here:

z. score means standardized value.

Land Use mix is the entropy index (Diversity).

Net Residential Density is calculated by dividing number of households by the area of the residential land use (Density).

Intersection Density is calculated by dividing number of true intersections by the area (Design).

The 3Ds concept have been further developed into "Neighbourhood Walkability" as the fourth element, net retail area ratio, was added (Koohsari et al., 2016). This is a similar measurement ("Walkability index") as IPEN (International Physical Activity and the Environment Network) uses in its research concerning physical activity and the built environment. Walkability index involves sum of connectivity index, entropy index, floor area ratio index and population density index (Dobesova, 2012):

- Connectivity index also referred as intersection density, street connectivity is measured by the number of true intersections (3- or 4-legged) in a particular area. Numerous studies have found positive relations between intersection density and willingness to walk (Carlson et al., 2015; Koohsari et al., 2016).
- Entropy index also referred as land use mix, is a mix of land uses in a particular area and it characterizes how diverse the area is. Land use mix and percentage of walking are positively correlated (Frank and Pivo, 1994). Concentrating diverse land uses in a particular area creates cluster of activities that also contributes to increased accessibility (Naess, 2004). Originally the methodology was developed in the USA where each area (polygon) represents unique type of usage. Nonetheless this is not relevant for European cities, including Tbilisi. Here, merged usage is prevalent, meaning several usages (residential, commercial, office, retail, institutional) can be present at the same place. The equation for calculation the entropy index following form was used from Dobesova and Krivka (2012):

$$H(S) = \frac{-\sum_{i=1}^{k}[(p_i)\cdot(lnp_i)]}{ln\ k}$$

Formula 2: How to calculate entropy index

Where:

H (S) Entropy index

P_i Area of a particular category of land use over the total area of all categories (within the scope of one district)

k the number of land use categories in the particular district

- "Floor area ratio index" is a proportion between the retail building floor area and the retail land area (Ellis et al., 2015).
- Population density is measured by the number of residents in a particular area. Frank and Pivo (1994) found significant correlation between population density and percentage of walking. Dense cities imply shorter distances between functions, also, in cities with high population density streets are narrow and there is less space for parking. Therefore, it contributes to increased usage of non-motorized transport modes. Besides, empirical research has confirmed less energy consumption by transportation sector in dense cities, than in sprawled ones (Naess, 2004).

Walkability Index formula that is used in this study is adapted from the one originally developed by Frank et al (2005). The formula adaptation is a common practice when tackling the issue of data availability. Adapted version of the formula and the reasons behind the adaptation is further elaborated in the Chapter 3.

Self-reported or subjective measures - Some authors posit that subjective variables have low reliability compared to objective measures. Therefore, they encourage using GIS to overcome reliability problems (Maghelal and Capp, 2011). Conversely, other researchers advocate including individuals' perceptions also, as they reveal the interaction between the environment and the user. To this end, subjective measures are used through surveys (Yin, 2017).

2.2 Overview of factors influencing walkability

As already mentioned, walking is the most basic and common mode of transportation. However, this does not mean that it is straightforward to analyse from the researcher's perspective. A growing number of researchers supports a need for a multidisciplinary approach to understanding factors influencing walkability fully. However, as previously stated, some factors are strongly associated with impact on walkability (Bierlaire and Robin, 2009). Adkins et al. cite Ewing and Cervero that "mode choices depend on both the built environment and socioeconomics characteristics" (2017, p. 301). Next sub-chapters present elements influencing walking. These elements are chosen according to the literature review taken into consideration Tbilisi context and are categorized into two groups: the physical built environment and socio-economic characteristics.

2.2.1 Physical built environment

The physical built environment influences on walking have been a great interest of researchers over decades. The literature review suggests that physical built infrastructure such as sidewalk, trees, crosswalks and streetlights have enormous impact on walkability.

Sidewalk presence creates comfort for pedestrians. In addition, the width of a sidewalk is one of the most important indicators encouraging walking within the neighbourhoods. Moreover, wide sidewalks enable users to walk at their pace, socialize and stand without impeding other users' walking experience (Wicramasinghe and Dissanayake, 2017; Institute of Urban Studies, 2016). Besides, trees and their canopies shelter pedestrians from the hot weather as the outdoor climate conditions are closely related to walking. Institute of Urban Studies (2016) references Maco and Mcpherson (2003) noting that trees might influence users' choice of side of a road. Similarly, presence of streetlights spawns the feeling of safety and, thus, increase the walkability (Peña-García et al., 2015; Sallis et al., 2015; Vich et al., 2018).

2.2.1.1 Land-use mix

Land use mix could be the indicator for the diversity of the neighbourhood. Land use mix and percentage of walking are positively correlated (Frank and Pivo, 1994). Concentrating diverse land uses in a particular area creates cluster of activities that also contributes to increased accessibility (Naess, 2004). Therefore, accessibility is one of the crucial components of the "built environment" and cannot be separated from it (Vale et al., 2016).

2.2.1.2 Street connectivity

Numerous studies have found positive relations between intersection density and willingness to walk. Highly interconnected street network creates short distances, is less suitable for car traffic and therefore facilitates more PA (Carlson et al., 2015; Koohsari et al., 2016).

2.2.1.3 Pedestrian level of walkability

Several factors influence pedestrian mobility. The plethora of researchers have been studying the perceptions of pedestrians and factors influencing their decisions. Researchers suggest that ideal situation, among other parameters, could be the one where pedestrian is walking along the low traffic, low speed pathway, sheltered by tree shade, safe, direct route with interesting scenery. Low speed and low traffic areas create sense of safety, while tree shelter provide shade from the sun and presence of greeneries is also positively perceived by the pedestrians. Short distances create possibility for pedestrians to often opt for walking as the main mode. Moreover, pedestrians tend to be very time sensitive and long routes inhibit walking. Additionally, interesting scenery could be the source of entertainment and facilitate social walking (Arellana et al., 2020; Zuniga-Teran et al., 2019; D'Orso and Migliore, 2019).

2.2.2 Socio-economic characteristics

Apart from already mentioned elements, socio-economic characteristics like age, gender, income, car ownership and household composition (having children) have been found to influence walkability (Schneider, 2013; Clifton et al, 2016). Clifton et al. (2016) found an evidence that pedestrians' will to walk is strongly influenced by socio-economic characteristics such as car ownership and children in household (household composition). Schneider, (2013), on the other hand, adds to the group of characteristics age, gender and income as significant influencers. Moreover, sense of safety has also been found to be one of the influencers (Peña-García et al., 2015).

2.2.2.1 Age

The correlation between age and walk is characterised as negative – as the age increases the willingness to walk decreases (Cervero and Kockelman, 1997; Aziz et al., 2018).

2.2.2.2 Gender

As for gender, the results are inconsistent - some researchers indicate that women tend to walk less compared to men (Owen et al., 2007; Aziz et al., 2018). Others', systematic review of studies shows that more women walk for leisure than man, and there was no gender difference detected in walk generally. However, a study conducted in Czech Republic show that women walk considerably more than men (Pollard and Wagnild, 2017).

2.2.2.3 Income

Higher the household income, lower the likelihood choosing walking as a mode (Guinn and Stangl, 2014; Aziz et al., 2018; Buehler, 2011). However, other studies found inconsistency in correlation between income and walking. Aziz et al. (2018) notes positive correlation between walking and income for New York city and Baltimore and negative correlation for Portland.

2.2.2.4 Household composition

Further, studies have shown strong negative correlation between households with children and choosing walking as a mode (Forsyth et al., 2008; Clifton et al, 2016; Riggs and Sethi, 2020).

2.2.2.5 Perceived safety

Sense of safety is one of the crucial elements affecting walkability. Different solutions for increasing the level of safety have been suggested, such as "reducing traffic speed and volume", "separating sidewalks and vehicle lines with curbs and trees" (Dörrzapf et al., 2019; Kockelman et al., 2013).

2.2.2.6 Car ownership

Another socio-economic characteristic researchers have found negatively influencing walking is car ownership. Households with availability of alternative modes are prone to walk less as they are more sensitive to their environment (Koh and Wong, 2013; Guinn and Stangl, 2014; Aziz et al., 2018; Clifton et al, 2016).

2.3 Conceptual framework

From the literature several factors were identified affecting walkability. These factors have been brought together in two groups: elements of the physical built environment and socio-economic characteristics. According to the theory review, each factor consolidated in these two groups have been proved to have considerable impact on walkability. Accordingly, while forming the conceptual framework, besides the information found in the academic literature, the context of Tbilisi was also taken into consideration to determine the walkability of Saburtalo district of the city.

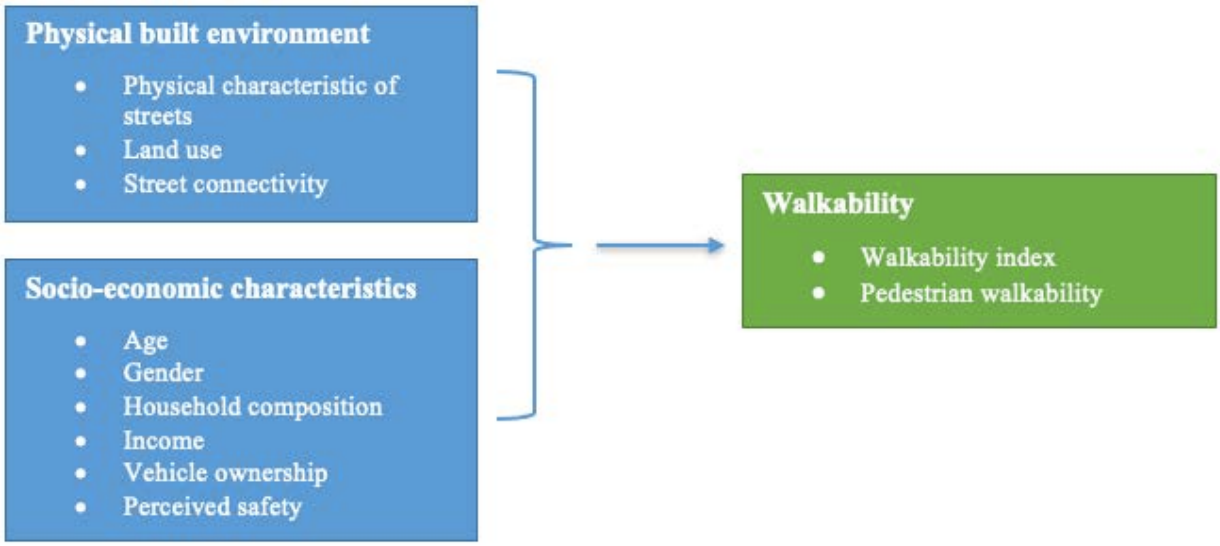


Figure 2. Conceptual framework

2.3.1 Physical Built Environment, Socio-economic Characteristics and Walkability

The relationship between these variables is characterized by interconnectedness. Plethora of studies have proved benefits of walking and even more studies have been trying to explore the factors influencing walkability. This determination for finding all influential factors is caused by the fact that our environment and population is in great danger in terms of ecology, health (Banister, 2011; Litman and Burwell, 2006; World Bank, 2014; World Health Organization, 2018) and now great economic challenges lie ahead of us owing to the pandemic (Covid-19). Understanding all these factors could help decision and policy makers to increase the effect of positive elements and decrease the influence of negative ones.

Now as the benefits of walking is known, the interest goes to the questions how walking could be encouraged? What factors do facilitate or inhibit walking? Theory of Built Environment suggests that physical built environment is one of the strongest determinants of human behaviour and there is defined close relationship between physical built environment and PA. Built Environment describes manmade structure in a broader sense any artificial modification of the nature (Moffatt and Kohler, 2008; Sallis, 2009). Physical built environment in this study includes street connectivity, land use and physical characteristics of streets. Street connectivity is measured by subjective and objective indicators and are compared to each other. Objective indicators include sidewalk presence, streetlight presence, accessibility, land use (diversity), population density, etc. While subjective indicators such as, level of intersection density (street connectivity), level of land use, level of safety, etc. explore perceptions and attitudes of the people within the district.

Academics and professionals worldwide have been looking for solutions to all these problems for a long time. It is not surprising that active transportation modes, like walking and cycling have been confirmed to be the remedy for abovementioned problems as the multidimensional characteristic of active travel enables cities to alleviate all problems discussed earlier in the study. Besides, academic, as well as empirical, evidence exists as proof that active transportation not only loosens problems but also creates financial, health and environmental benefits. By promoting walking and cycling health of an individual can be improved; as fewer people are likely to use private vehicles noise and air pollution can be reduced, which contributes to less congestion; an increase of the liveability and overall quality of life can also be achieved. With such advantages,

the question to ask is how to encourage walking. Among academics, several ways have evolved to encourage people to walk, one of which is altering the physical built environment (BE) features (Vale et al., 2016).

Chapter 3: Research design, methods and limitations

This chapter includes the description of the research design and methods. Here, on the basis of conceptual framework the operationalization table is also presented. It makes possible to link with each other the theoretical and empirical parts of the research. Moreover, this chapter discusses challenges and limitations of the research and offers the possible ways how to overcome them.

3.1 Description of the research design and methods

3.1.1 Research type and strategy

To answer the research question, an explanatory research type was considered to be adequate. The survey strategy has been chosen in order to answer the research question. A survey is the adequate strategy to reach a large number of population and thus, generalize research findings on the whole population of the district, that also increases the level of external validity of the study (Van Thiel, 2014). According to the research strategy a questionnaire will be administered. Moreover, a survey of residents will be coupled with objective measures of the built environment that will create an opportunity to compare and contrast different measurement tools.

3.1.2 Data collection

According to the research strategy data for subjective measures, such as level of land-use, level of population density, etc is collected via the field survey, that is the primary source of the information. The subjective indicators, as explained in the sub-chapter 2.1.4.1, measure sense and perceptions of density, safety, mix development and so on among the respondents. All the indicators are categorized and listed in the operationalization table (see Table 4). The survey is undertaken using the questionnaire instrument. Comprising 40 questions, the survey tried to determine perceptions of the Saburtalo district residents. Moreover, survey is the common tool to gather information about the attitudes and perceptions of the respondents within neighbourhoods. The primary data that is collected in the research is quantitative in nature. Quantitative data collection method is chosen in order to gather large amount of information and to analyse it statistically.

Some objective measures using the secondary data was gathered from the local authorities such as Tbilisi City Hall, National Statistics Office of Georgia, to name a few.

As the study is considering the survey as the research strategy, triangulation is not necessary. However, in order to increase the internal validity, triangulation is introduced. Therefore, in this regard, triangulation is based on the survey, secondary data from the municipality and other authorities and data from spatial/network analysis using Geographic Information Systems (GIS).

3.1.3 Research instruments

This research uses one of the most prevalent research instruments that is questionnaire. The questionnaire is based on survey. The intercept survey provided short questionnaires for the respondents during the data collection. Respondents were asked to indicate how distinct variables influence their choice to walk. For some questions 5-point Likert-scale format is adopted to detect a respondent’s perceptions. Other questions use closed-ended fixed-response items, for questions like monthly income, ownership of vehicle and so forth. The questionnaire is formed based on the extensive literature review.

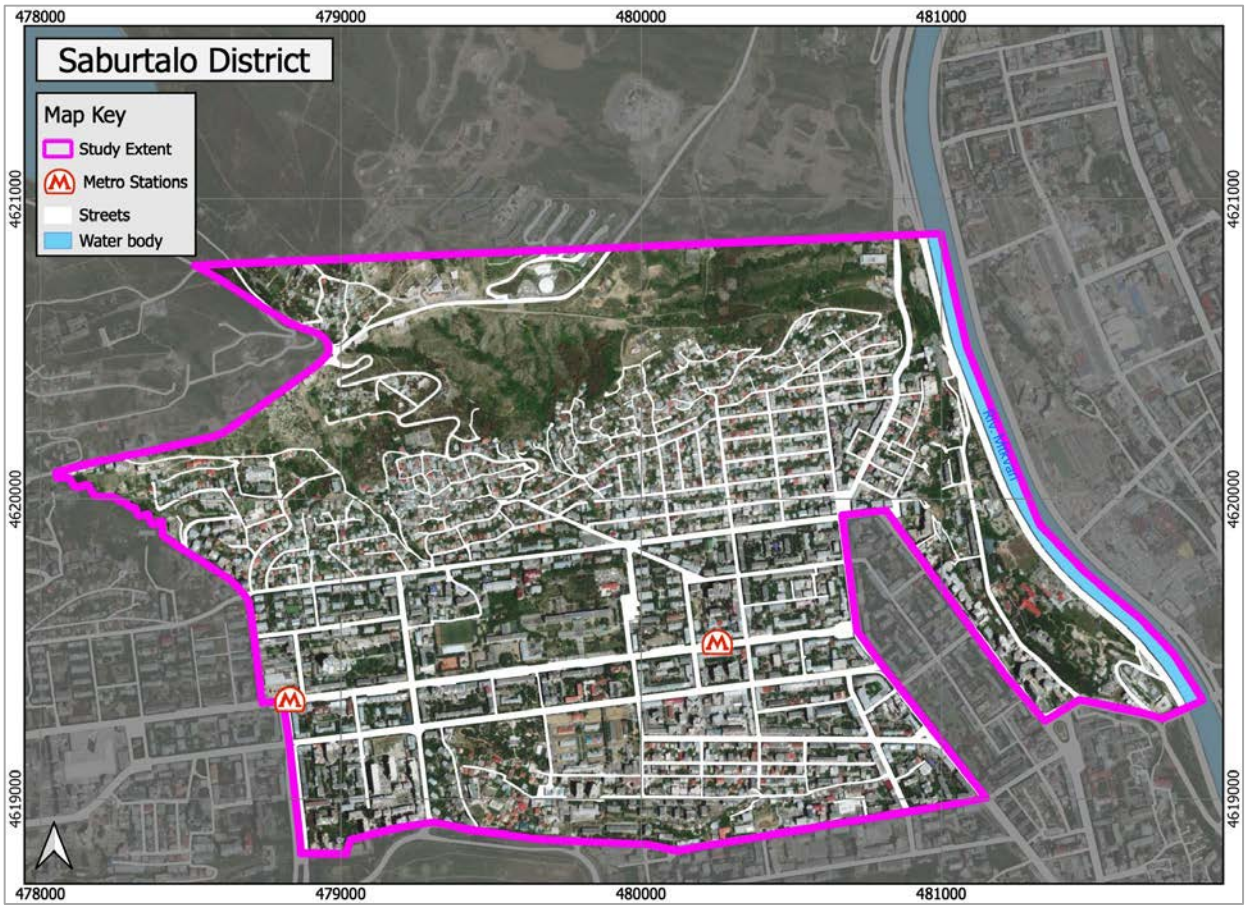
Besides, before finalizing the survey questions a pilot study was conducted to ensure the unambiguity and straightforwardness of the questionnaire. Also, to reveal potential weaknesses

and sensitive issues. Ten respondents of Saburtalo district from various age groups were selected to form non-homogenous group of ten. The group was asked to complete the first version of the questionnaire. Respondents had to report any dubious terms or questions. Unclear questions and issues were corrected and then the final version was provided to the sample population. The survey was conducted in Georgian language. Samples of questionnaire in English and in Georgian are presented in Annex 1. This survey created the possibility to connect objective and subjective elements of walkability.

Besides the questionnaire data, spatial data (secondary data) including objective elements of the physical built environment were collected from the municipality of Tbilisi and the National Statistics Office of Georgia. In addition, open street data was also obtained.

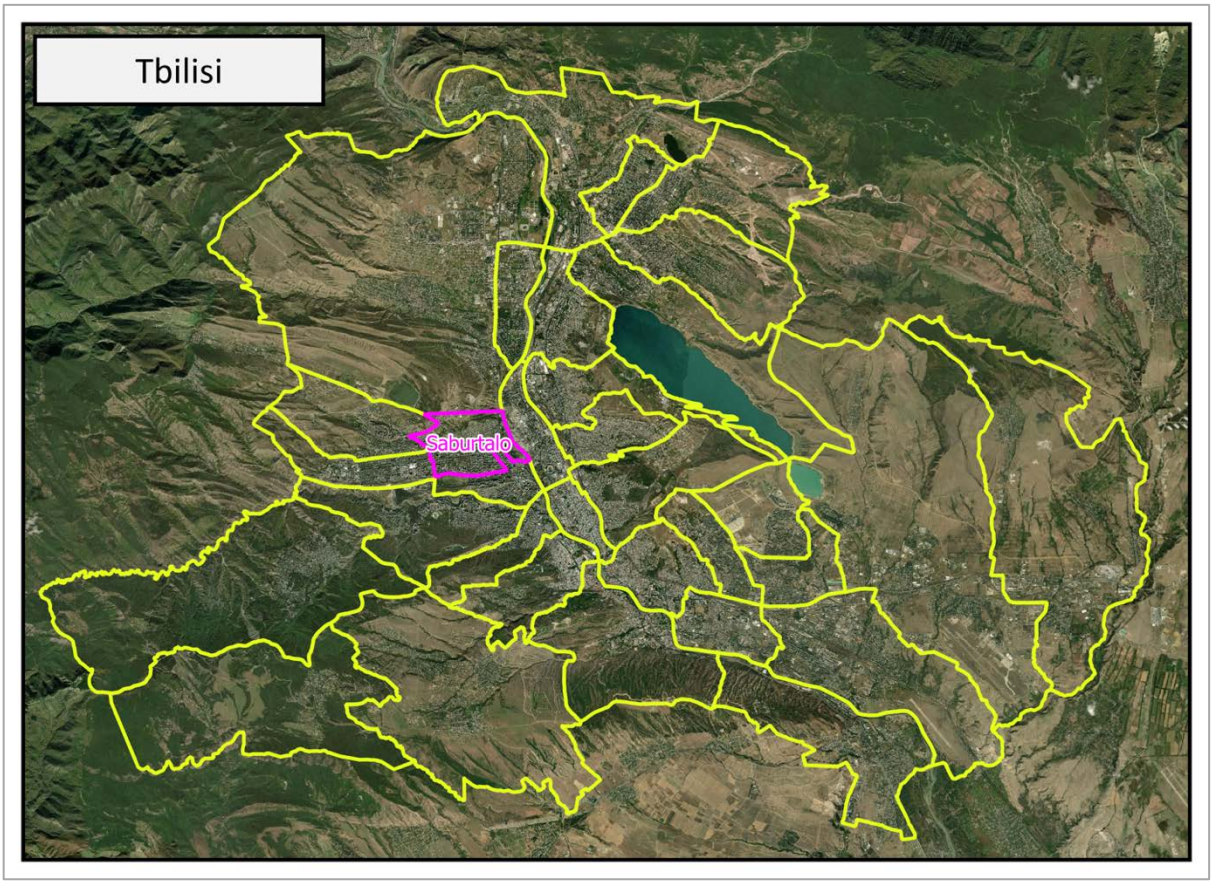
3.1.4 Sampling design and selection

The district Saburtalo is selected based on several factors mentioned in problem statement. Moreover, after careful observation and investigation of maps, Saburtalo district clearly faces the problem of connectivity and inadequate accessibility. However, it has to be mentioned, that due to limited timeframe and pandemic restrictions a sub-district of Saburtalo has been chosen as the research area. For the purpose of this study this sub-district is also called “Saburtalo”, as there is no name corresponding the area. Additionally, neighbourhoods are not delimited by the administrative boundaries in Georgia. Hence, the study area is determined in accordance with the area used in census by the National Statistics Office of Georgia and there is data available of land uses and population (see Map 1 and Map 2).



Map 1. Saburtalo district – study area

Map 1 represents the delimited study area and shows the boundary of the area (district), street network, existing two metro stations and the river Mtkvari stretching at the edge of the area.



Map 2. Saburtalo district in Tbilisi city

Map 2 shows the study area within the purple polygon compared to the city scale, city boundaries and research area boundaries are also presented on the map.

After district selection, probability sampling method, a random sample form has been chosen with the sample size of 150. The sample was calculated as follows:

The population of Saburtalo is 47 368. While calculating the sample size, confidence level of 95% and margin of error 8% was considered.

District name	population	Margin of error	Confidence level	Calculated Sample size
Saburtalo	47 368	8%	95%	150

Table 2. Sample size calculation

3.1.5 Validity and reliability

To ensure the reliability, the measurement instrument - a questionnaire is carefully formed and designed to accurately represent the variables that are clearly and distinctly defined. Also, choice of measurement instruments is based on the extensive literature review (Van Thiel, 2014).

As for Validity, already validated, standardized and broadly used measurements are used. In addition, triangulating the survey with secondary data from the municipality and spatial/network analysis data from Geographic Information Systems (GIS), enhances the validity. The research results cannot be generalized on the whole population of the city as only one district is studied and each district (neighbourhood), likely, has different socio-economic composition and physical built environment; but probability sampling created the opportunity for result generalization on districts with similar built environment and socio-economic characteristics. This is possible because the method allows researcher to choose study units by chance and avoid any bias. Also, the generalization of the findings is one of the important options facilitated by the probability sampling method (Van Thiel, 2014).

3.1.6 Data analysis

The primary data will be analysed using descriptive statistical methods and inferential statistics. As the types of variables are categorical, numerical and nominal it creates possibility to use factorial ANOVA test and Chi-Square test. With a help of multiple linear regression the relation nature between the dependent and independent variables will be determined.

For the secondary data, network analysis, density and proximity analysis will be used, in the GIS environment, using the GIS software. Results and findings will be visualized with charts, graphs and maps, using the QGIS, excel or SPSS software.

The network/spatial analysis was used to study the objective elements of the physical built environment. The analysis was performed using Geographic Information System (GIS) software (Bejleri et al., 2011; Kelly et al., 2011), QGIS to be exact. Using the QGIS software is efficient as it creates possibility to use existing data sources and measure objective elements.

The data type detailed descriptions are represented in the table below:

Data Set	*Data type*	*Source*	*Description*
Streets.shp	Line shape file	Municipality (2019)	The centerlines of the street network in Saburtalo
Parks.shp	Polygon shape file	Municipality (2019)	Parks and recreational areas with borders in Saburtalo
Busstops.shp	Point shape file	Municipality (2019)	Locations of bus stops in Saburtalo
Sidewalks	Line shape file	Municipality (2021)	Sidewalks
Trees	Point shape file	Author's field work (2021)	Trees
Facilities	Point shape file	Author's field work (2021)	Schools, recreational facilities, grocery stores, financial facilities, bus stops and metro stations

Table 3. List of Data Sets

Walkability index is calculated based on the following formula:

$$walability\ index = \mathrm{Z}\ population\ density + 2 \times Z\ street\ connectivity\ + Z\ land\ use\ mix$$

Formula 2. How to calculate the Walkability index

It is important to mention that previous studies have used walkability index (WI) consisted of four items: "residential density, street connectivity, land use mix and retail floor area ratio". The

formula in the study is, however, different and uses only three items, unlike to American and Australian context. The adaptation of the formula is based on the common practice of omitting the item when there is no relevant data available. Therefore, this study follows the practice of Belgian context and uses only three items like they did (Van Dyck et al., 2009) because there is no information regarding retail floor area in Tbilisi.

"Population density" was calculated as the number of residents in an area per square km. "Street connectivity" was represented by the number of 3- or 4-leg intersections per square km. "Land use mix" indicated the "evenness of different land uses". Land use categories include residential, commercial and office. Thus, WI is the sum of the Z scores. Higher WI scores indicate greater walkability.

3.2 Operationalization

Operationalization makes possible to link the theoretical part of the research to the empirical part. After defining the concepts and variables they are available to use in formulating the questions for the survey.

Based on the conceptual framework variables are categorized in the table 2. It also presents the sub-variables and indicators are also determined.

Theory/concept	**Variable**	**Sub-variables**	**Indicators**	
Theory of built environment	The physical built environment	Physical characteristics of streets	Sidewalk availability	Objective
			Sidewalk conditions	
			Width of sidewalk	
			Streetlight coverage	
			Types of aesthetics	
			Amount of sidewalk covered by green canopy	
			Presence or absence of pedestrian crossings	
		Land use	Land use mix (entropy index)	
			Population density	
			Accessibility	
		Street connectivity	Intersection density (number of intersections per square km)	
Social Economics theory	Socio-economic characteristics	Age	Different age groups	Subjective
		Gender	Male/Female	
		Household composition	Family composition types	
		Income (monthly)	Different income groups	
		Vehicle-ownership	Ownership of different types of vehicles, Non-ownership of vehicles	
		Perceived safety	Level of safety	
Travel behaviour theory	Walkability	Walkability Index	Level of land use	
			Level of population density	

			Level of intersection density (street connectivity)	
		Pedestrian walkability level	Level of satisfaction on physical characteristics	
			Level of satisfaction on accessibility to mixed-land-uses	
			Level of satisfaction on accessibility to walking infrastructures	
			Level of satisfaction on street connectivity	
			Pre-Covid-19 and current walking rates	

Table 4. Operationalization table

3.3 Challenges and limitations

Several challenges and limitations are expected during undertaking the study. The major limitation that study has is the complex nature of the research item. Walkability maybe understood as an intricate "decision-making process", that is influenced by numerous factors. Due to time constraints only some relevant parts of factors are investigated. For example, some known strong influencers on walking are not included in the study (for example, weather, slope). However, this does not undermine the importance of the study. Moreover, it creates opportunity and base for the future research.

Another challenge that is expected, is the Covid-19's influence on response rate. To overcome this barrier, if respondents' willingness to answer hands-on questionnaire is low, online version will be readily available as an alternative as according to the National Statistics office of Georgia, 88.4 % of Tbilisi residents have access to the internet (2019).

Another possible limitation that study could face is the language barrier, therefore, to eliminate the barrier questions will be provided in local language. Even though the questionnaire survey design lacks depth as compared to semi-structured interviews, the literature review suggests the survey to be the best method to analyse mode choices and preferences.

In addition, when a researcher studies the built environment and walkability, specific geographic scale must be chosen (neighbourhood, census area, city). However, the question about which scale could be the most suitable is left unanswered as no clear unity has been achieved among academia. This fact affects the results (great variation) and complicates the process to compare the results between different research (Learnihan and Giles-Corti, 2011). To overcome this challenge, one of the most prevalent scales has been chosen as a study area. That is a census area that is named in the study as Saburtalo district.

Chapter 4: Presentation of data and analysis

This chapter includes the overview of the study area, respondents' profile and analysis. Here, the survey sample demographics are presented, and analysis are followed by survey and spatial analysis results. Firstly, the districts' overview is offered, followed by the descriptive statistics of each variables. Descriptive statistics sub-chapter includes normality check that is primary step before conducting any SPSS analysis. Besides, this chapter presents the influence of the pandemic Covid-19 on respondents' walking rates. Moreover, WI is determined, and final score is also presented here. The WI calculations are followed by the accessibility analysis for several main facilities. Inferential statistics are also demonstrated in the chapter.

4.1 Overview of Saburtalo district

Data collection is completed in Georgia, Tbilisi, Saburtalo with the area of 4.9 square kilometres and population of 47,368 people that is 4% of Tbilisi population. Saburtalo district with diverse public, private and educational facilities, workplaces and recreational areas, is traversed with two main arterial avenues, each one serving one-directional mixed traffic.

As already mentioned, due to restricted timeframe and pandemic constraints the research area included only the sub-district of Saburtalo district.

The targeted sample size was 150. However, after taking into consideration pandemic constraints the decision was made to reach more people in order to increase the chance of achieving the goal. Therefore, to achieve desirable sample size 180 questionnaires were handed out. Some of the respondents refused to answer the questions using hard copy of questionnaires. Alternatively, on-line questionnaire was offered to them using Qualtrics platform. Entirely, 180 respondents were reached out and the response rate was about 88% as 159 people have completed the questionnaire (incomplete questionnaires are disregarded). However, the target sample is a bit over 100% reached, which is better for quantitative analysis, as additional nine more respondents were achieved in addition to the required sample size of 150, making a total of 159 respondents.

4.2 Descriptive statistics

4.2.1 Socio-economic characteristics

Regarding the *gender*, out of the whole sample 57% are female respondents and, accordingly, 43% are male. The sample includes diverse *age* groups from 16 to 65+, with 35% (majority) representing 19-28 age group. As for *income*, 30% of the respondents' monthly income is within the range of 600-1001 GEL, while 27% have up to 300 GEL. It has to be mentioned, that compared to the average monthly income of 1350 GEL (GeoStat, 2019) up to 60% of the respondents have well below the average salary. From the sample 62% does not have *child/children* (5 years old or smaller), while 27% has one child (5 years old or smaller) and 11% has two children (5 years old or smaller). As for the vehicle ownership 39% of the respondents indicated that they own at least one motorized vehicle. Table 5 shows a profile of respondents.

		number	percentage
Gender	*Female*	91	57%
	Male	68	43%
Age	*less than 18*	9	6%
	19-28	55	35%
	29-38	34	21%
	39-48	29	18%
	49-58	15	9%
	59-68	10	6%

	69+	7	4%
Monthly income	*up to 300 GEL*	43	27%
	301 – 600 GEL	18	11%
	601 – 1000 GEL	48	30%
	1001 – 1500 GEL	29	18%
	1501 – 2000 GEL	13	8%
	2001+	8	5%
Household composition (N of Children (younger than 5))	*0*	98	62%
	1	43	27%
	2	18	11%
Vehicle owner	*Yes*	62	39%
	No	97	61%
Total	159	100%	*Total*

Table 5. Survey respondents' profile (source: Author, 2020)

Descriptive statistics table (see Table 6) shows the mean and standard deviation of the variables.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Walkability	159	1	4	2.21	0.741
LandUse	159	1	5	1.99	0.911
street_connectivity	159	1	4	2.19	0.658
physical_characteristiscs	159	1	5	2.58	1.063
Gender	159	1	2	1.43	0.496
Age	159	1	7	3.28	1.53
Monthly income	159	1	6	2.84	1.465
Vehicle ownership	159	1	2	1.39	0.489
Family size	159	1	8	3.78	1.362
number of children	159	0	2	0.5	0.692

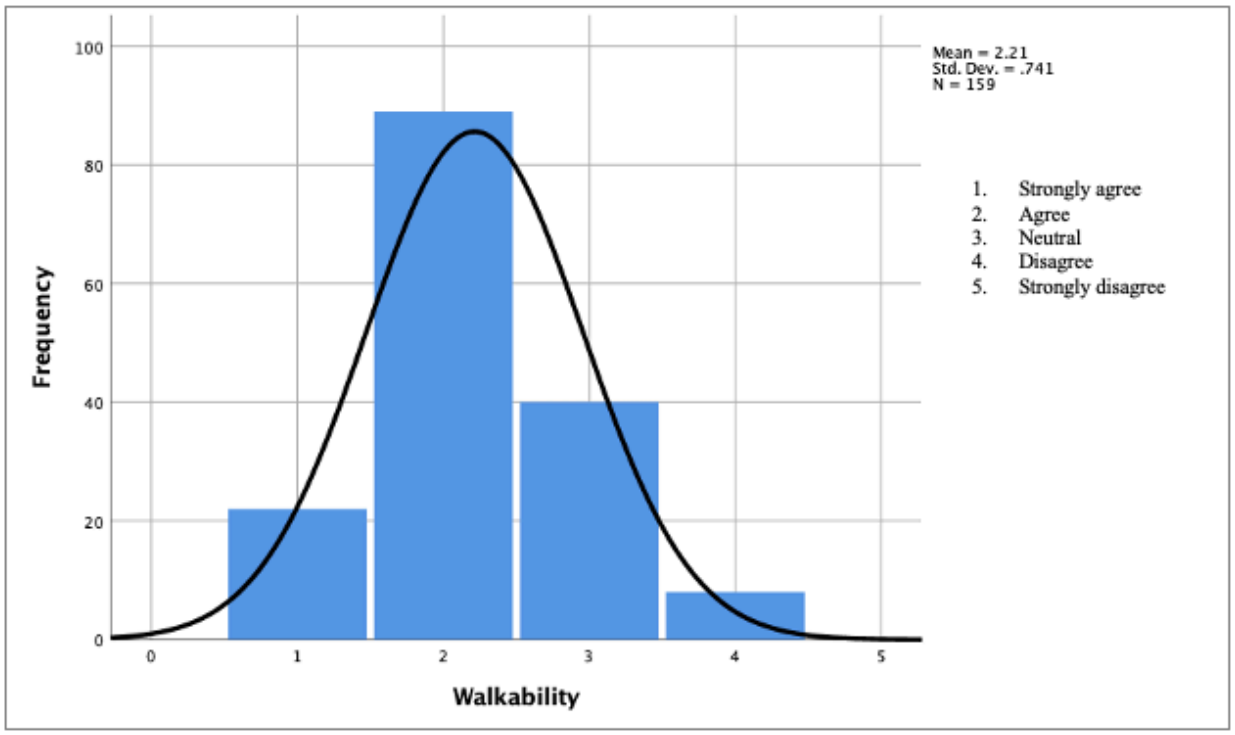
Table 6. Descriptive statistics (source: Author, 2020)

Maximum and minimum values for the variables are shown in the Table 3 in Annex 2.

4.2.2 Walkability

Before the analysis begin, normality check should be carried out. Normality check is used to determine whether the data was drawn from the normally distributed population. There are several methods to test the normality. One of them is eyeballing the histogram.

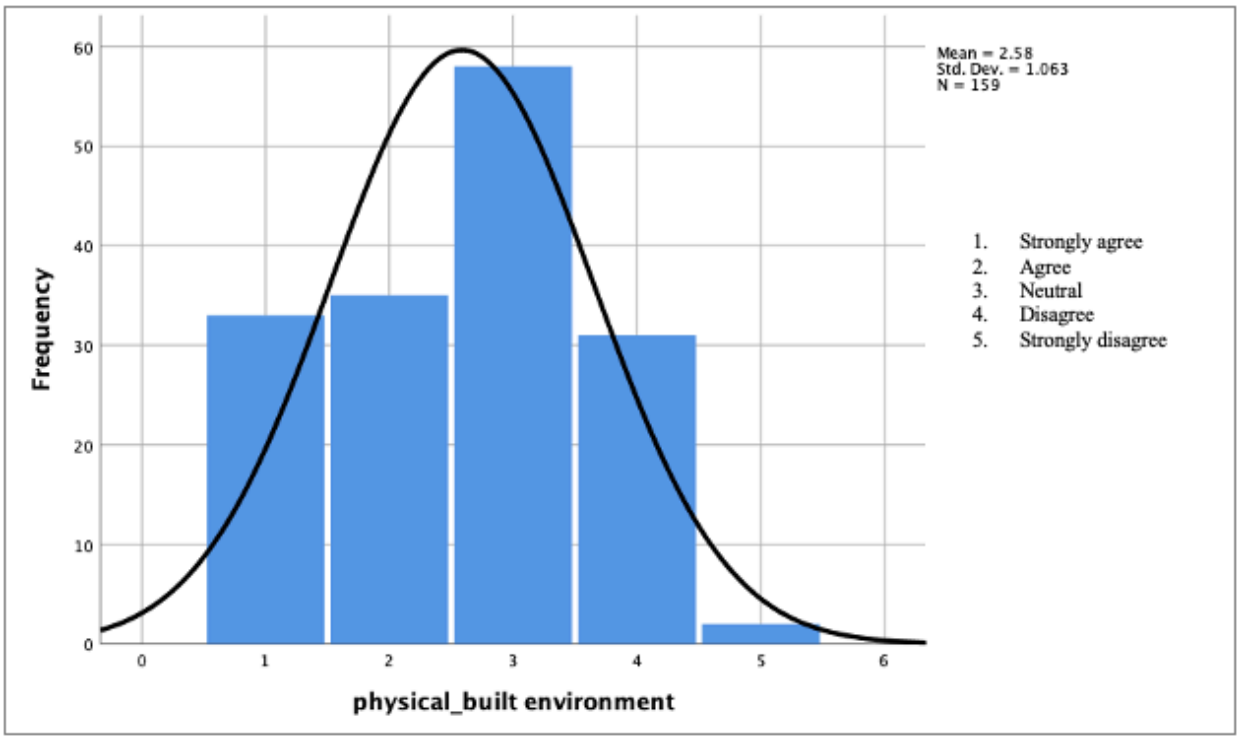
Dependent variable histogram demonstrates the normal distribution. The mean value of the variable is 2.21. While the standard deviation is 0.741 (n=159). The maximum value is 4 and the minimum is 1. The values represent a five-points Likert scale "1" = "strongly agree", "2" = "agree", "3" = "neutral", "4" = "disagree", "5" = "strongly disagree" (see Graph 1).



Graph 2. Histogram of Walkability (source: Author, 2020)

4.2.3 Physical built environment

Independent variable histogram demonstrates the not normal distribution. The mean value of the variable is 2.58. While the standard deviation is 1.063 (n=159). The maximum value is 5 and the minimum is 1. The values represent a five-points Likert scale “1” = “strongly agree”, “2” = “agree”, “3” = “neutral”, “4” = “disagree”, “5” = “strongly disagree” (see Graph 2).



Graph 3. Histogram of physical built environment (source: Author, 2020)

4.3 Walkability analysis

It is very interesting to compare sample's current and before the pandemic (Covid-19) walking rates. After analysing the data, it is clear that 42.1% walks six to ten times per week while, before the pandemic only 26.4% walked six to ten times per week. However, percentage of the people who walked more than ten times per week before the pandemic is now considerably decreased from 34.6% to 21.4% (See Figure 3 and Figure 4 and Appendix 2. Table 1 and Table 2).

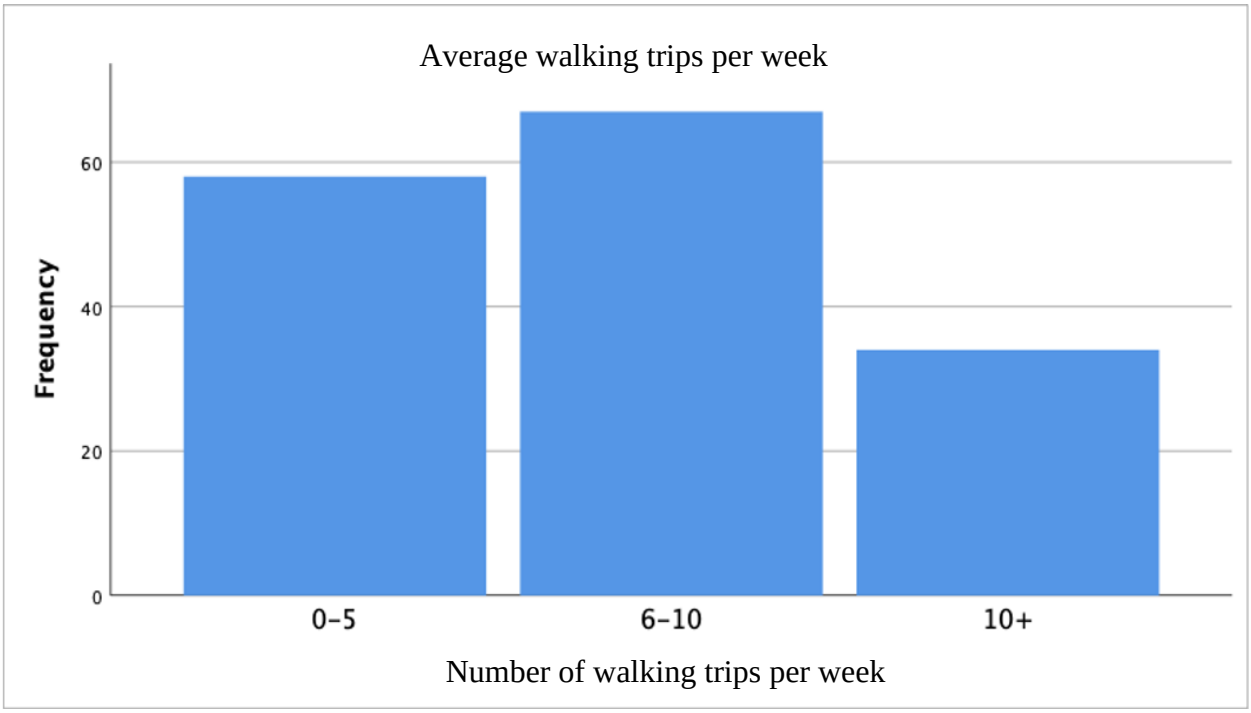


Figure 3. Average trips per week current state (source: Author, 2020)

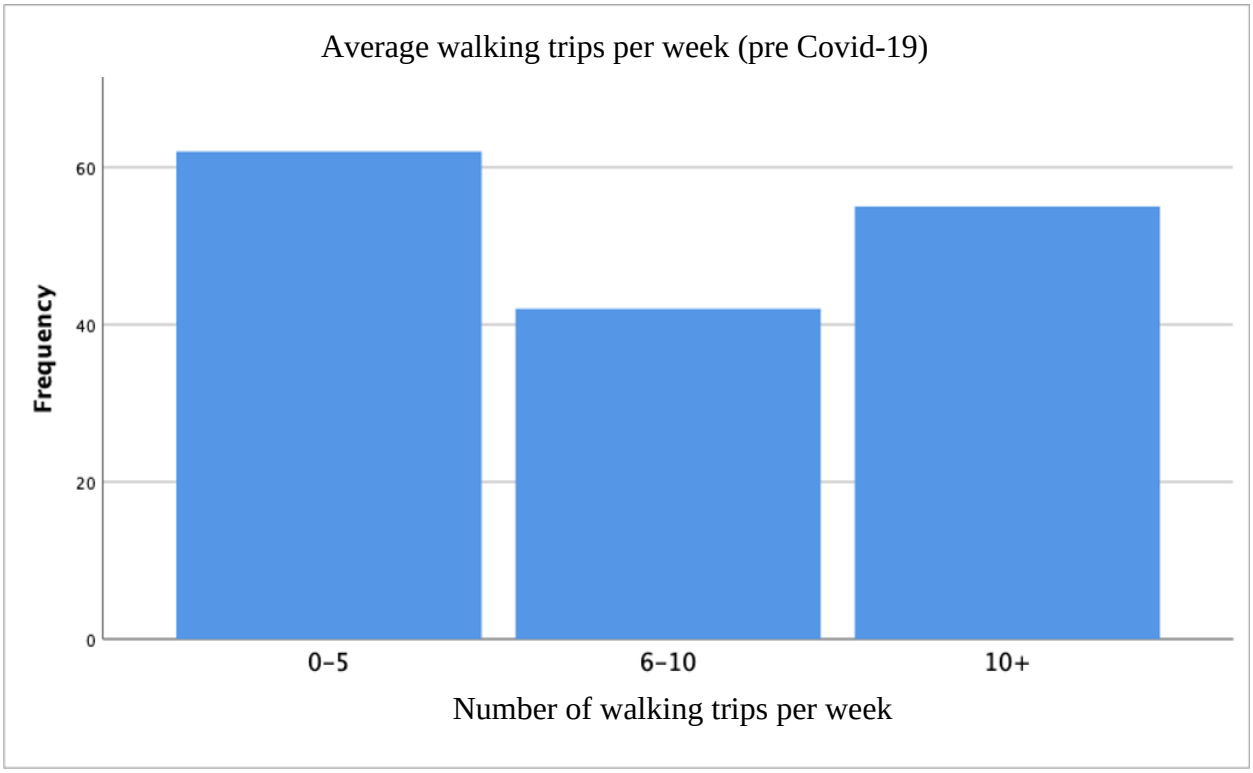


Figure 4. Average trips per week pre-Covid state (source: Author, 2020)

Reliability statistics for eleven items (physical characteristics) were generated using Cronbach's alpha. The value of .868 suggests high internal consistency between the items.

Reliability Statistics

Cronbach's Alpha	N of Items
.868	11

Reliability statistics for thirteen items (street connectivity) were generated the same way. The value of .772 suggests high internal consistency between the items.

Reliability Statistics

Cronbach's Alpha	N of Items
.772	13

4.3.1 Walkability index

Walkability Index formula that is used in this study is adapted from the one originally developed by Frank et al (2005) and discussed here in the 3rd Chapter.

Walkability index formula is composed of three parts: "z score of population density, z score of street connectivity and z score of land use mix". For standardization of the calculated values, equal weights (0.33) have been assigned to each part. Formula used to calculate the index is as follows:

$$walability\ index = \mathrm{Z}\ population\ density + 2 \times Z\ street\ connectivity\ + Z\ land\ use\ mix$$

Formula 3. How to calculate the Walkability index

Data was prepared manually for street connectivity calculations. This was the only option taken into consideration the fact that no suitable data was available. Besides, the considerably smaller extent as a study area made the manual data preparation possible at this level. Street layer data obtained from the municipality was examined using QGIS software. True intersections (with 3 or more legs) where identified manually and was divided by the square km of the study extent.

$$Street\ connectivity = \ N\ of\ Tru\ intersections/Study\ area = 384/4.9 = 78.4$$

For standardization of the calculated values, equal weights (0.33) have been assigned to each part.

$$Z\ Street\ connectivity = 78.4 * 0.33 = 25.9$$

Another part of the WI formula is population density. To calculate population density of Saburtalo the data from National Statistics Office of Georgia was used.

$$Population\ density = Population/Study\ area = 47368/4.9 = 96.67$$

The standardization value is as follows:

$$Z\ Population\ density = 96.67 * 0.33 = 31.9$$

The third part of the WI is land use mix (Entropy index) that represents the evenness of different land uses. In the Land Use Mix here three categories (k) were used: Residential, Commercial and Office. Entropy index (land use mix) is calculated using the formula 2 (see the Formula 2):

$$Land\ use\ mix = 0.65$$

The standardization value is as follows:

$$Z\ Land\ use\ mix = 0.21$$

The final score represents the sum of these three parts.

$$walability\ index = 31.9 + 2 \times 25.9\ + 0.21 = 85.86$$

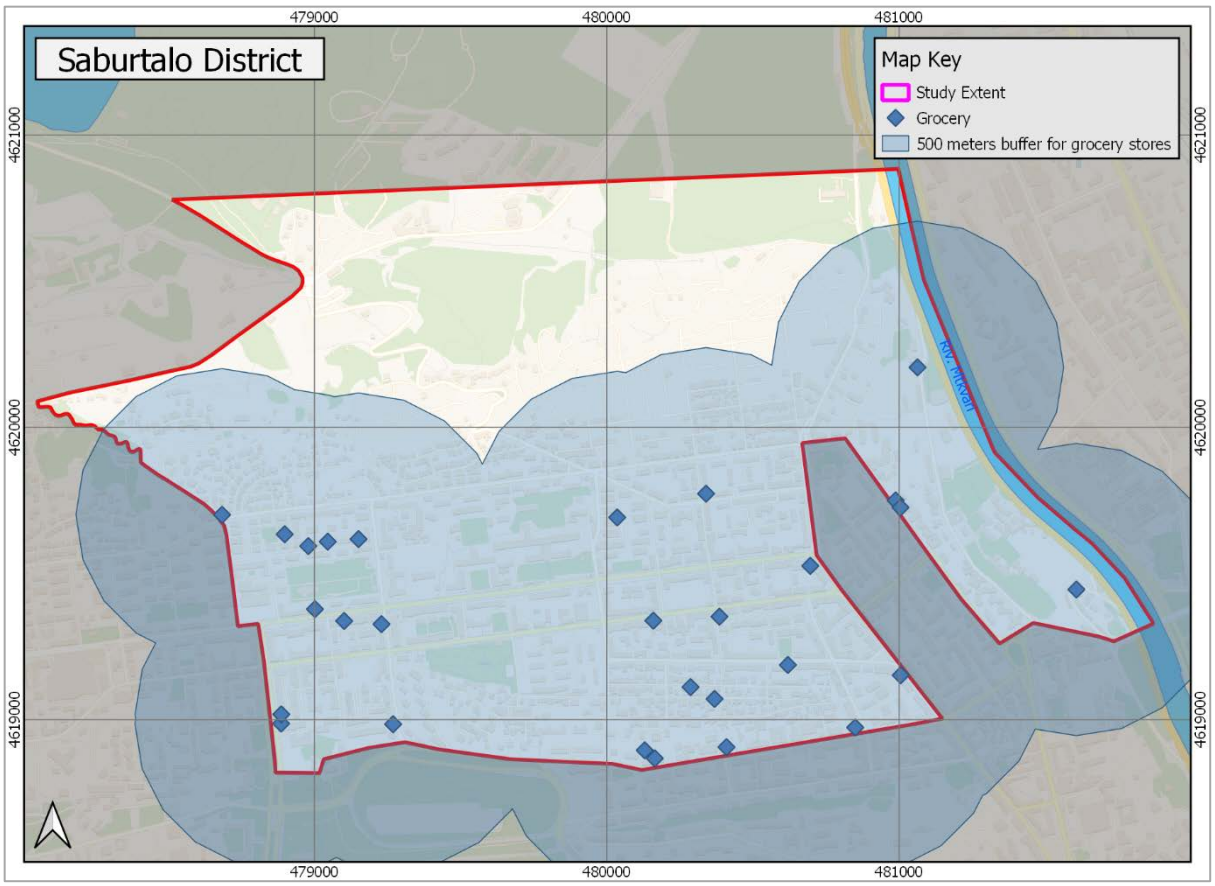
The result is WI=85.86. It is an unitless score and higher score indicates higher walkability level.

4.3.2 Accessibility analysis

Accessibility is one of the significant "aspects of the built environment" and can be "defined as the ability to reach" the desirable location. It can be measured by the travel time (or distance) that is needed to reach the destination. Walking distance is considered to be approximately 400-500 meters, that equals 5-minute walk (Hess, 2011). However, it differs by the purpose of the travel and is depended on the slope, scenery, infrastructure, etc. For example, for walking for transport, comfortable walking distance considered is 400-500 meters, that amounts approximately to 5-minute walk. However, these estimates vary (Hess, 2011). For this study 500 meter accessibility buffer was deduced from the HHS (2016) results concluded 1.5 km to be driving distance in Tbilisi. Moreover, studies have shown the results that "propensity to walk" starts to decrease when walking time surpasses 5 minutes (Tiran et al., 2019). Accessibility buffer in the research amounts for 500 meters (5-minute walk) and is calculated from the centroid of the polygon. The buffer represents the Euclidean distance from the centroid.

4.3.2.1 Accessibility to Grocery stores

According to spatial analysis buffer of 500 meters is taken into consideration as for the comfortable walking distance to grocery stores (4-5 minutes walking distance). Dots on the map are all grocery stores, that is very common in Georgia, for example, "Nikora" along the Sergo Zakariadze street (479045.43; 4619608.81), "SPAR" along the Vazha-Pshavela Avenue (479101.52; 4619337.40), "Ori Nabiji" along the Nutsubidze street (478683.90; 4619700.73) to name a few. Analysis shows that approximately 69% of the district has comfortable access to the grocery stores (see Map 3).



Map 3. 500-meter buffer to grocery stores (source: Author, 2020)

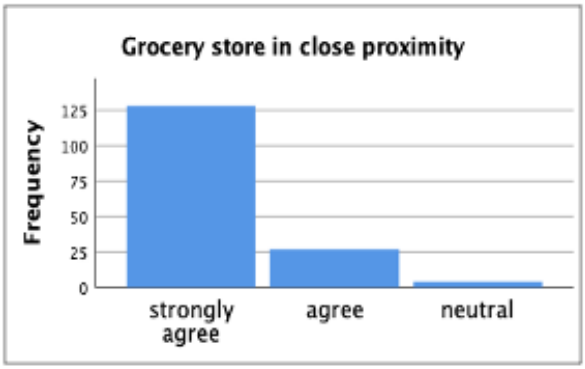
It is interesting to see the survey results as well to detect any similarities or differences.

Survey results suggest that about 80% of respondents feel they have grocery store in the close proximity to their homes (see Table 7).

There is a grocery store in close proximity to my house in this district

		Frequency	Percent	Valid Percent
Valid	strongly agree	128	80.5	80.5
	agree	27	17.0	17.0
	neutral	4	2.5	2.5
	Total	159	100.0	100.0

Frequency table



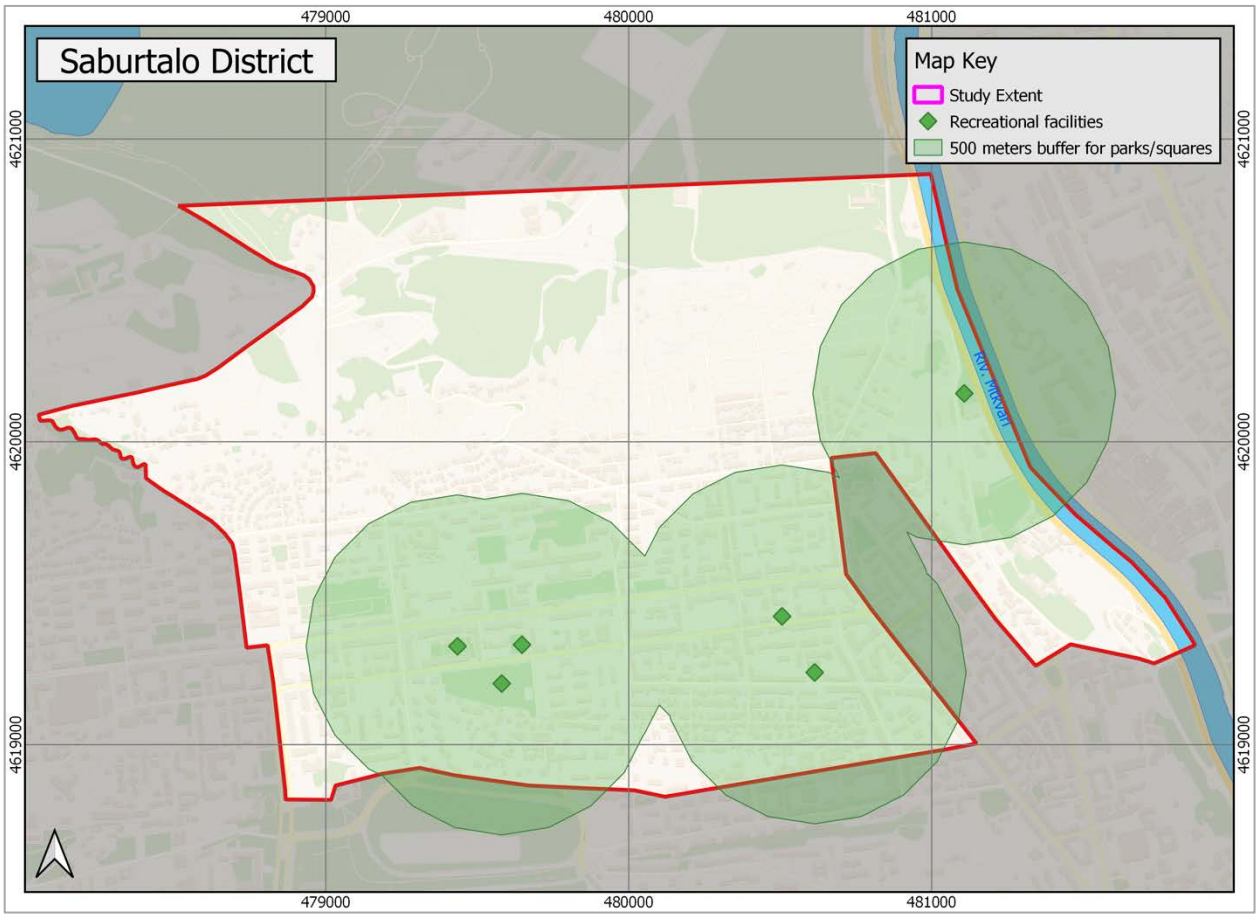
Graph

Table 7. Survey results: access to grocery stores (source: Author, 2020)

Difference between spatial analysis and survey results is approximately 11% in terms of accessibility to grocery stores.

4.3.2.2 Accessibility to recreational areas

For the recreational areas, 500 meters was considered as for the comfortable walking distance (4-5 minutes walking distance). Analysis has demonstrated that about 39% of the area has comfortable access to recreational areas (see Map 4).

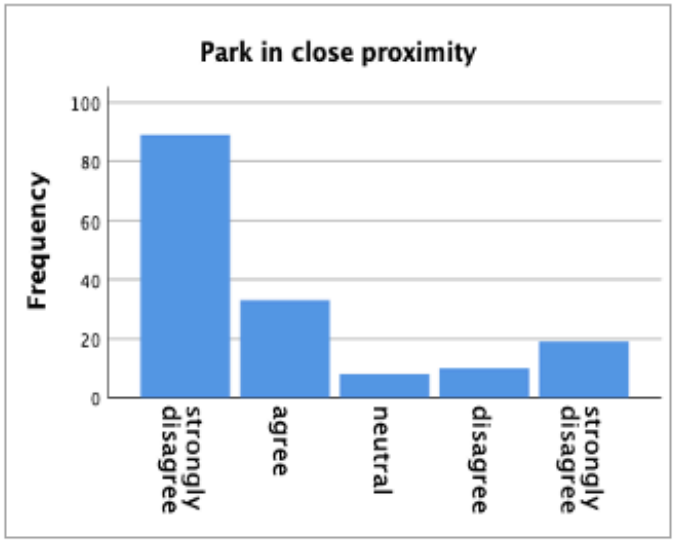


Map 4. 500-meter access to recreational areas (source: Author, 2020)

As for recreations facilities such as parks, plazas and squares survey results suggest that little more than 50% of respondents feel they have access to such areas (see Table 8). Dots on the map represent the recreational facilities in the district. Some "green" areas on the map are not marked as the recreational facilities as they represent forest-type areas and are not classified as parks, plazas or squares, however, all recreational facilities that are classified are covered.

There is a park in close proximity to my house in this district				
		Frequency	Percent	Valid Percent
Valid	strongly agree	89	56.0	56.0
	agree	33	20.8	20.8
	neutral	8	5.0	5.0
	disagree	10	6.3	6.3
	strongly disagree	19	11.9	11.9
	Total	159	100.0	100.0

Frequency table



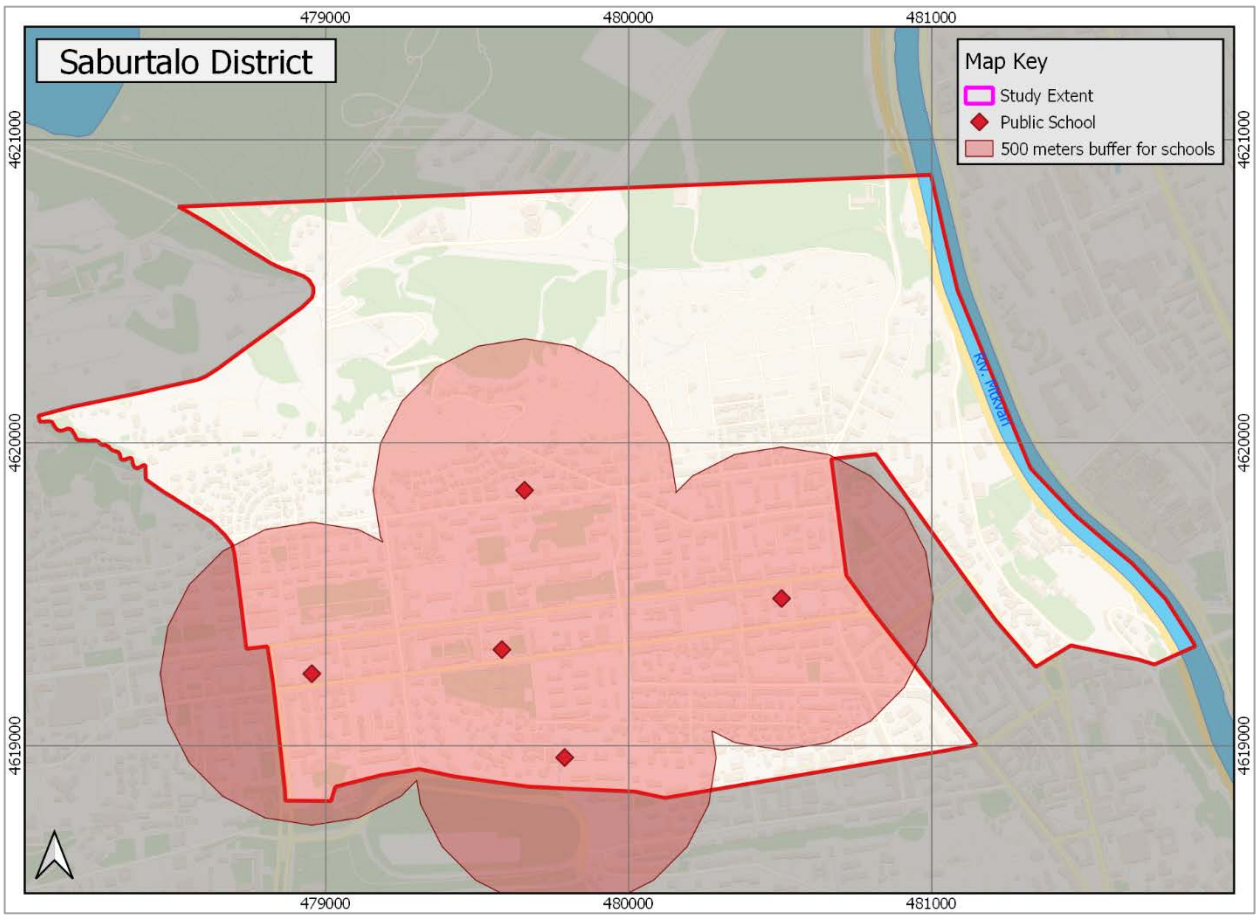
Graph

Table 8. Survey results: access to parks (source: Author, 2020)

Difference between spatial analysis and survey results is approximately 11% in terms of accessibility to parks.

4.3.2.3 Accessibility to schools

As for the accessibility to public schools 500 meters of comfortable distance have been chosen (4-5 minutes walking distance). As the analysis shows little more than 42% of the area is in the cover of 500 meters buffer (see Map 5). Public schools in Georgia unite primary, secondary or tertiary schools. The analysis does not include private schools as they tend to be very expensive and are not accessible to everyone.



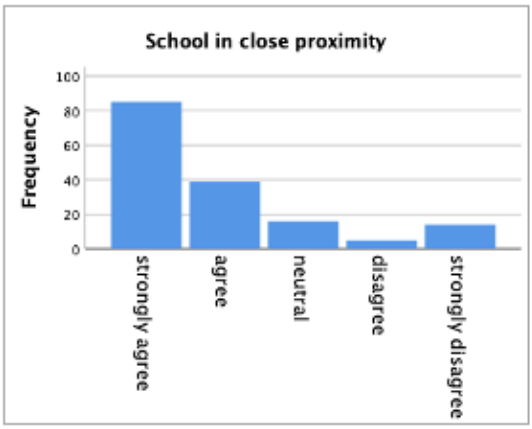
Map 5. 500-meter access to public schools (source: Author, 2020)

The survey results suggest that 53% of respondents feel they have access to schools (see Table 9).

There is a school in close proximity to my house in this district

		Frequency	Percent	Valid Percent
Valid	strongly agree	85	53.5	53.5
	agree	39	24.5	24.5
	neutral	16	10.1	10.1
	disagree	5	3.1	3.1
	strongly disagree	14	8.8	8.8
	Total	159	100.0	100.0

Frequency table



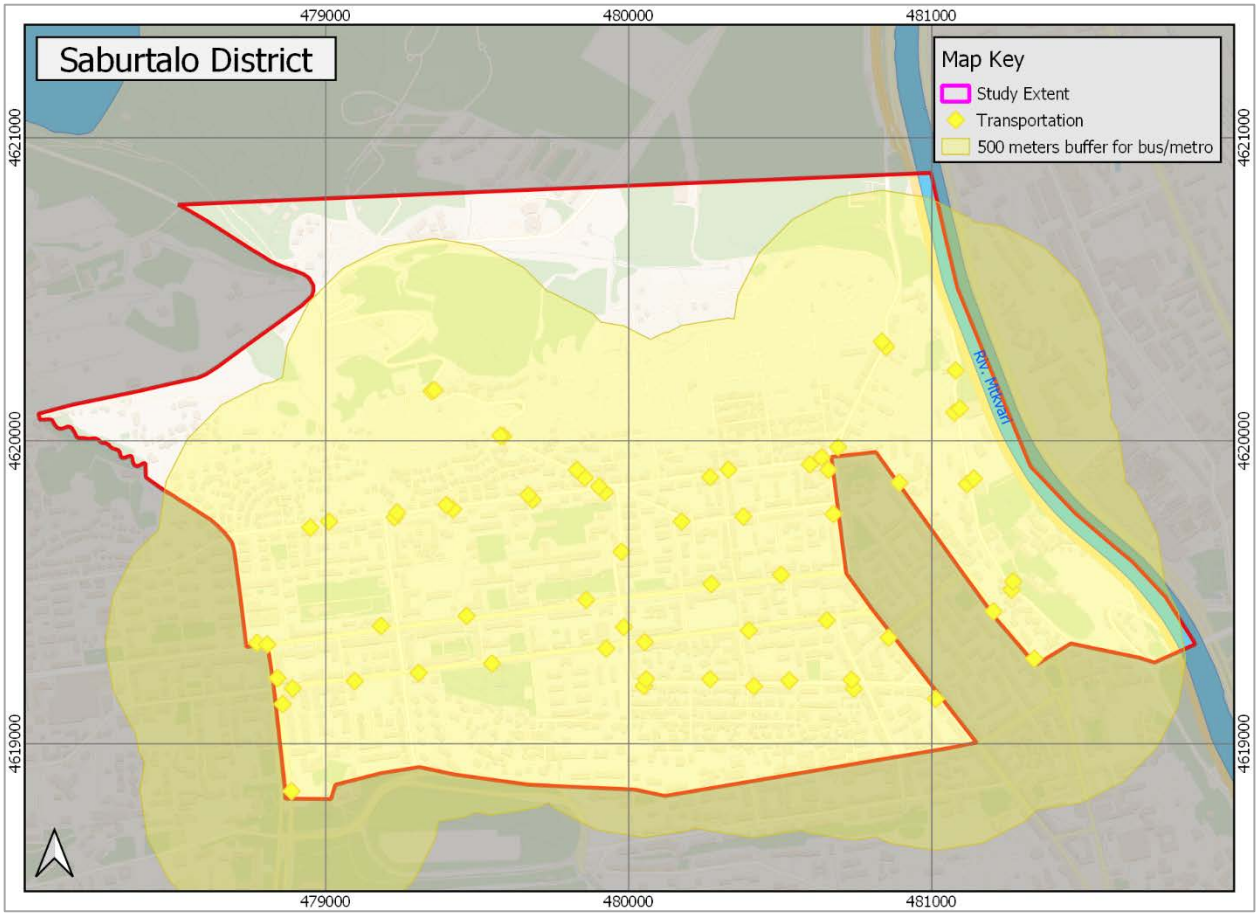
Graph

Table 9. Survey results: access to schools (source: Author, 2020)

Difference between spatial analysis and survey results is approximately 11% in terms of accessibility to schools.

4.3.2.4 Accessibility to transportation

As for access to transportation facilities such as bus stops and metro stations, 500 meters is considered as comfortable walking distance, that is considered as 4-5 minutes walking distance. As the analysis reveals about 84% of the area has the access (see Map 6). Dots on the map represent bus stops and metro stations in the district.

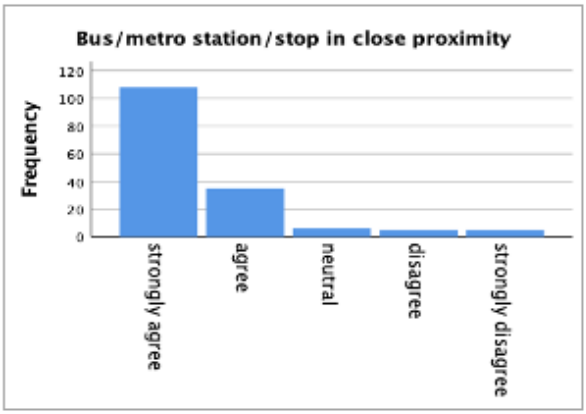


Map 6. 500-meter access to transportation facilities (source: Author, 2020)

The survey results suggest that 67% of respondents feel they have access to transportation facilities (see Table 10).

There is a bus/metro station/stop in close proximity to my house in this district				
		Frequency	Percent	Valid Percent
Valid	strongly agree	108	67.9	67.9
	agree	35	22.0	22.0
	neutral	6	3.8	3.8
	disagree	5	3.1	3.1
	strongly disagree	5	3.1	3.1
	Total	159	100.0	100.0

Frequency table



Graph

Table 10. Survey results: access to schools (source: Author, 2020)

Difference between spatial analysis and survey results is approximately 17% in terms of accessibility to bus stops/metro stations.

4.3.3 Inferential statistics

Multiple linear regression has been used to determine the relationship nature between walkability and physical built environment and socio-economic characteristics of the district. In Multiple linear regression analysis most important components that are most commonly reported are values (highlighted in tables):

- „R-square“ – explaining the variance. The R-square value is always between 0-1 and it determines the fit of the model into the data. Higher the value, better (Stockemer, 2019).
- „Coefficient B“ – representing the effect of variable X on variable Y, in other words, “it indicates the change in the DV associated with a 1-unit change in the IV” (Stockemer, 2019).
- „sig“ – representing statistical significance.

4.3.3.1 Physical built environment

Models measures the relationship between physical built environment and walkability in Saburtalo district.

Table 11 presents correlation between physical characteristics variables in Saburtalo district. The most significant positive correlation is shown between physical characteristics and sidewalk quality and sidewalk width.

	physical_characteristiscs	street_connectivity	Land Use	Sidewalks presence	Quality of sidewalks	Sidewalk width	Streetlights presence	Street furniture presence	Trees presence	Crosswalks_presence

physical_characteristics	Pearson Correlation	1									
	Sig. (2-tailed)										
street_connectivity	Pearson Correlation	**.402****	1								
	Sig. (2-tailed)	.000									
LandUse	Pearson Correlation	.298**	**.425****	1							
	Sig. (2-tailed)	.000	.000								
Sidewalks presence	Pearson Correlation	**.538****	.230**	.221**	1						
	Sig. (2-tailed)	.000	.004	.005							
Quality of sidewalks	Pearson Correlation	**.720****	.294**	.277**	**.557****	1					
	Sig. (2-tailed)	.000	.000	.000	.000						
Sidewalk width	Pearson Correlation	**.624****	.169*	.260**	**.574****	**.717****	1				
	Sig. (2-tailed)	.000	.034	.001	.000	.000					
Streetlights	Pearson Correlation	.418**	.097	.050	.214**	.412**	.343**	1			

presence	Sig. (2-tailed)	.000	.225	.531	.007	.000	.000				
Street furniture presence	Pearson Correlation	**.670****	.309**	.221**	.383**	.380**	.249**	.277**	1		
	Sig. (2-tailed)	.000	.000	.005	.000	.000	.002	.000			
trees presence	Pearson Correlation	**.682****	.327**	.193*	.309**	.416**	.300**	.390**	**.573****	1	
	Sig. (2-tailed)	.000	.000	.015	.000	.000	.000	.000	.000		
crosswalks presence	Pearson Correlation	**.601****	.409**	.438**	.224**	.374**	.216**	.161*	.481**	.378**	1
	Sig. (2-tailed)	.000	.000	.000	.004	.000	.006	.042	.000	.000	
	N	159	159	159	159	159	159	159	159	159	159

Table 11. Correlation (Source: Author, 2020)

Regression analysis output shows some difference in R square value between two models. The Model 1 illustrates a positive (+) and statistically significant (.000) relationship between variables. The R-squared value (.560) of the model underlines that the physical characteristics explain the 56% of the variance in the walkability. Coefficient B (.521) suggests if in the area more physical characteristics are introduced walkability will increase by .521 (See Table 12).

The Model 2 illustrates a positive (+) but not statistically significant (.332 and .330) relationship between variables. However, there are several exceptions:

- "Streetlight presence" shows a negative (-) relationship with walkability with .002 statistical significance. In other words, it shows the relationship when one variable decreases the other one increases, or vice versa. This result suggests that if independent variable (here, streetlight presence) increases, dependent variable (walkability) decreases by .172. That is very unexpected result, because as the literature suggests streetlight

presence facilitates sense of safety that, in turn, is associated with increased walkability (Peña-García et al., 2015; Sallis et al., 2015; Vich et al., 2018).

- "Crosswalks" show a positive (+) relationship with walkability with .000 statistical significance. In other words, if the presence of crosswalks is increased the walkability will also increase by .156.

The R-squared value (.861) of the model is similar to the model 1 and it underlines that the physical characteristics with perceived safety explain the 86.1% of the variance in the walkability (See Table 12).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.748[a]	.560	.557	.493
2	.809[b]	.654	.638	.446

a. Predictors: (Constant), physical_characteristiscs

b. Predictors: (Constant), physical_characteristiscs, streetlights, sidewalks, crosswalks, trees, Sidewalk width, Quality of sidewalks

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.866	.103		8.402	.000
	physical_characteristiscs	.521	.037	.748	14.127	.000
2	(Constant)	.950	.101		9.370	.000
	physical_characteristiscs	.221	.074	.317	2.974	.003
	sidewalks	.039	.040	.060	.977	.330
	quality of sidewalks	.104	.042	.199	2.449	.015
	Sidewalk width	.038	.039	.074	.974	.332
	streetlights	-.172	.054	-.176	-3.204	.002
	trees	.097	.039	.170	2.476	.014
	Crosswalks	.156	.035	.278	4.437	.000

a. Dependent Variable: Walkability

Table 12. Regression analysis (source: Author 2020)

4.3.3.2 Socio-economic characteristics

Models measure the relationship between socio-economic characteristics and perceived safety and walkability.

Table 13 presents correlation between socio-economic characteristics and perceived safety. The most significant correlations are shown between “sense of safety (traffic)” and “sense of safety (streetlight)”. Moreover, a weak and moderate negative correlation is presented between “age” and “gender”, “sense of safety (traffic)” and “age”, “gender”.

		Gender	Age	Monthly income	Vehicle ownership	Family composition (N of children)	Sense of safety (in terms of traffic)	Sense of safety (in terms of streetlights)
Gender	Pearson Correlation	1						

	Sig. (2-tailed)							
Age	Pearson Correlation	-.023	1					
	Sig. (2-tailed)	.769						
Monthly income	Pearson Correlation	.023	-.037	1				
	Sig. (2-tailed)	.769	.644					
Vehicle ownership	Pearson Correlation	.195*	-.111	.448**	1			
	Sig. (2-tailed)	.014	.163	.000				
Family composition (N of children)	Pearson Correlation	.041	.007	.271**	.247**	1		
	Sig. (2-tailed)	.610	.932	.001	.002			
Sense of safety (in terms of traffic)	Pearson Correlation	-.133	-.111	.090	-.011	.082	1	
	Sig. (2-tailed)	.094	.164	.260	.891	.305		
Sense of safety (in terms of streetlights)	Pearson Correlation	-.056	-.087	.274**	.126	.031	.569**	1
	Sig. (2-tailed)	.480	.274	.000	.115	.696	.000	
	N	159	159	159	159	159	159	159

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 13. Correlation (Source, Author 2020)

Regression analysis output shows significance difference in R square value between two models.

The Model 1 illustrates a negative (-) and not statistically significant (.198 and .541) relationship between variables “age” and “family composition” and “walkability”. Coefficient B for “age” (-

.050) and “family composition” (-.055) implies if the age increases the walkability decreases by .050 and if the number of children increases the walkability decreases by .055. The R-squared value (.033) of the model underlines that the physical characteristics explain the 3.3% of the variance in the walkability (see Table 14).

The Model 2 illustrates negative (-) and not statistically significance (.488 and .249) relationship between the same variables as Model 1. However, “sense of safety” shows high statistical significance and the value of coefficient B (.254) implies if the sense of safety increases the walkability will also increases by .254. The R-squared value (.229) of the model underlines that the physical characteristics and sense of safety explain 22.9% of the variance in the walkability.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.182[a]	.033	.002	.740
2	.479[b]	.229	.194	.665

a. Predictors: (Constant), Family composition (N of children), Age, Gender, Monthly income, Vehicle ownership

b. Predictors: (Constant), Family composition (N of children), Age, Gender, Monthly income, Vehicle ownership, Sense of safety (in terms of traffic), Sense of safety (in terms of streetlight)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.028	.274		7.404	.000
	Gender	.098	.121	.066	.808	.420
	Age	-.050	.039	-.104	-1.293	.198
	Monthly income	.052	.046	.102	1.126	.262
	Vehicle ownership	.065	.140	.043	.463	.644
	Family composition (N of children)	-.055	.089	-.051	-.613	.541
2	(Constant)	1.310	.275		4.760	.000
	Gender	.186	.110	.125	1.691	.093
	Age	-.024	.035	-.050	-.695	.488
	Monthly income	.032	.043	.063	.745	.457
	Vehicle ownership	.107	.126	.071	.851	.396
	Family composition (N of children)	-.094	.081	-.088	-1.157	.249
	Sense of safety (in terms of traffic)	.254	.049	.462	5.196	.000
	Sense of safety (in terms of streetlight)	-.014	.082	-.016	-.175	.861

a. Dependent Variable: Walkability

Overall, the second model with „sense of safety in terms of traffic“ and „ sense of safety in terms of streetlight“ explains the data better as the R-square value of the model 2 is higher than the model 1.

4.3.3.3 Chi square test

Gender and walking

The test results show not statistically significant (p=.631) association between gender and average weekly walking among the respondents.

N trips by walking per week * gender

Count

		gender		Total
		female	male	
N trips by walking per week	0-5	36	22	58
	6-10	37	30	67
	10+	18	16	34
Total		91	68	159

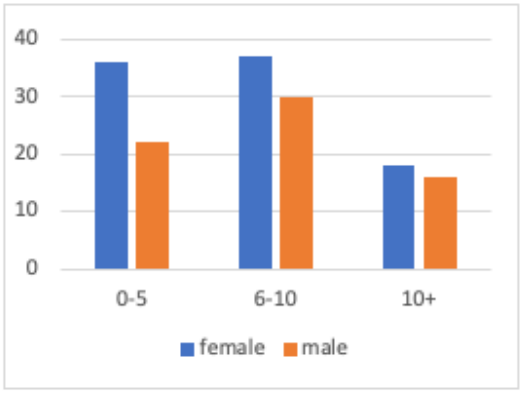


Table 14. Association between gender and walking (Source: Author, 2020)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.921[a]	2	.631
Likelihood Ratio	.925	2	.630
Linear-by-Linear Association	.835	1	.361
N of Valid Cases	159		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.54.

Table 15. Chi-Square test (Source: Author, 2020)

Income and walking

The test results show statistically significant (p=.004) association between monthly income and average weekly walking among the respondents. Which means that relationship between monthly income and average weekly walking rates is unlikely to be caused by the chance. Also, it is clear that respondents with higher monthly income walk less, compared to respondents with lower monthly income.

N trips by walking per week * monthly income

Count

		monthly income?						Total
		up to 300 GEL	301 – 600 GEL	601 – 1000 GEL	1001 – 1500 GEL	1501 – 2000 GEL	2001+	
N trips by walking per week	0-5	13	6	13	15	7	4	58
	6-10	22	10	25	4	6	0	67
	10+	8	2	10	10	0	4	34
Total		43	18	48	29	13	8	159

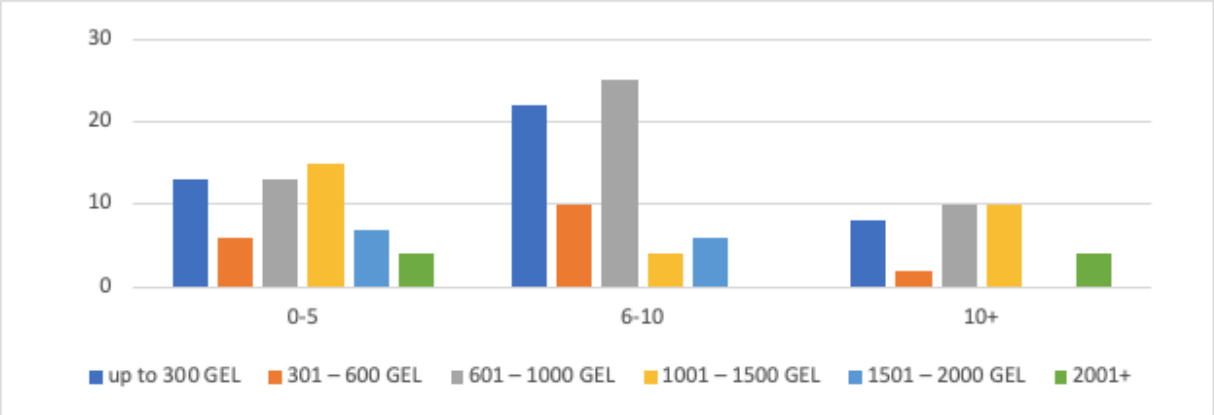


Table 16. Association between income and walking (Source: Author, 2020)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	25.892[a]	10	.004
Likelihood Ratio	32.547	10	.000
Linear-by-Linear Association	.406	1	.524
N of Valid Cases	159		

a. 6 cells (33.3%) have expected count less than 5. The minimum expected count is 1.71.

Table 17. Chi-Square test (Source: Author, 2020)

Family composition and walking

The test results show not statistically significant (p=.036) association between family composition (number of children) and average weekly walking among the respondents.

N trips by walking per week * N children

Count

		N children		
		0	1	2
N trips by walking per week	0-5	30	18	10
	6-10	49	16	2
	10+	19	9	6
Total		98	43	18

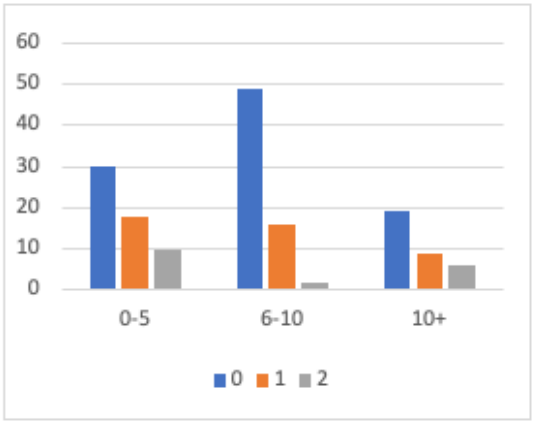


Table 18. Association between family composition and walking (Source: Author, 2020)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.248[a]	4	.036
Likelihood Ratio	11.519	4	.021
Linear-by-Linear Association	.608	1	.436
N of Valid Cases	159		

a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 3.85.

Table 19. Chi-Square test (Source: Author, 2020)

Age and walking

The test results show not statistically significant (p=.041) association between age and average weekly walking among the respondents.

N trips by walking per week * age

Count

		age							Total
		less than 18	19-28	29-38	39-48	49-58	59-68	69+	
N trips by walking per week	0-5	0	16	16	13	8	4	1	58
	6-10	5	27	9	10	7	6	3	67
	10+	4	12	9	6	0	0	3	34
Total		9	55	34	29	15	10	7	159

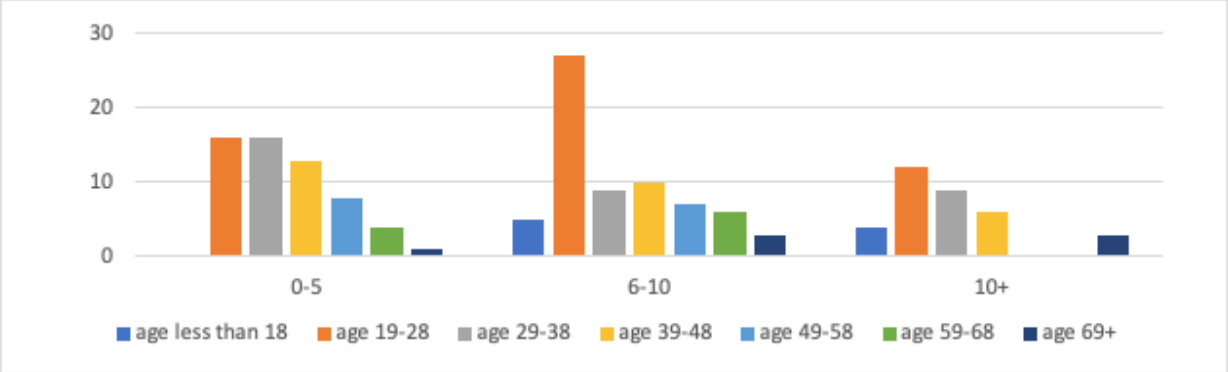


Table 20. Association between age and walking (Source: Author, 2020)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.598[a]	12	.042
Likelihood Ratio	29.564	12	.003
Linear-by-Linear Association	2.868	1	.090
N of Valid Cases	159		

a. 10 cells (47.6%) have expected count less than 5. The minimum expected count is 1.50.

Table 21. Chi-Square test (Source: Author, 2020)

Vehicle ownership and walking

The test results show not statistically significant (p=.484) association between vehicle ownership and average weekly walking among the respondents.

N trips by walking per week * vehicle ownership

Count

		vehicle ownership		Total
		no	yes	
N trips by walking per week	0-5	32	26	58
	6-10	44	23	67
	10+	21	13	34
Total		97	62	159

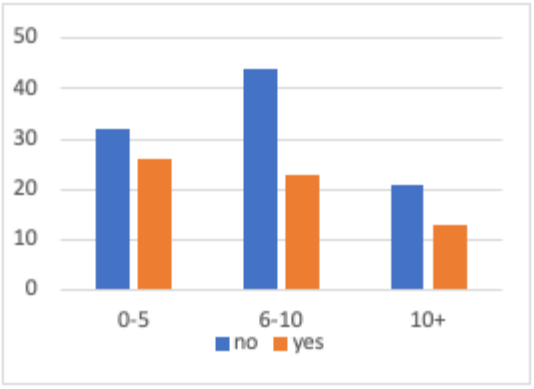


Table 22. Association between vehicle ownership and walking (Source: Author, 2020)

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.451[a]	2	.484
Likelihood Ratio	1.448	2	.485
Linear-by-Linear Association	.627	1	.429
N of Valid Cases	159		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.26.

Table 23. Chi-Square test (Source: Author, 2020)

perceived safety and walking

The test results show not statistically significant (p=.539) association between perceived safety and average weekly walking among the respondents.

N trips by walking per week * perceived safety							
Count							
		Perceived safety					Total
		Strongly agree	agree	neutral	disagree	Strongly disagree	
N trips by walking per week	0-5	26	13	13	4	2	58
	6-10	30	18	17	2	0	67
	10+	11	12	7	2	2	34
Total		67	43	37	8	4	159

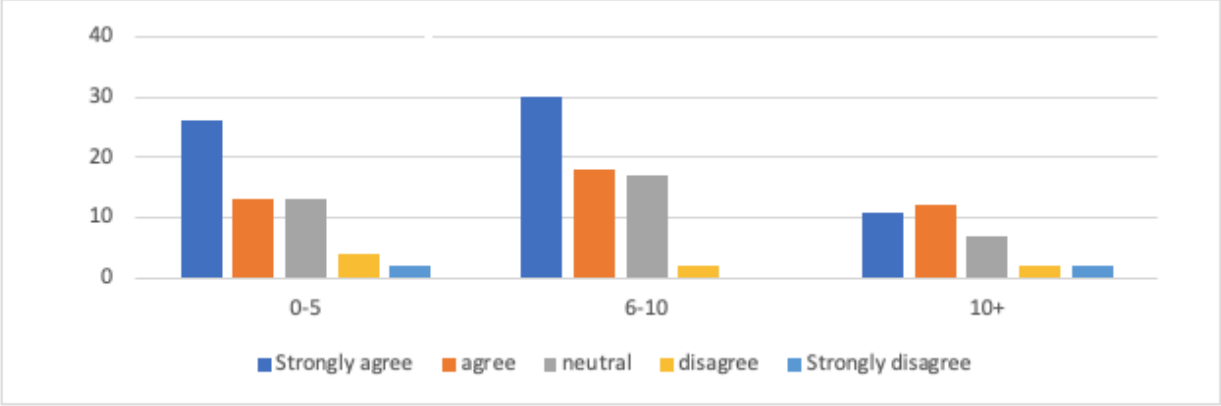


Table 24. Association between perceived safety and walking (Source: Author, 2020)

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.975[a]	8	.539
Likelihood Ratio	8.285	8	.406
Linear-by-Linear Association	.229	1	.632
N of Valid Cases	159		

a. 6 cells (40.0%) have expected count less than 5. The minimum expected count is .86.

Table 25. Chi-Square test (Source: Author, 2020)

Chapter 5: Conclusions

Environment crucially needs changing people's behaviours to face up challenges connected to climate change. Only the transportation sector is responsible for 20.4% of CO2 emission from fuel combustion (World Bank, 2014). Moreover, challenges connected to human health are associated with transportation as according to the World Health Organization (2018), road traffic-related deaths remain consistently high as 1.35 million people die globally each year. People spent more and more hours in congestion and congestion develops into "economic tax on cities". In addition, transportation is one of the substantial items of a household budget and in car-dependent cities underdeveloped opportunities for other modes, other than a private vehicle, social exclusion increases (Leveraging Urban Mobility Disruptions to Create Better Cities, 2020). Thus, changing travel behaviour could affect on the three pillars of sustainable development. To change the travel patterns and behaviour it is crucial to fully understand what factors influence walkability in a particular neighbourhood. One of the most important and common factors influencing walkability could include physical built environment and socio-economic characteristics.

Thus, the research was motivated to study the walkability of Saburtalo District of Tbilisi and to compare subjective and objective measures. The study focused on quantitative data collection method and also gathered data from the municipality and other local sources to achieve the triangulation and arrive at a reasonable conclusion. It has to be mentioned that the survey showed unexpected results that will be elaborated further in the following sections.

With regards to the main research question, the study explored the walkability index measured by survey and by spatial analysis. Walkability index was defined as the dependent variable, while physical built environment and socio-economic characteristics were represented as independent variables.

Several challenges and limitations were identified during undertaking the study. The major limitation that the study has is the complex nature of the research item. Walkability may be understood as an intricate decision-making process, that is influenced by numerous factors. Due to time constraints, only some relevant parts of factors are investigated. For example, some known strong influencers on walking are not included in the study (for example, weather, slope). However, this does not undermine the importance of the study. Moreover, it creates opportunity and base for future research.

Another challenge that was identified, is the Covid-19's influence on the response rate. To overcome this barrier, in case of respondents' willingness not to answer a hands-on questionnaire, the online version was available as an alternative as according to the National Statistics Office of Georgia, 88.4 % of Tbilisi residents have access to the internet (2019).

Another possible limitation identified was the language barrier, therefore, to eliminate the barrier questions was provided in local language.

In addition, the question about which scale is the most suitable for walkability research is left unanswered as no clear unity has been achieved among academia. This fact affects the results (great variation) and complicates the comparison process of different studies' results (Learnihan and Giles-Corti, 2011). To overcome this challenge, one of the most prevalent scales has been chosen as a study area. That is a census area that is named in the study as Saburtalo district.

During the analysis, descriptive and inferential statistics were used.

5.1 Sub-research question 1

The first sub-research question is trying to understand how does physical infrastructure influence walkability in Saburtalo district. The research question is explored via the sub-variables and their indicators such as physical street infrastructure, land use and street connectivity. In response to the first sub-question primary and secondary data was used in analysis subjective measures were coupled with objective measures. This created an opportunity to compare and contrast different measurement tools.

The analysis shows a moderate difference between the subjective and objective approaches. For example, the difference between GIS analysis and survey results is approximately 11% in terms of accessibility to grocery stores, parks and schools. In terms of transportation, the difference equals 17%. Meaning of the difference is that more respondents feel they have parks, grocery stores, transportation facilities and schools in the vicinity of their homes.

On the other hand, majority of the respondents answered that in Saburtalo, physical infrastructure is adapted to disabled people's needs, which is not (Institute for Development of Freedom of Information, 2016). That could be the reason for previous attitudes and lifestyle, when disabled people tend to stay at home, only since 2010 started the awareness rising for the inclusive education, for example. One could rarely see a disabled person in the street. Two reasons may be behind this fact: the first, the lack of awareness and the second the lack of infrastructure, that is still missing in the Tbilisi, however, apparently, still not many people are aware of the fact.

Regarding the first sub-question, literature suggests that sidewalk presence (see Annex 2: Visualizations, Map 7. Sidewalk presence in Saburtalo district) and width is one of the most encouraging factors for people to walk (Wicramasinghe and Dissanayake, 2017; Institute of Urban Studies, 2016). However, even though, in fact, there are limited space available for sidewalks people still think that their neighbourhood is mostly covered by the sidewalk grid.

On the other hand, trees (see Annex 2: Visualizations, Map 8. Trees presence alongside sidewalks in Saburtalo district) along the sidewalk are presented in the district and so it is proved by the survey that it creates a pleasant atmosphere. Similarly, encouraging nature of the presence of streetlights (Peña-García et al., 2015; Sallis et al., 2015; Vich et al., 2018) or walkability is also proved as the district is covered by the streetlights.

The land-use mix is also considered to be one of the strongest influencers of walkability and quite an array of facilities (see Annex 2: Visualizations, Map 9. Facilities in Saburtalo district) are presented in the district.

Therefore, physical infrastructure encourages walkability in Saburtalo district by mixed land use, streetlight presence, presence of trees alongside sidewalks that can provide pedestrians with shade from the sun in hot summer days and be aesthetically pleasing for them that is shown in the analysis by the effect and significance level.

5.2 Sub-research question 2

The second sub-research question is trying to understand how the socio-economic characteristics influence walkability in Saburtalo district of Tbilisi. The research question is explored via the sub-variables and their indicators like monthly income, age, vehicle ownership, gender, household composition and perceived safety.

Regarding the second sub-questions, the influence of socio-economic characteristics on walkability was explored. This is the place where unexpected results were revealed. Scio-economic characteristics were expected to be influencers of walkability; however, the results are different.

Literature suggests that socio-economic characteristics like age, gender, income, car ownership and household composition (having children) have been found to influence walkability (Schneider, 2013; Clifton et al, 2016). Clifton et al. (2016) found evidence that pedestrians' will to walk is strongly influenced by socio-economic characteristics such as car ownership and children in household (household composition). Schneider, (2013), on the other hand, adds to the group of characteristics age, gender and income as significant influencers. Moreover, the sense of safety has also been found to be one of the influencers (Peña-García et al., 2015). However, most of the socio-economic variables show not statistically significant association between them and walkability in the district of Saburtalo. With only one exception, monthly income and walking seem to have a statistically significant association between two of them (p=.004).

This could be explained by the fact that lower-income households are likely not able to purchase a vehicle.

Therefore, the effect of socio-economic characteristics influencing walkability is not found in Saburtalo district. None of the variables, except monthly income, have shown significant association with walkability in the analysis.

5.3 Main research question

The main research question is trying to answer the question of how the physical built environment and socio-economic characteristics influence walkability in Saburtalo district. Answers to the first and the second sub-questions provide an answer to the main research question.

As the interpretation of the analysis of the first and the second sub-research questions suggests subjective indicators play a lesser role in walkability determination rather than the objective ones in Saburtalo district. In other words, analysis has shown that mixed land use, presence of streetlight and trees have a more significant position in determining walkability in Saburtalo district than age, gender or vehicle ownership, for example.

Thus, it can be concluded that the analysis has shown less influence than expected. As the answers to the sub-research questions suggest in Saburtalo district physical built environment has more influence on walkability than socio-economic characteristics.

5.5 Recommendations

First of all, this research is the initial effort to explore characteristics influencing walkability in Saburtalo districts. The research findings show that there is a need for a wider variable range, for example, education level, relief and weather.

Secondly, time and pandemic constraints restricted the ability to include several districts in the survey and spatial analysis. Therefore, another recommendation is to widen the study area. This would create an opportunity to generalize the findings on the whole city.

Thirdly, another recommendation is to include a pedestrian network in spatial analysis instead of the street network. Pedestrian networks represent a much precise picture while assessing the walkability of the district. Also, another important aspect to include in the analysis is the actual

pedestrian network while assessing the accessibility of the district. In this study Euclidean distance is used, which in fact is not a precise representation of the pedestrian route. The choice of the Euclidean distance in this research is influenced by the unavailability of data. Besides, field collection of such data is time and labour consuming which was not possible in the case.

5.6 The Author's outlook

The analysis clearly shows how physical built environment encourages walking in the district. If the sidewalk network will increase and adequate width will be provided it is evident that walkability in the district will increase. Moreover, types of aesthetics and green areas could also be developed along the sidewalks to create more interesting surroundings. Pedestrian crossings could be added too as the facts clearly show the need for them, even though the survey showed satisfying results.

To reflect on the Covid-19 pandemic, it has laid great challenges on Tbilisi, and on the world in general. Currently, the government has stopped the operation of public transport and private vehicles are allowed to use newly implemented bus lanes, now people completely rely on other modes of transportation – mostly taxi and private vehicles. If the pandemic persists, it seems that changing people's travel behaviour will be an even more painful process as now vehicle-owners are getting used to using bus-lanes. Moreover, work already done towards influencing people's behaviour to use more sustainable modes by providing them with adequate mode choice could be wasted.

However, if the pandemic disappears in a few months or even in a year, the municipality could shift on a path of resilient recovery and continue aspiration towards sustainable development.

To summarize, the key to increased walkability in Saburtalo district clearly is refining and developing physical built environment.

Bibliography

Adkins, A., Makarewicz, C., Scanze, M., Ingram, M. et al., 2017a. Contextualizing Walkability: Do Relationships Between Built Environments and Walking Vary by Socioeconomic Context? *Journal of the American Planning Association,* 83 (3), pp. 296-314 doi: 10.1080/01944363.2017.1322527 Available at: http://www.tandfonline.com/doi/abs/10.1080/01944363.2017.1322527 .

Adkins, A., Makarewicz, C., Scanze, M., Ingram, M. et al. , 2017b. Contextualizing Walkability: Do Relationships Between Built Environments and Walking Vary by Socioeconomic Context? Journal of the American Planning Association, 83 (3), pp. 296-314 doi: 10.1080/01944363.2017.1322527 Available at: http://www.tandfonline.com/doi/abs/10.1080/01944363.2017.1322527 .

Aghaabbasi, M., Moeinaddini, M., Zaly Shah, M., Asadi-Shekari, Z. et al., 2017. Evaluating the capability of walkability audit tools for assessing sidewalks. doi: 10.1016/j.scs.2017.12.001 .

Ajzen, I., 1991. The Theory of Planned Behavior. doi: 10.1016/0749-5978(91)90020-T.

Anable, J., 2005. 'Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behaviour segments using attitude theory. Transport Policy, 12 (1), pp. 65-78 doi: 10.1016/j.tranpol.2004.11.004 Available at: http://dx.doi.org/10.1016/j.tranpol.2004.11.004 .

Arabuli Nastasia, 2020. Sidewalk occupation continues. Available at: https://bit.ly/2Y7osUl.

Aziz, H.M.A., Nagle, N., Morton, A., Hilliard, M. et al., 2018. Exploring the impact of walk–bike infrastructure, safety perception, and built-environment on active transportation mode choice: a random parameter model using New York City commuter data. Transportation, 45 (5), pp. 1207-1229 doi: 10.1007/s11116-017-9760-8 Available at: https://search.proquest.com/docview/2092774061 .

Arellana, J., Saltarín, M., Larrañaga, A.M., Alvarez, V. et al. , 2020. Urban walkability considering pedestrians' perceptions of the built environment: a 10-year review and a case study in a medium-sized city in Latin America. Transport Reviews, 40 (2), pp. 183-203 doi: 10.1080/01441647.2019.1703842 Available at: http://www.tandfonline.com/doi/abs/10.1080/01441647.2019.1703842 .

Babunashvili Giorgi, 2018. სივრცითი მობილობა თბილისში: გამოწვევები და პერსპექტივები (Spatial Mobility in Tbilisi: Challenges and Perspectives).

Bamberg, S., Fujii, S., Friman, M. and Gärling, T., 2011. Behaviour theory and soft transport policy measures. Transport Policy, 18 (1), pp. 228-235 doi: 10.1016/j.tranpol.2010.08.006 Available at: http://dx.doi.org/10.1016/j.tranpol.2010.08.006 .

Banister, D., 2011. Cities, mobility and climate change. Journal of Transport Geography, 19 (6), pp. 1538-1546. Available at: http://dx.doi.org/10.1016/j.jtrangeo.2011.03.009 .

Barros, A.P., Martínez, L.M. and Viegas, J.M., 2015. A New Approach to Understand Modal and Pedestrians Route in Portugal. Transportation Research Procedia, 10 pp. 860-869 doi: 10.1016/j.trpro.2015.09.039 Available at: http://dx.doi.org/10.1016/j.trpro.2015.09.039 .

Bauwens, M., Compernolle, S., Stavrakou, T., Müller, J.- et al., 2020. Impact of coronavirus outbreak on NO2 pollution assessed using TROPOMI and OMI observations. Geophysical Research Letters, doi: 10.1029/2020GL087978 .

Bejleri, I., Steiner, R.L., Fischman, A. and Schmucker, J.M., 2011. Using GIS to analyze the role of barriers and facilitators to walking in children's travel to school. URBAN DESIGN International, 16 (1), pp. 51-62 doi: 10.1057/udi.2010.18 Available at: http://dx.doi.org/10.1057/udi.2010.18 .

Benton, J.S., Anderson, J., Hunter, R.F. and French, D.P., 2016. The effect of changing the built

environment on physical activity: a quantitative review of the risk of bias in natural experiments. The International Journal of Behavioral Nutrition and Physical Activity, 13 (1), pp. 107 doi: 10.1186/s12966-016-0433-3 Available at: https://www.ncbi.nlm.nih.gov/pubmed/27717360 .

Bierlaire, M. and Robin, T., 2009. Pedestrians Choices.

Brownson, R.C., Hoehner, C.M., Day, K., Forsyth, A. et al. , 2009. Measuring the Built Environment for Physical Activity. *American Journal of Preventive Medicine,* 36 (4), pp. S99-S123.e12 doi: 10.1016/j.amepre.2009.01.005 Available at: https://www.clinicalkey.es/playcontent/1-s2.0-S0749379709000130 .

Buehler, R., 2011. Determinants of transport mode choice: a comparison of Germany and the USA. Journal of Transport Geography, 19 (4), pp. 644-657 doi: 10.1016/j.jtrangeo.2010.07.005 Available at: http://dx.doi.org/10.1016/j.jtrangeo.2010.07.005 .

Carlson, J.A., Saelens, B.E., Kerr, J., Schipperijn, J. et al., 2015. Association between neighborhood walkability and GPS-measured walking, bicycling and vehicle time in adolescents. Health and Place, 32 pp. 1-7 doi: 10.1016/j.healthplace.2014.12.008 Available at: http://dx.doi.org/10.1016/j.healthplace.2014.12.008 .

Cervero, R. and Duncan, M., 2003. Walking, Bicycling, and Urban Landscapes: Evidence from the San Francisco Bay Area. *American Journal of Public Health,* 93 (9), pp. 1478-1483 doi: 10.2105/AJPH.93.9.1478 Available at: http://ajph.aphapublications.org/cgi/content/abstract/93/9/1478 .

Cervero, R. and Kockelman, K., 1997. Travel demand and the 3Ds: Density, diversity, and design. Transportation Research Part D, 2 (3), pp. 199-219 doi: 10.1016/S1361-9209(97)00009-6 Available at: http://dx.doi.org/10.1016/S1361-9209(97)00009-6 .

Leveraging Urban Mobility Disruptions to Create Better Cities . 2020. Chase, R. and Natalia Barbour (Lecturers), EDx.Available at: https://courses.edx.org/courses/course-v1:MITx+11.550x+2T2020/courseware/069b83c180aa4b219a26322ec78d6499/1da22c3d2c22482d810c84c990e98eb6/?child=last .

Clark, A., Scott, D. and Yiannakoulias, N., 2014. Examining the relationship between active travel, weather, and the built environment: a multilevel approach using a GPS-enhanced dataset. Transportation, 41 (2), pp. 325-338 doi: 10.1007/s11116-013-9476-3 Available at: https://search.proquest.com/docview/1497355644 .

Clifton, K.J., Singleton, P.A., Muhs, C.D. and Schneider, R.J., 2016. Development of destination choice models for pedestrian travel. Transportation Research Part A, 94 pp. 255-265 doi: 10.1016/j.tra.2016.09.017 Available at: http://dx.doi.org/10.1016/j.tra.2016.09.017 .

De Witte, A. Hollevoet, J., Dobruszkes, F., Hubert, M. et al., 2013. Linking modal choice to motility: A comprehensive review. *Transportation Research Part A,* 49 pp. 329-341 doi: 10.1016/j.tra.2013.01.009 Available at: http://dx.doi.org/10.1016/j.tra.2013.01.009 .

Dobesova, Z., 2012.Walkability Index in the Urban Planning: A Case Study in Olomouc City. In: Walkability Index in the Urban Planning: A Case Study in Olomouc City. In: IntechOpen. Available at: https://openresearchlibrary.org/viewer/60b79720-1a0d-44fe-b4cf-fe7229d6876c .

Dobesova, Z. and Krivka, T., 2012. Advances in Spatial Planning. InTech. doi: 10.5772/2123 Available at: https://search.datacite.org/works/10.5772/2123 .

Dörrzapf, L., Kovács-Győri, A., Resch, B. and Zeile, P., 2019. Defining and assessing walkability: a concept for an integrated approach using surveys, biosensors and geospatial analysis. *Urban Development Issues,* 62 (1), pp. 5-15 doi: 10.2478/udi-2019-0008 Available at: http://www.degruyter.com/doi/10.2478/udi-2019-0008 .

D'Orso, G. and Migliore, M., 2019. A GIS-based method for evaluating the walkability of a pedestrian environment and prioritised investments. Available at: https://doi.org/10.1016/j.jtrangeo.2019.102555 .
Dovey, K. and Pafka, E., 2018. What is walkability? The urban DMA.
Ellis, G., Hunter, R., Tully, M.A., Donnelly, M. et al., 2015. Connectivity and physical activity: using footpath networks to measure the walkability of built environments. Environment and Planning B: Planning and Design, 43 (1), pp. 130-151 doi: 10.1177/0265813515610672 Available at: https://search.datacite.org/works/10.1177/0265813515610672 .
Forsyth, A., 2015. What is a walkable place? The walkability debate in urban design. URBAN DESIGN International, 20 (4), pp. 274-292 doi: 10.1057/udi.2015.22 Available at: https://search.proquest.com/docview/1730497087 .
Forsyth, A., Hearst, M., Oakes, J.M. and Schmitz, K.H., 2008. Design and Destinations: Factors Influencing Walking and Total Physical Activity. Urban Studies, 45 (9), pp. 1973-1996 doi: 10.1177/0042098008093386 Available at: https://www.jstor.org/stable/43198450 .
Frank, L.D., Sallis, J.F., Saelens, B.E., Leary, L. et al., 2010. The development of a walkability index: application to the Neighborhood Quality of Life Study. doi: 10.1136/bjsm.2009.058701 .
Frank, L.D., Sallis, J.F., Conway, T.L., Chapman, J.E. et al., 2006. Many Pathways from Land Use to Health: Associations between Neighborhood Walkability and Active Transportation, Body Mass Index, and Air Quality. Journal of the American Planning Association, 72 (1), pp. 75-87 doi: 10.1080/01944360608976725 Available at: http://www.tandfonline.com/doi/abs/10.1080/01944360608976725 .
Frank, L.D. and Pivo, G., 1994. Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single-Occupant Vehicle, Transit, and Walking.
Frank, L.D., Schmid, T.L., Sallis, J.F., Chapman, J. et al., 2005. Linking objectively measured physical activity with objectively measured urban form. *American Journal of Preventive Medicine*, 28 (2), pp. 117-125 doi: 10.1016/j.amepre.2004.11.001 Available at: https://search.datacite.org/works/10.1016/j.amepre.2004.11.001 .
Gardner, B. and Abraham, C., 2008. Psychological correlates of car use: A meta-analysis. Transportation Research Part F: Psychology and Behaviour, 11 (4), pp. 300-311 doi: 10.1016/j.trf.2008.01.004 Available at: http://dx.doi.org/10.1016/j.trf.2008.01.004 .
Gehl, J., 2011. Cities for People. Available at: https://sf.streetsblog.org/2011/06/14/danish-architect-jan-gehl-on-good-cities-for-walking/ .
Glanz, K. and Kegler, M.C., 2009. Environments: Theory, Research and Measures of the Built Environment. Available at: http://cancercontrol.cancer.gov/brp/constructs/environment/environment.pdf .
Giely, J., 2015. Tbilisi Sustainable Urban Transport Strategy. Tbilisi .
Giorgi Kankia, 2019. მობილობის სოციალური ინფრასტრქტურა და საცხოვრებელი სივრცეები (Social Infrastructure of Mobility and Housing).
Glazier, R.H., Weyman, J.T., Creatore, M.I., Gozdyra, P. et al., 2015. Development and Validation of an Urban Walkability Index for Toronto, Canada.
Gonçalves, J., Asanidze, D. and Pinto, P., 2016. The Riverfront as a Mirror: The Case of the Transformations in Post-Soviet Cities. *New Water Policy & Practice*, 2 (2), pp. 21-35. Available at: https://onlinelibrary.wiley.com/doi/abs/10.18278/nwpp.2.2.4 .
Götschi, T., de Nazelle, A., Brand, C. and Gerike, R., 2017. Towards a Comprehensive Conceptual Framework of Active Travel Behavior: a Review and Synthesis of Published

Frameworks. Current Environmental Health Reports, 4 (3), pp. 286-295 doi: 10.1007/s40572-017-0149-9 Available at: https://www.ncbi.nlm.nih.gov/pubmed/28707281 .
Guinn, J.M. and Stangl, P., 2014. Pedestrian and bicyclist motivation: an assessment of influences on pedestrians' and bicyclists' mode choice in Mt. Pleasant, Vancouver. Urban, Planning and Transport Research, 2 (1), pp. 105-125 doi: 10.1080/21650020.2014.906907 Available at: http://www.tandfonline.com/doi/abs/10.1080/21650020.2014.906907 .
INRIX, 2019. Traffic Scorecard 2019. Available at: https://inrix.com/scorecard/ .
Institute of Urban Studies, 2016. Downtown Dallas: Walkability Study.
Institute for Development of Freedom of Information, 2016. Needs of disabled people in Georgia.
Hall, C.M. and Ram, Y., 2018. Walk score (R) and its potential contribution to the study of active transport and walkability. Available at: http://urn.kb.se/resolve?urn=urn:nbn:se:lnu:diva-77011 .
Hall, R.A., 2019. HPE's Walkability Index – Quantifying the Pedestrian Experience. Oakland, California: University of California Press.
Heinen, E., 2016. Identity and travel behaviour: A cross-sectional study on commute mode choice and intention to change. Transportation Research. Part F, Traffic Psychology and Behaviour, 43 pp. 238-253 doi: 10.1016/j.trf.2016.10.016 Available at: http://dx.doi.org/10.1016/j.trf.2016.10.016 .
Hess, D.B., 2011. Walking to the bus: perceived versus actual walking distance to bus stops for older adults. *Transportation (Dordrecht)*, 39 (2), pp. 247-266 doi: 10.1007/s11116-011-9341-1 Available at: https://search.datacite.org/works/10.1007/s11116-011-9341-1 .
John Butcher, 1999. Walk21. Available at: https://arquitecturia.org/en/the-international-charter-for-walking-valencia-2016/ [Accessed 12-11-2020].
Kelly, C.E., Tight, M.R., Hodgson, F.C. and Page, M.W., 2011. A comparison of three methods for assessing the walkability of the pedestrian environment. Journal of Transport Geography, 19 (6), pp. 1500-1508 doi: 10.1016/j.jtrangeo.2010.08.001 Available at: http://dx.doi.org/10.1016/j.jtrangeo.2010.08.001 .
Kim, E.J., Won, J. and Kim, J., 2019. Is Seoul Walkable? Assessing a Walkability Score and Examining Its Relationship with Pedestrian Satisfaction in Seoul, Korea. Sustainability, 11 (24), pp. 6915 doi: 10.3390/su11246915 .
Kockelman, K., Chen, D., Larsen, K. and Nichols, B., 2013. The Economics Of Transportation Systems: A Reference For Practitioners.
Koh, P.P. and Wong, Y.D., 2013. Comparing pedestrians' needs and behaviours in different land use environments. Available at: http://www.sciencedirect.com/science/journal/09666923 .
Koohsari, M.J., Owen, N., Cerin, E., Giles-Corti, B. et al., 2016. Walkability and walking for transport: characterizing the built environment using space syntax. The International Journal of Behavioral Nutrition and Physical Activity, 13 (1), pp. 121 doi: 10.1186/s12966-016-0448-9 Available at: https://www.ncbi.nlm.nih.gov/pubmed/27881173 .
Koohsari, M.J., Sugiyama, T., Mavoa, S., Villanueva, K. et al., 2016. Street network measures and adults' walking for transport: Application of space syntax. Health and Place, 38 pp. 89-95 doi: 10.1016/j.healthplace.2015.12.009 Available at: http://dx.doi.org/10.1016/j.healthplace.2015.12.009 .
Learnihan, V. and Giles-Corti, B., 2011. Effect of Scale on the Links between Walking and Urban Design. *Geographical Research*, 49 (2), pp. 183-191 doi: 10.1111/j.1745-5871.2011.00689.

Litman, T., 2017. Evaluating Active Transport Benefits and Costs. Victoria Transport Policy Institute. Available at: https://deslibris.ca/ID/10092048 .
Litman, T. and Burwell, D., 2006. Issues in sustainable transportation. *International Journal of* Global *Environmental Issues*, 6 (4), pp. 331-347 doi: 10.1504/IJGENVI.2006.010889 Available at: https://www.inderscienceonline.com/doi/10.1504/IJGENVI.2006.010889 .
Loh, V.H., Rachele, J.N., Brown, W.J., Ghani, F. et al. , 2019. The potential for walkability to narrow neighbourhood socioeconomic inequalities in physical function: A case study of middle-aged to older adults in Brisbane, Australia. Health & Place, 56 pp. 99-105 doi: 10.1016/j.healthplace.2019.01.020 Available at: http://dx.doi.org/10.1016/j.healthplace.2019.01.020 .
Ma, L. and Cao, J., 2019. How perceptions mediate the effects of the built environment on travel behavior? Transportation (Dordrecht), 46 (1), pp. 175-197 doi: 10.1007/s11116-017-9800-4 Available at: https://search.proquest.com/docview/2198935720 .
Maghelal, P.K. and Capp, C.J., 2011. Walkability: a review of existing pedestrian indices. URISA Journal, 23 (2).
Moffatt, S. and Kohler, N., 2008. Conceptualizing the built environment as a social-ecological system. Building Research & Information: DevelopingTheories of the Built Environment, 36 (3), pp. 248-268 doi: 10.1080/09613210801928131 Available at: http://www.tandfonline.com/doi/abs/10.1080/09613210801928131 .
Naess, P., 2004. Urban Structures and Travel Behavior. Experiences from Empirical Research in Norway and Denmark .
National Statistics Office of Georgia, 2019. Information and Communication Technology in Georgia.
National Statistics Office of Georgia, 2019. Average monthly nominal earnings by regions.
Oriol, Marquet, Carme and Miralles-Guasch, 2014. Walking short distances. The socioeconomic drivers for the use of proximity in everyday mobility in Barcelona. Available at: https://doi.org/10.1016/j.tra.2014.10.007 .
Owen, N., Cerin, E., Leslie, E., duToit, L. et al. , 2007. Neighborhood Walkability and the Walking Behavior of Australian Adults. American Journal of Preventive Medicine, 33 (5), pp. 387-395 doi: 10.1016/j.amepre.2007.07.025 Available at: https://www.clinicalkey.es/playcontent/1-s2.0-S0749379707004680 .
Peña-García, A., Hurtado, A. and Aguilar-Luzón, M.C., 2015. Impact of public lighting on pedestrians' perception of safety and well-being. Safety Science, 78 pp. 142-148 doi: 10.1016/j.ssci.2015.04.009 Available at: http://dx.doi.org/10.1016/j.ssci.2015.04.009 .
Pollard, T.M. and Wagnild, J.M., 2017. Gender differences in walking (for leisure, transport and in total) across adult life: a systematic review. BMC Public Health, 17 (1), pp. 341 doi: 10.1186/s12889-017-4253-4 Available at: https://www.ncbi.nlm.nih.gov/pubmed/28427376 .
Rafiemanzelat, R., Emadi, M.I. and Kamali, A.J., 2017. City sustainability: the influence of walkability on built environments. Transportation Research Procedia, 24 pp. 97-104 doi: 10.1016/j.trpro.2017.05.074 Available at: http://dx.doi.org/10.1016/j.trpro.2017.05.074 .
Renalds, A., Smith, T.H. and Hale, P.J., 2010. A Systematic Review of Built Environment and Health.
Rhodes, R.E., Zhang, R. and Zhang, C., 2020. Direct and Indirect Relationships Between the Built Environment and Individual-Level Perceptions of Physical Activity: A Systematic Review. *Annals of Behavioral Medicine*, 54 (7), pp. 495-509 doi: 10.1093/abm/kaz068 Available at: https://www.ncbi.nlm.nih.gov/pubmed/31926006 .

Riggs, W. and Sethi, S.A., 2020. Multimodal travel behaviour, walkability indices, and social mobility: how neighbourhood walkability, income and household characteristics guide walking, biking & transit decisions. Local Environment, 25 (1), pp. 57-68 doi: 10.1080/13549839.2019.1698529 Available at: http://www.tandfonline.com/doi/abs/10.1080/13549839.2019.1698529 .

Root, E.D., Silbernagel, K. and Litt, J.S., 2017. Unpacking healthy landscapes: Empirical assessment of neighborhood aesthetic ratings in an urban setting. doi: 10.1016/j.landurbplan.2017.09.028 .

Sallis, J.F., 2009. Measuring physical activity environments: a brief history. American Journal of Preventive Medicine, 36 (4 Suppl), pp. S86-S92 doi: 10.1016/j.amepre.2009.01.002 Available at: https://www.ncbi.nlm.nih.gov/pubmed/19285214 .

Sallis, J.F., Cain, K.L., Conway, T.L., Gavand, K.A. et al. , 2015. Is Your Neighborhood Designed to Support Physical Activity? A Brief Streetscape Audit Tool. Preventing Chronic Disease, 12 pp. E141 doi: 10.5888/pcd12.150098 Available at: https://www.ncbi.nlm.nih.gov/pubmed/26334713 .

Salukvadze, J. and Golubchikov, O., 2016. City as a geopolitics: Tbilisi, Georgia — A globalizing metropolis in a turbulent region. *Cities*, 52 pp. 39-54 doi: 10.1016/j.cities.2015.11.013 Available at: http://dx.doi.org/10.1016/j.cities.2015.11.013 .

Schneider, R.J., 2013. Theory of routine mode choice decisions: An operational framework to increase sustainable transportation. *Transport Policy*, 25 pp. 128-137 doi: 10.1016/j.tranpol.2012.10.007 Available at: http://dx.doi.org/10.1016/j.tranpol.2012.10.007 .

Shi, X. and Brasseur, G.P., 2020. The Response in Air Quality to the Reduction of Chinese Economic Activities during the COVID-19 Outbreak. Geophysical Research Letters, doi: 10.1029/2020GL088070 .

Siradze N., 2020. Safe Mobility. Imedi.

Sopromadze, 2020. Tbilisi Forum. [Online] Available at: https://bit.ly/3eZBMRn

Speck, J., 2018. Walkable City Rules: 101 Steps to Making Better Places. doi: 10.5822/978-1-61091-899-2.

Stafford, L. and Baldwin, C., 2018. Planning Walkable Neighborhoods. Journal of Planning Literature, 33 (1), pp. 17-30 doi: 10.1177/0885412217704649 Available at: https://journals.sagepub.com/doi/full/10.1177/0885412217704649 .

State Audit Office, 2018. Effectiveness Audit Report.

Stevenson, M., Thompson, J., Herick de Sa, T., Ewing, R. et al., 2016. Land-use, transport and population health: estimating the health benefits of compact cities. Available at: http://researchbank.rmit.edu.au/view/rmit:39817 .

Stockemer, D., 2019. Quantitative Methods for the social sciences: a practical introduction with examples in SPSS and Stata. American Library Association Choice.

Sundquist, K., Eriksson, U., Kawakami, N., Skog, L. et al., 2011. Neighborhood walkability, physical activity, and walking behavior: The Swedish Neighborhood and Physical Activity (SNAP) study. Social Science & Medicine, 72 (8), pp. 1266-1273 doi: 10.1016/j.socscimed.2011.03.004 Available at: http://dx.doi.org/10.1016/j.socscimed.2011.03.004 .

SYSTRA, 2016. Sustainable Urban Transport Investment Program.

Tao, Y., Yang, J. and Chai, Y., 2019. The Anatomy of Health-Supportive Neighborhoods: A Multilevel Analysis of Built Environment, Perceived Disorder, Social Interaction and Mental Health in Beijing.

Tiran, J., Lakner, M. and Drobne, S., 2019. Modelling walking accessibility: A case study of Ljubljana, Slovenia. Moravian Geographical Reports, 27 (4), pp. 194-206 doi: 10.2478/mgr-2019-0015 Available at: http://www.degruyter.com/doi/10.2478/mgr-2019-0015 .
Topmiller, M., 2013. Access, Neighbourhood Walkability, & an Urban Greenway A Qualitative GIS Approach.
Turoń, K., Czech, P. and Juzek, M., 2017. The Concept of a Walkable City as an Alternative form of Urban Mobility. Available at: http://sjsutst.polsl.pl/ .
Vale, D.S., Saraiva, M. and Pereira, M., 2016. Active accessibility. Journal of Transport and Land Use, 9 (1), pp. 209-235 doi: 10.5198/jtlu.2015.593 Available at: https://www.jstor.org/stable/26203215 .
Van Acker, V. and Witlox, F., 2009. Why land use patterns affect travel behaviour (or not). Belgeo, (1), pp. 5-26 doi: 10.4000/belgeo.8777 .
Van Assche, K. and Salukvadze, J., 2012. Tbilisi reinvented: planning, development and the unfinished project of democracy in Georgia. *Planning Perspectives,* 27 (1), pp. 1-24 doi: 10.1080/02665433.2011.601611 Available at: http://www.tandfonline.com/doi/abs/10.1080/02665433.2011.601611 .
Van de Coevering, P., Maat, K., Kroesen, M. and Van Wee, B., 2016. Causal effects of built environment characteristics on travel behaviour: a longitudinal approach. European Journal of Transport and Infrastructure Research, 16 (4), pp. 674-697 doi: 10.18757/ejtir.2016.16.4.3165 Available at: https://www.narcis.nl/publication/RecordID/oai:pure.buas.nl:publications%2F87e7bea6-9f0c-474b-afa8-dca3e78dbde7 .
Van Dender, K., 2007. Alleviating Urban Traffic Congestion. Chicago: Taylor & Francis Group LLC. Available at: https://search.proquest.com/docview/229658327 .
Van Dyck, D., Cardon, G., Deforche, B., Sallis, J.F. et al. , 2009. Neighborhood SES and walkability are related to physical activity behavior in Belgian adults. Preventive Medicine, 50 pp. S74-S79 doi: 10.1016/j.ypmed.2009.07.027 Available at: https://www.clinicalkey.es/playcontent/1-s2.0-S0091743509004253 .
Van Thiel, S., 2014. Research Methods in Public Administration and Public Management.
Vich, G., Marquet, O. and Miralles-Guasch, C., 2018. Green streetscape and walking: Exploring active mobility patterns in dense and compact cities. *Injury Prevention,* 20 (4), pp. 292 doi: 10.1136/injuryprev-2014-041194 Available at: http://dx.doi.org/10.1136/injuryprev-2014-041194 .
Vivion, N., 2013. Walkonomics: A new app aggregates community data on walkable streets. Available at: https://www.phocuswire.com/Walkonomics-A-new-app-aggregates-community-data-on-walkable-streets .
Walk, 2019. Walk In Didi Dighomi.
Wicramasinghe, V. and Dissanayake, S., 2017. Evaluation of pedestrians' sidewalk behavior in developing countries. Transportation Research Procedia, 25 pp. 4068-4078 doi: 10.1016/j.trpro.2017.05.327 Available at: http://dx.doi.org/10.1016/j.trpro.2017.05.327 .
World Bank, 2014. CO2 emissions from transport. Available at: https://data.worldbank.org/indicator/en.co2.tran.zs?end=2014&start=2014&view=map .
World Health Organization, 2018. Global status report on road safety. Available at: http://dx.doi.org/10.1136/ip.2009.023697 .
Zhang, X., Zhou, S., Lin, R. and Su, L., 2020. Relationship between Long-Term Residential Green Exposure and Individuals' Mental Health: Moderated by Income Differences and

Residential Location in Urban China.
Yin, L., 2017. Street level urban design qualities for walkability: Combining 2D and 3D GIS measures. Computers, Environment and Urban Systems, 64 pp. 288-296 doi: 10.1016/j.compenvurbsys.2017.04.001 Available at: https://search.datacite.org/works/10.1016/j.compenvurbsys.2017.04.001 .
Zuniga-Teran, A.A., Stoker, P., Gimblett, R.H., Orr, B.J. et al. , 2019. Exploring the influence of neighborhood walkability on the frequency of use of greenspace. Available at: https://doi.org/10.1016/j.landurbplan.2019.103609 .

Annex 1: Samples of the questionnaire

English:

Introduction

Tbilisi, Saburtalo district

2020

Hello, my name is Salome Sharashenidze. I am currently enrolled in the Urban Management and Development (UMD) Masters' course in Erasmus University, Rotterdam. This is the study that aims to investigate how built environment and socio-economic characteristics affect walkability in Saburtalo district of Tbilisi city. The study is confidential, and the information will be used only for academic purposes. Please answer all the question by ticking the relevant box.

Thank you for your time.

Date _____

Place _____

Number of interviews: _____

Name of interviewer: _____

Please circle the correct answer.

1. **Do you live in Saburtalo district?**

   □ yes □ no

   If the answer on 1st question is "no" please do not fill the rest of the questionnaire

2. **What is the purpose of today's trip by walking? Please choose more than one answer if applicable.**

   □ work □ bus stop □ exercise/recreation □ shopping/eating

3. **On average how many trips do you make by walking per week?**

   □ 0-5 □ 6-10 □ 10+

4. **On average how many trips did you make by walking per week before the pandemic (Covid-19)?**

   □ 0-5 □ 6-10 □ 10+

5. **What is the common purpose of your trips by walking per week? Please choose more than one answer if applicable.**

   □ work □ bus stop □ exercise/recreation □ shopping/eating

6. **There are sidewalks along the streets in this district**

   □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

7. **Quality of sidewalks encourages walking in this district**

   □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

8. **Sidewalk width is enough for two people to walk comfortably side-by-side in this district**

   □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

9. **There are streetlights along the streets in this district**

   □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

10. **There are interesting sculptures in this district**

    □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

11. **Scenic views make walking in this district pleasant**

    □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

12. **Street furniture makes walking in this district pleasant**

    □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

13. **Beautiful parks make walking in this district pleasant**

    □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

14. **There are trees along the streets in this district to provide shade from sun while walking**

    □ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

15. There are several crosswalks that make walking easier in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

16. There are diverse residential options (apartments, houses) in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

17. There are diverse public/private options (offices, banks, schools, restaurants) in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

18. This is a densely populated district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

19. Direct routes with numerous intersections make walking pleasant in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

20. Walking in this district is safe (in terms of traffic)

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

21. Walking at night in this district is safe because streets are adequately lit

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

22. There is a grocery store in close proximity to my house in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

23. There is a park in close proximity to my house in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

24. There is a school in close proximity to my house in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

25. There is a bus/metro station/stop in close proximity to my house in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

26. My workplace is in close proximity to my house in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

27. Sidewalks are easily accessible to people with disabilities in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

28. Sidewalks in this district are barrier (parked cars, construction fences, trash bins) free

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

29. There are several paths to access grocery store in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

30. There are several paths to access park in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

31. There are several paths to access school in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

32. There are several paths to access bus/metro station/stop in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

33. There are several paths to access my workplace in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

34. There are no or few cul-de-sacs in this district

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree

35. What is your gender?

□ Female □ Male

36. What is your age?

□ less than 18 □ 19 – 28 □ 29 – 38 □ 39 – 48 □ 49 – 58 □ 59 – 68

□ 69 +

37. What is your monthly income?

□ up to 300 GEL □ 301 – 600 GEL □ 601 – 1000 GEL □ 1001 – 1500 GEL

□ 1501 – 2000 GEL □ 2001 +

38. Do you own a vehicle (car, motorcycle, etc)?

□ yes □ no

39. How many members does your family have? Please indicate a numeric value

□

40. How many children does your family have? Please indicate a numeric value

□

Georgian:

შესავალი

თბილისი, საბურთალოს რაიონი

2020

მოგესალმებით, მე გახლავართ სალომე შარაშენიძე. ამჟამად ვსწავლობ როტერდამის ერასმუსის უნივერსიტეტში, ურბანული მართვისა და განვითარების სამაგისტრო პროგრამაზე. აღნიშნული პროგრამის ფარგლებში, თბილისში, საბურთალოს რაიონში, ვატარებ კვლევას, რომლის მიზანია გამოიკვლიოს საფეხმავლო ინფრასტრუქტურისა და სოციო-ეკონომიკური მახასიათებლების გავლენა უბნის ფარგლებში ფეხით გადაადგილებაზე.

აღნიშნული კვლევა კონფიდენციალურია, თქვენს მიერ მოწოდებული ინფორმაცია გამოიყენება მხოლოდ აკადემიური მიზნებისთვის.

გმადლობთ დათმობილი დროისთვის.

თარიღი _____

ადგილი _____

ინტერვიუს ნომერი: _____

ინტერვიუერის სახელი: _____

გთხოვთ მონიშნოთ სასურველი პასუხ(ებ)ი.

1. ცხოვრობთ საბურთალოს რაიონში (რუკაზე მონიშნული ტერიტორიის ფარგლებში)?

□ კი □ არა

თუ პირველ კითხვაზე პასუხია „არა“, გთხოვთ <u>აღარ</u> შეავსოთ კითხვარი.

2. რა არის დღევანდელი თქვენი ფეხით გადაადგილების მიზანი? საჭიროების შემთხვევაში, გთხოვთ აირჩიოთ რამდენიმე პასუხი

□ სამსახური □ ავტობუსის გაჩერება/მეტროს სადგური □ გასეირნება/ვარჯიში □ საყიდლები/კვება

3. კვირაში საშუალოდ რამდენჯერ დადიხართ ფეხით?

□ 0-5 □ 6-10 □ 10+

4. კვირაში საშუალოდ რამდენჯერ დადიოდით ფეხით პანდემიამდე (Covid-19)?

□ 0-5 □ 6-10 □ 10+

5. ძირითადად რა მიზნით დადიხართ ფეხით კვირის განმავლობაში?

□ სამსახური □ ავტობუსის გაჩერება/მეტროს სადგური □ გასეირნება/ვარჯიში □ საყიდლები/კვება

6. ჩემს უბანში არის ტროტუარები

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

7. ჩემი უბნის ტროტუარების საფარის მდგომარეობა ფეხით სიარულს ახალისებს

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

8. ჩემი უბნის ტროტუარების სიგანე საკმარისია იმისათვის, რომ ორმა ადამიანმა კომფორტულად გაიაროს გვერდიგვერდ

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

9. ჩემი უბნის ქუჩები განათებულია

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

10. ჩემს უბანში საინტერესო სკულპტურებია

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

11. საინტერესო ხედები ჩემს უბანში ფეხით სიარულს სასიამოვნოს ხდის

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

12. ჩემს უბანში განთავსებული ქუჩის ავეჯი (გრძელი სკამები, მიმართულების ნიშნები, სატრანსპორტო ნაკადებისგან გამყოფი ბარიერები და სხვ.) ფეხით სიარულს სასიამოვნოს ხდის

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

13. ჩემს უბანში არსებული მოწესრიგებული პარკები/სკვერები ფეხით სიარულს სასიამოვნოს ხდის

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

14. ჩემს უბანში, ქუჩების გასწვრივ დარგული ხეები ფეხით სიარულისას მზისგან მიცავს

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

15. ჩემს უბანში არსებული „ზებრა“ გადასასვლელები ფეხით გადაადგილებას ამარტივებს

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

16. ჩემს უბანში საცხოვრებლის მრავალფეროვანი ტიპებია წარმოდგენილი (მრავალბინიანი საცხოვრებელი, ინდივიდუალური საცხოვრებელი)

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

17. ჩემს უბანში მრავალფეროვანი კერძო/საჯარო დაწესებულებებია (ოფისები, ბანკები, სკოლები, რესტორნები, კაფეები)

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

18. ეს უბანი მჭიდროდ დასახლებულია

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

19. ჩემს უბანში ძირითადი ობიექტები ერთმანეთთან დაკავშირებულია პირდაპირი და მოკლე გზებით, რაც ფეხით სიარულს აადვილებს

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

20. ჩემს უბანში ფეხით გადაადგილება უსაფრთხოა (სატრანსპორტო ნაკადთან მიმართებით)

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

21. ღამით ჩემს უბანში ფეხით გადაადგილება უსაფრთხოა რადგან ქუჩები განათებულია

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ ნაწილობრივ ვეთანხმები, ნაწილობრივ არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

22. უბანში, ჩემს სახლთან ახლოს არის მაღაზია ყოველდღიური საყიდლებისთვის

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

23. უბანში, ჩემს სახლთან ახლოს არის პარკი/სკვერი

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

24. უბანში, ჩემს სახლთან ახლოს არის სკოლა

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

25. უბანში, ჩემს სახლთან ახლოს არის ავტობუსის გაჩერება/მეტროს სადგური

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

26. ჩემი სამუშაო ადგილი უბანში, სახლთან ახლოსაა

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

27. უბნის ტროტუარები მარტივად მისაწვდომია შეზღუდული შესაძლებლობის მქონე პირთათვის

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

28. უბნის ტროტუარებზე ბარიერები (პარკირებული ავტომობილები, სამშენებლო ღობეები, ნაგვის ურნები და სხვ.) არ არის

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

29. უბანში, მაღაზიამდე (ყოველდღიური საყიდლებისთვის) ფეხით მისვლა რამდენიმე გზით არის შესაძლებელი

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

30. უბანში, პარკამდე/სკვერამდე ფეხით მისვლა რამდენიმე გზით არის შესაძლებელი

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

31. უბანში, სკოლამდე ფეხით მისვლა რამდენიმე გზით არის შესაძლებელი

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

32. უბანში, ავტობუსის გაჩერებამდე/მეტრო სადგურამდე ფეხით მისვლა რამდენიმე გზით არის შესაძლებელი

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

33. უბანში, ჩემს სამსახურამდე ფეხით მისვლა რამდენიმე გზით არის შესაძლებელი

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

34. უბანში არ არის ან ცოტა ჩიხია

□ სრულად ვეთანხმები □ ნაწილობრივ ვეთანხმები □ არც ვეთანხმები, არც არ ვეთანხმები □ ნაწილობრივ არ ვეთანხმები □ სრულად არ ვეთანხმები

35. თქვენი სქესი

□ ქალი □ მამაკაცი

36. თქვენი ასაკი

□ 18-ზე ნაკლები □ 19 – 28 □ 29 – 38 □ 39 – 48 □ 49 – 58 □ 59 – 68

□ 69 +

37. რა არის თქვენი თვიური შემოსავალი

□ 300 ლარამდე □ 301 – 600 ლარი □ 601 – 1000 ლარი □ 1001 – 1500 ლარი

□ 1501 – 2000 ლარი □ 2001 +

38. ფლობთ თუ არა ძრავიან სატრანსპორტო საშუალებას (კერძო ავტომობილი, მოტოციკლი, ფურგონი, მიკრო ავტობუსი, მსუბუქი სატვირთო, სატვირთო)? საჭიროების შემთხვევაში მონიშნეთ რამდენიმე პასუხი

□ არა □ დიახ, მსუბუქ ავტომობილს □ დიახ, მოტოციკლს □ დიახ, ფურგონს □ დიახ, მიკრო ავტობუსს □ დიახ, სატვირთოს □ დიახ, მსუბუქ სატვირთოს

39. სულ რამდენი წევრია თქვენს ოჯახში (5 წლამდე ასაკის ჩათვლით)? გთხოვთ, მიუთითეთ რაოდენობა ციფრით

□ ----------

40. რამდენი წევრია თქვენს ოჯახში 5 წელზე მეტი ასაკის? გთხოვთ, მიუთითეთ რაოდენობა ციფრით

□ ----------

Annex 2: Visualizations

Table 1. Average walking trips per week

On average how many trips do you make by walking per week?			
	Frequency	Percent	Valid Percent
0-5	58	36.5	36.5
6-10	67	42.1	42.1
10+	34	21.4	21.4
Total	159	100.0	100.0

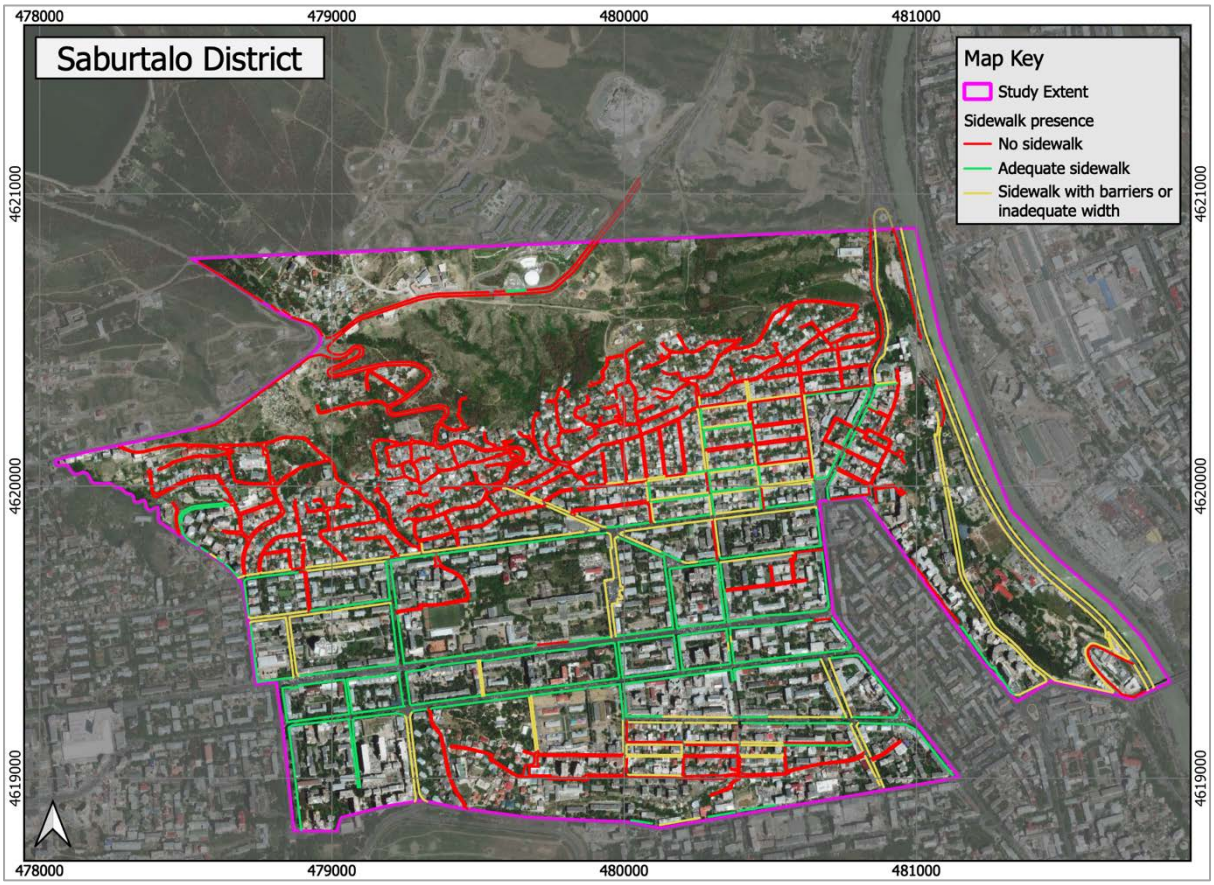
Table 2. Average walking trips per week pre Covid-19

On average how many trips did you make by walking per week before the pandemic (Covid-19)			
	Frequency	Percent	Valid Percent
0-5	62	39.0	39.0
6-10	42	26.4	26.4
10+	55	34.6	34.6
Total	159	100.0	100.0

Table 3. Maximum and minimum values of the variables

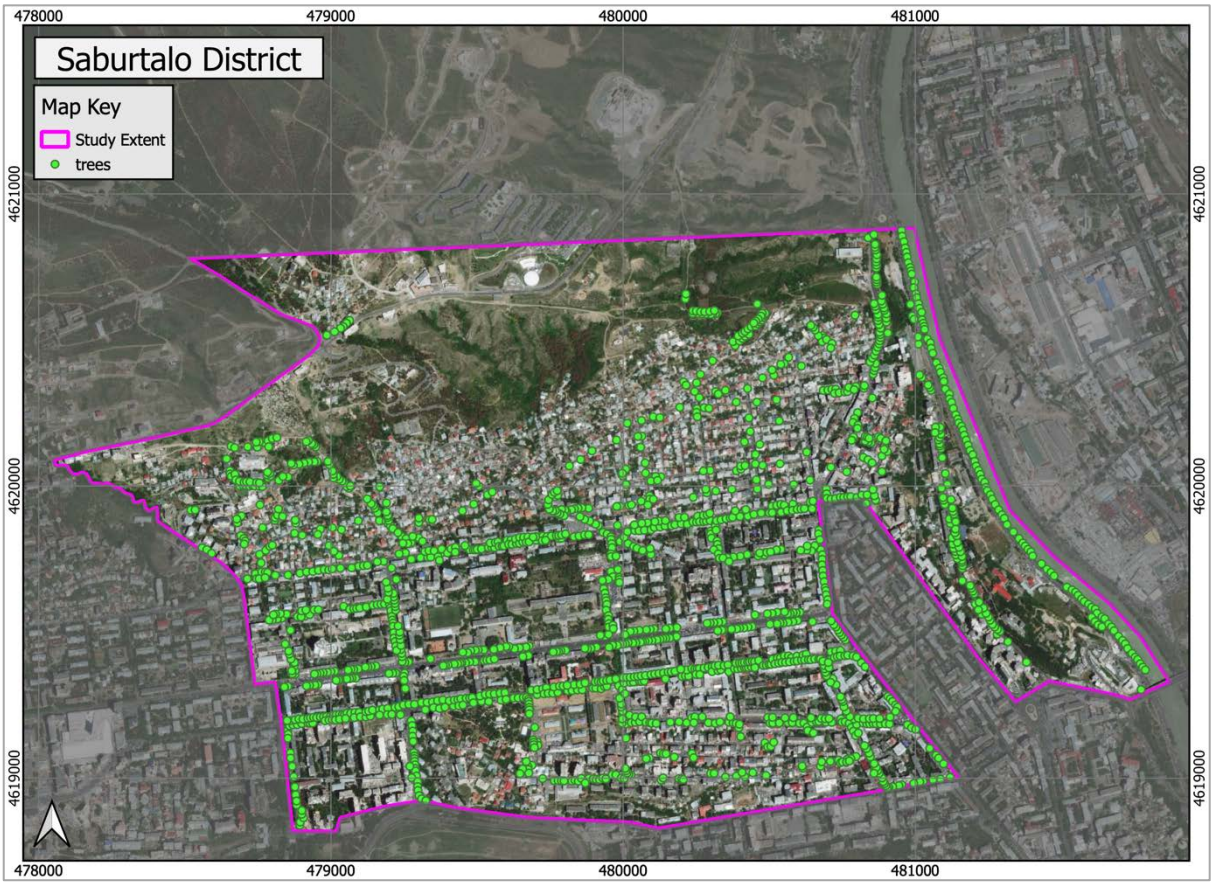
	Minimum	Value	Maximum	Value
Walkability	1	Strongly agree	4	Disagree
LandUse	1	Strongly agree	5	Strongly disagree
street_connectivity	1	Strongly agree	4	Disagree
physical_characteristiscs	1	Strongly agree	5	Strongly disagree
Gender	1	Female	2	Male
Age	1	Less than 18	7	69+
Monthly income	1	Up to 300 GEL	6	2001+
Vehicle ownership	1	Yes	2	No
Family size	1	Total value	8	Total value
number of children	0	Total value	2	Total value

Map 8. Sidewalk presence in Saburtalo district (Source: Author, 2021)



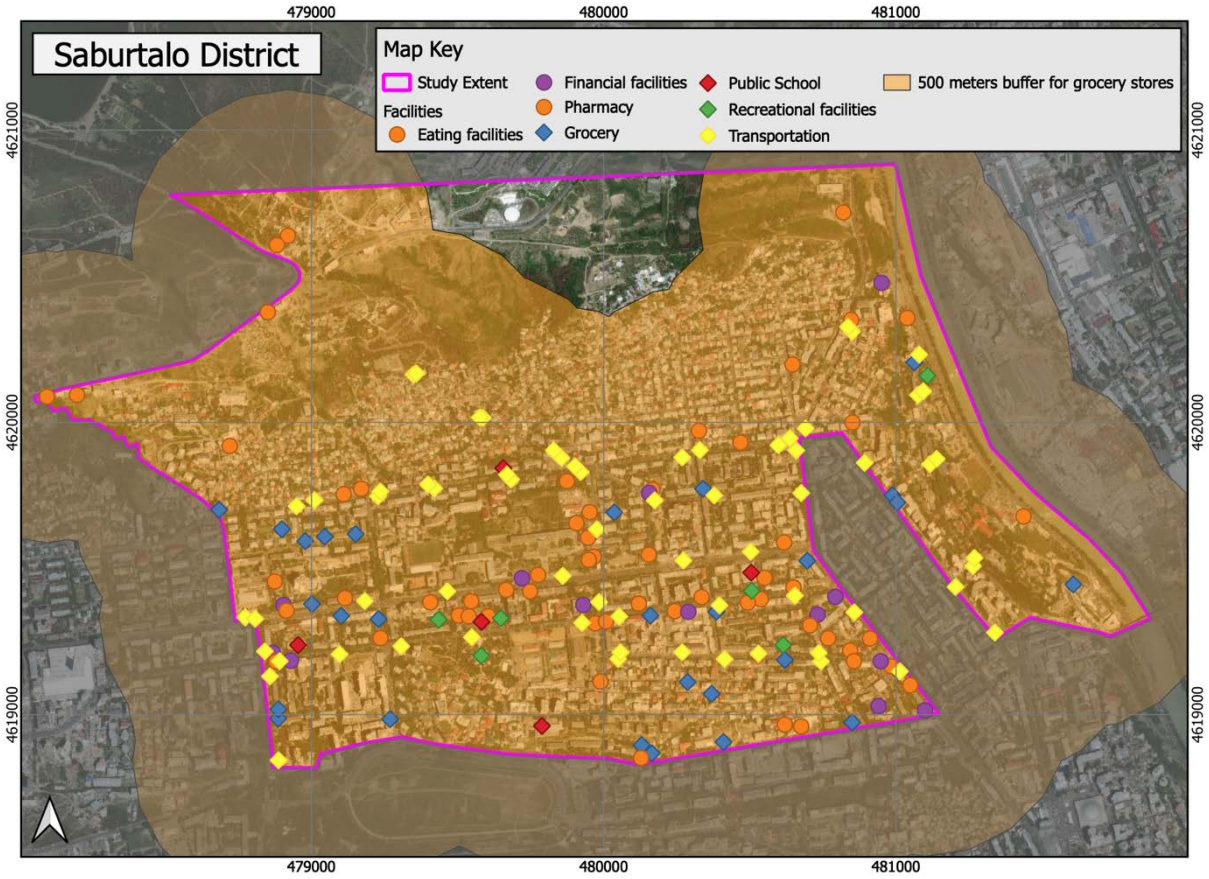
Here, on the map with purple boundary is shown the study area. Red lines represent streets without sidewalk. Yellow lines on the other hand show streets with inadequate width or with barriers. Green lines present streets with adequate sidewalk.

Map 9. Trees presence alongside sidewalks in Saburtalo district (Source: Author, 2021)



Here, on the map with purple boundary is shown the study area. Green dots represent trees. However, it has to be mentioned that not every single tree is marked on the map. Only ones that are alongside streets and provide pedestrians shade from the sun are taken into consideration and are represented on the map as green dots.

Map 10. Facilities in Saburtalo district (Source: Author, 2021)



Here, on the map with purple boundary is shown the study area. Colourful dots represent various facilities, with 500-meter accessibility buffer. The colour code is explained in Map Key.

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