

**A walkable city strategy for VlietZone: key principles,
the role of local dwellers, and the strategy's climate change
mitigation benefits**

FINAL THESIS

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ABSTRACT

Today, the emission of greenhouse gases as well as the rapid climate change is a major concern of many countries in the world. One promising and doable solution, compatible with human life, low cost, and also having beneficial results for human health, and finally, a very efficient way to reduce greenhouse gases, is the walkable city approach. This research investigates, the implementation of the walkable city concept in the city of Leeuwarden. Researchers shown that this concept of walkable city has direct effect on several items, and all of these item related together. For example, increasing of walkable city means increasing body activities then reducing to using personal vehicles and increasing to using public transportation. On the other hand, academic literature indicated several positive points for the health of citizens. For example, increasing physical activity, reducing cars in the city and reducing traffic, increasing commercial-entertainment functions, improving human mental and physical health, protection of green space, development of the social environment. Since the proposed topic is the presentation of a walkable city social solution, three main cases were investigated. Health, transportation and urban elements were the three main goals that were investigated in this research. As it is known, walkable city is a social concept and must be accepted by the people of the region, and on the other hand, it is directly related to people's lives and jobs. For this purpose, one of the best frameworks for this research is the environmental design framework (EDF). This thesis interpreted the steps of this framework as follows: first, to identify the problems, second, to investigate the problems in the region, third, to ask the problems and solutions provided by the people of the region, and finally, to provide useful solutions for the stated goals. About 83% and 81% of the respondents were dissatisfied with the existing facilities and green space, respectively, and did not consider these facilities suitable for the implementation of this concept. About the benefits of walkable city, about 52% of people gave a score of 4 out of 5 to the things that can help the concept of walkable city. Also, to confirm the impact of this concept on people's health, about 59% and 18.5% of the respondents gave a score of 4 out of 5 and 5 out of 5, respectively. In addition, about 57% of the questionnaire respondents gave a score of 4 out of 5 to the positive impact of the public transportation system for this concept. Finally, the very interesting point is the desire and interest in learning and participation and helping to implement this concept (NGO or social media, online or face to face). According to Table No. 2 in the conclusion and recommendation section, in Stage 2 of the framework, the opportunities and benefits and the results obtained were examined, and in Stage 3, solutions were presented, and in Stage 4, by presenting a picture of the goals and results were shown.

Keywords: walkable cities, climate change, urban livability, urban design, Netherlands.

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1. INTRODUCTION

1.1. Foreword

Recent years have seen a significant increase in urbanization and urban densification, which is being fueled by the development of urban life systems and communities as well as technological advancements, especially in major cities. However, there are both advantages and disadvantages to this trend. On the plus side, urbanization has prompted the creation of improved transportation networks and expanded access to public services. Nevertheless, because urbanization can have a considerable impact on the environment, social structures, and economic development, it is crucial to carefully analyze these effects (Williamson, 1988). Among the negative aspects that exist in this process, we can mention the indiscriminate expansion of the urban population, the ever-increasing expansion of CO₂ and other green-house gas (GHG) emissions, endangering the health of the people in the region, for instance, air pollution, noise, and lack of healthy lifestyle options, the increase in accidents and the reduction of urban services (Short & Pinet-Peralta, 2010). Figure 1 shows that since 1900 CE, the rate of population expansion on our world has been rising logarithmically. Numerous variables, including the sustainability of urban living in terms of health and cleanliness, can be recognized for this rise (Puiu, 2020).

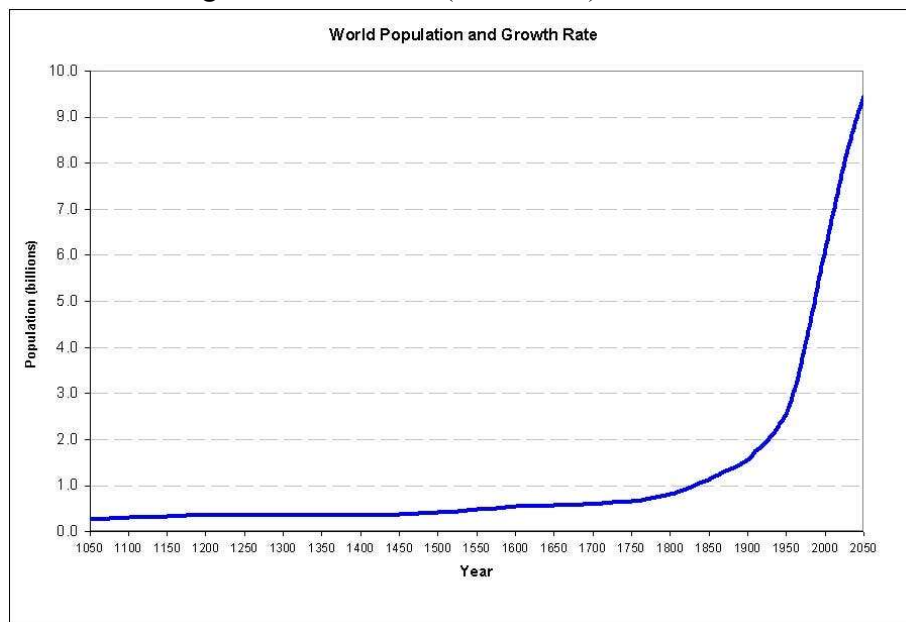


Figure 1: World Population and Growth (Puiu, 2020)

According to Figure 2 (Ritchie & Roser, 2018), coinciding with the global economic recession, there has been a shift in the trend of where people choose to live since 2007. People are increasingly choosing to live in less populated rural locations in an effort to reduce social risk. However, there is no significant change in the total share of rural population, whereas the urban population has been increasing fast. Urban living is still in high demand, which has led to challenges like marginalization, cultural issues, and a lack of services for immigrants. Given that these trends have the potential to significantly affect society, the economy, and the environment, it is necessary to consider these effects into perspective. In order to guarantee a higher standard of living for

everyone, it is essential to find strategies to address these problems and advance sustainable development in both urban and rural areas.

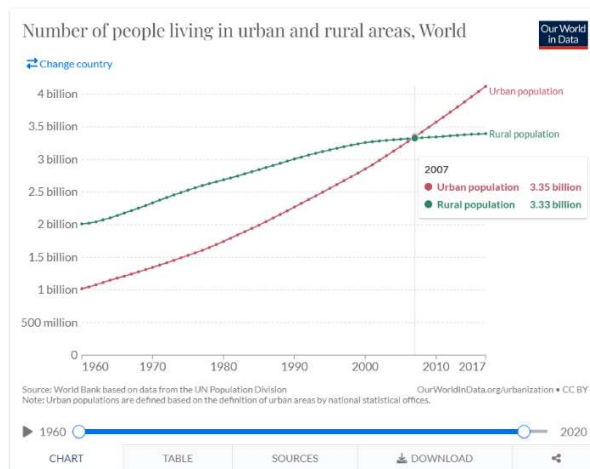


Figure 2: Number of People living in Urban and Rural, World (Ritchie & Roser, 2018)

According to the IPCC (IPCC AR 5 WG3 Chapter 12, 2014) The increasing rate of population relocating from rural to urban areas is shown in Figure 3 from 2014. The number of large and medium-sized cities has rapidly increased between 1990 and 2030. This implies that people favor residing in metropolitan regions with greater amenities and a higher density, as demonstrated in Figure 2. People have become increasingly open to living in cities as a result of the facilities and welfare that are available. To address the increasing need for urban life, it is crucial to offer sustainable transportation and public services. The creation of suitable arrangements in cities will be required to meet the rising demand for urban life while also providing greater services and sustainability. In order to accommodate the growing population, both urban and rural public services and transportation are available (IPCC AR 5 WG3 Chapter 12, 2014).

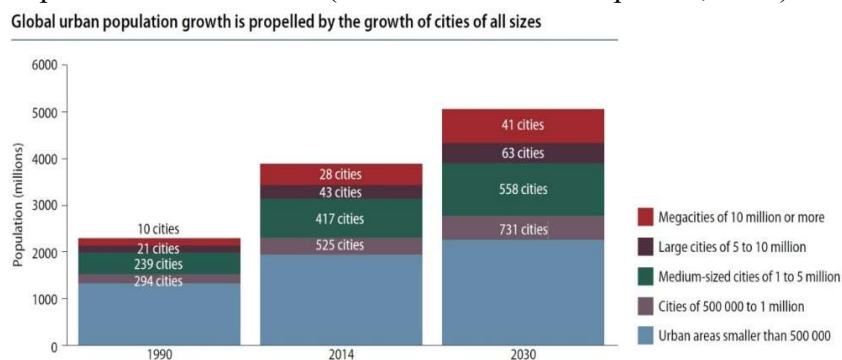


Figure 3: Global Urban Growth Population (IPCC AR 5 WG3 Chapter 12, 2014)

Some of the key goals to improving urban life and improving the appearance of the city are the welfare of residents, simple availability of urban services, and the promotion of health and hygiene. The idea of a walkable city, often known alternatively as the 15-minute city (FMC), is now being implemented in large cities as one of the most appealing and cutting-edge alternatives. This strategy focuses on creating neighborhoods where residents can easily access all of their daily

necessities, including schools, supermarkets, and medical services, within a 15-minute walking or bicycle ride. According to the reports presented in the previous paragraphs, with the expansion of urban life and the increase in the risk of people's health and safety, and to reduce these risks, the spirit of distancing from urban life should be spread among the people. The spirit of people's social interactions with each other, as well as less use of personal cars and replacing them with walking, causes more interactions between people on the street and increases social-sports activities. And as the life of people in rural areas is based on less use of personal vehicles and more on walking or cycling, and on the other hand, it is based on more social interactions between people and neighbors. This concept that rural people are implementing can be put forward in a different way and method and with a suitable for urban concept as walkable city concept (Figure 4, further introduced in section 2).



Figure 4: The concept of Walkable City (<https://www.cdc.gov/vitalsigns/walking/>)

1.2. Conceptual framework: the walkable city or 15-minute city concept

Walking is one of the first and most convenient ways of human mobility, and in addition to this, it has cultural value and economic benefits for the environment. Politicians got concerned about the risk to the urban-psychological health, health, and cleanliness of the living environment at the turn of the 20th century as urbanization increased and personal vehicle use increased. The idea of a walkable city was first adopted by Copenhagen, Denmark (Moreno, Allam, Chabaud, Gall, & Pratlong, 2021), but it is currently being expanded and put into practice by Paris and its mayor (Khavarian-Garmsir, Sharifi, & Sadeghi, 2023). Paris also suggests putting abandoned structures, including schools, to good use. Due to their structures from the time when cars were frequently used, European capitals demonstrated their walkable city characteristics well in a 2019 Arup business survey of 5000 persons in the capitals of London, Berlin, Paris, Milan, and Madrid (Cutieru, 2023). Urban design places a priority on creating pedestrian spaces while decreasing the number of vehicles in high-traffic regions in many cities throughout the world. Concerns have been expressed regarding the impact of increasing urbanization and the use of transportation systems on people's safety and health. As a result, many individuals have started using private vehicles less frequently or not at all (Lo, 2009).

In 1997, The Lyon conference, at France covered the topic of "moving towards pedestrian cities," which originally saw only limited implementation but ultimately resulted in positive results. This idea had an important effect on urban design in many places, leading to remarkable successes like enhanced social contacts, improved conditions for the environment, economic advantages, and decreased pollution. Additionally, pedestrian streets promote a secure environment (Massot, Baltenneck, Gehin, Dittmar, & McAdams, 2011). Decrease of the use of motor vehicles, the promotion of bicycles, the revitalization of socio-cultural and ethnic elements of urban life, and the reduction of urban distances are all necessary for the development of walkable cities. Some of the advantages may be realized by combining these components into the design and planning of the urban built environment, including enhancing people's quality of life, making the best use of available renewable energy sources, and improving citizen travel (Massot et al., 2011; Múgica González, 2022). Figure 4 is a schematic illustration of the walkable city concept.

"A city that enables unhindered, free travel across its entirety is said to be pedestrian-oriented. The correct infrastructure must be put in place for this purpose. The design and implementation of appropriate sidewalks in all areas of the city is one of its primary requirements. It's important to keep in mind that a "walkable city" is one in which the pedestrian axis serves multiple purposes, including the sustainable delivery of public urban services" (Speck, 2015). In his book, "The Walkable City," Jeff Speck emphasizes that vehicles are not merely man-made objects designed for general use but also a device that people can utilize at their discretion (Speck, 2015).

According to (Speck, 2015), there is a huge difference between officials' awareness and their actions in the actual city, and he has fully separated these two fields. The author argues that local government policies frequently damaged citizens' lives rather than making them improve. For mayors, planners, urban designers, and anyone else interested in enhancing the quality of life and building a livable city in the present and the future, he offers a step-by-step manual to handle this issue. The objective of the manual is to improve the relationship between planning and decision-making on urban initiatives. Although, the book is described as a planning handbook, planning is not its only subject. Instead, it identifies the trouble spots and proposes fixes to the issues facing modern cities, (Speck, 2015). Speck (2018) has also written about what is the function of cities and not why and how they function, and he has prescribed the best function for pedestrianized cities and tried to simplify the challenges of cities in planning to create a pedestrianized city and provide solutions. A sidewalk is a street whose entire path is dedicated to pedestrian movement, while a sidewalk is a space next to car, bicycle, tram, bus, and other paths, these paths must have minimal physical and physical characteristics. Pedestrian access in a walkable city should be provided in all urban, street, commercial and even highway areas, without disturbing people to each other or urban elements. Therefore, the minimum width of the sidewalk so that two pedestrians can move shoulder to shoulder or a disabled person can easily travel on it, and these things must be observed according to the standard (Balsas, 2019). The area in issue was entirely devoid entirely devoid of shopping malls or other commercial establishments. To ensure that people, pedestrians, and even shops may move around and use the space without any disruption, a

greater distance should be taken into consideration in walkable cities where there are commercial and administrative places (Música González, 2022).

According to the municipality, having shops and restaurants close by with urban furniture is vital for increasing urban life and vitality. To make sure that the infrastructure design is not compromised, urban and environmental design factors must also be taken into account while measuring the walkability of the city. For instance, it is inappropriate to put telephone booths and other urban furniture right in the middle of the sidewalk. Instead, a location ought to be set aside for the installation of urban furniture and greenery. The pedestrian path must be modified bigger to allow for the usage of the sidewalk by a store owner. The municipality's overall goal is to develop a lively, livable urban environment that combines vital design elements and makes sure that the infrastructure is not compromised (Forsyth, 2015).

It is important to have a sidewalk that is wide enough, and the path should continue unbroken the entire distance. Only on roads like freeways or highway, where pedestrian traffic is not permitted then could pedestrian bridges be used. In other places, sidewalks should be parallel to the ground to allow for easy pedestrian circulation. Other modes of transportation should, if necessary, be modified to match pedestrians' speed. However, attempts are made to improve the speed of vehicles rather than promote pedestrian convenience and safety in many places across the nation. Overall, it is essential to provide continuous, level sidewalks that prioritize pedestrian movement and safety in order to provide a safe and accessible pedestrian environment (Duncan, Aldstadt, Whalen, & Melly, 2013; Forsyth, 2015).

1.3. Scope of Study

Recent years have seen a significant increase in urbanization and urban density, which has expanded with the development of urban living communities as well as technological advances, especially in large cities. However, this process has both advantages and disadvantages. On the positive side, urbanization has led to improved transportation networks and access to public services. However, because urbanization can have a significant impact on the environment, social structures and economic development. Among the negative aspects that exist in this process, we can mention the excessive expansion of the urban population, the increasing spread of CO₂ and other greenhouse gases (GHG) and endangering the health of the people of the region.

Along with the global economic recession, since 2007, there has been a change in the way people choose to live. Social Risk However, there is no significant change in the share of the total rural population, while the urban population is increasing rapidly. Urban living is still very demanding, which has led to challenges such as marginalization, cultural issues, and a lack of services for immigrants. Given that these trends have the potential to significantly impact society, the economy, and the environment, it is necessary to consider these impacts in perspective. In order to ensure a higher standard of living for all, it is necessary to find strategies to address these problems and promote sustainable development in urban and rural areas.

There are many solutions to control the effects of this population movement (both in the form of intra-regional migration and as migration from other countries). As mentioned above, the movement of the population to bigger cities to have a better quality of life cannot be denied, nor

can it be stopped, and as a result, this migration and movement will bring complications, some of which are mentioned above. One of the control solutions to increase the physical and mental health of people as well as to reduce GHG gases and their effects is a concept called walkable city, which aims to reduce the use of private cars and also increase personal health and mental health, develop modern transportation, beautify Urban elements can be used in big cities. Another advantage of this concept is people's participation in neighborhood or city development. That this participation increases the spirit of responsibility of the people of the region towards the neighborhood or the city.

This concept is now being implemented in big cities as one of the attractive and advanced options to achieve the mentioned goals. This strategy focuses on creating neighborhoods where residents can easily access all their daily needs, including schools, supermarkets and medical services, by walking or cycling. According to the reports presented in the previous paragraphs, with the expansion of urban life and the increase in the risk of people's health and safety, and to reduce these risks, the spirit of avoiding urban life should be spread among the people. The spirit of people's social interaction with each other, as well as less use of private cars and replacing it with walking, causes more interaction between people in the street and increases social-sports activities. Considering the issues raised above and to reduce the negative effects of urban life, it was suggested to implement this concept in the city of Leeuwarden and in the VlietZone section. The main reason for choosing the city of Leeuwarden is because it is the capital of the state and according to the statistics, the population of this city is expanding and it should provide the right platform and infrastructure for the future.

And the reason for choosing the VlietZone area is because, due to the historical background of this neighborhood and the existence of old buildings in this area and one of the important business centers of the city of Leeuwarden and the neighborhood where people of different ethnicities are living and with their participation This concept can be implemented. On the other hand, during the meetings that some government and municipal officials had with students and professors in the MEEM course, and by raising the current or future problems of this region, the implementation of this concept in this region as a solution to reduce GHG gases and increase People's health and... were brought up. A neighborhood with the main street of VlietZone with direct and convenient access to the main shopping centers as well as the city center and a street with a high volume of car traffic and the activity of many businesses and shops and a wide width compared to other streets of the city of Leeuwarden has been chosen. As will be discussed in detail in the next sections, three challenges of health, transportation, and urban elements that have a major impact on the implementation of a walkable city were selected. (such as green spaces, suitable urban elements, etc.) And in the next sections, with literature review, local research and the potential of the region, the main question and sub-questions were designed. And finally, by designing a questionnaire and asking the people of the region and analyzing the results according to the EDF framework, we reached results for the future of this region in case of the implementation of a walkable city (For more information about EDF I refer to parts 3.3-3.5).

As a leading country in the field of sustainability and achieving SDG goals and living with prosperity for citizens, the Netherlands has always been one of the leading countries in the field of creating a suitable environment for individual and social life (Guo, 2023). On the other hand, with the threat of global warming and the expansion of CO2 and other Green House Gas (GHG) emissions, the Dutch government has taken effective measures to reduce greenhouse gases. One of the effective urban planning and design concepts that can be implemented both in the Netherlands and in the most populated cities of the world and can also take into account the well-being of citizens is the Walkable City idea. For example, the city of Amsterdam, as the capital of this country, is one of the areas with the mentioned characteristics (Liu, Ettema, & Helbich, 2023). *In this research, we are looking for solutions to implement walkable city ideas in the city of Leeuwarden to improve individual and social health in an area of this city called Vliet Zone.*

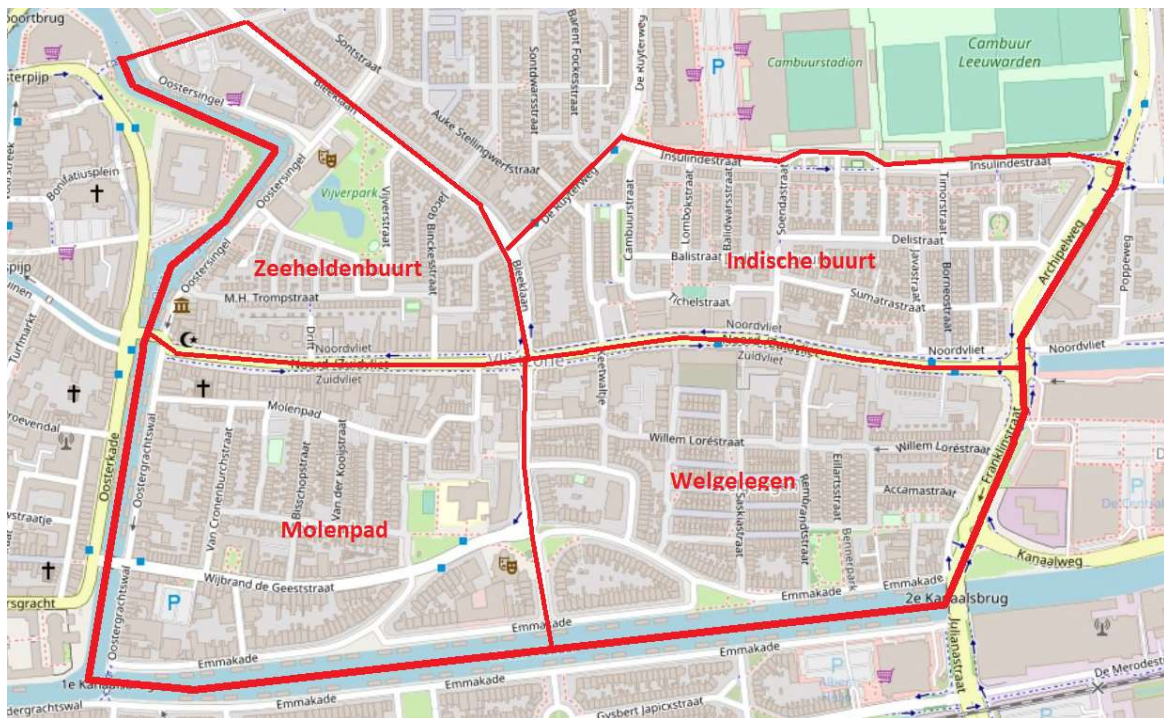


Figure 5: The VlietZone area. <https://leidschendam-voorburghbuurtinformatie.blogspot.com/2011/07/het-regionaal-structuurplan-haaglanden.html>

According to Ministerie van Algemene Zaken (2021), nestled at the confluence of history and innovation, VlietZone stands as a testament to the ever-evolving tapestry of urban development. Situated on the banks of the Vliet River, this neighborhood encapsulates a rich history while embracing the principles of sustainability and livability that define modern urban planning. The origins of VlietZone can be traced back to the 19th century, when it emerged as a bustling industrial hub, playing a pivotal role in the region's economic growth. Over the years, the landscape evolved, weaving together remnants of its industrial past with contemporary sustainable practices to create a unique urban fabric. VlietZone urban area is one of the old urban areas in Leeuwarden. The area

where one of the main urban water channels existed until a few decades ago. And today that water channel has been dismantled and turned into a wide street. As mentioned above, the area has a population of around 5000 people and has a dense texture in terms of density, both in terms of population and different ethnicities. An area that has been one of the important economic centers in the city of Leeuwarden since the past. Today (Ministerie van Algemene Zaken, 2021), VlietZone is celebrated for its pioneering efforts in sustainability. The neighborhood boasts a comprehensive public transportation system, and cycling networks that encourage residents to embrace alternative modes of travel, reducing their reliance on cars. Renewable energy sources are seamlessly integrated into the urban infrastructure, from solar panels adorning rooftops strategically positioned at roof of buldings. Green spaces are thoughtfully integrated into the urban design, providing residents with pockets of respite amid the bustling cityscape. The adaptive reuse of historic industrial buildings into eco-friendly residences and vibrant cultural spaces further underscores the commitment to sustainable growth. From the standpoint of cultivating a walkable city, VlietZone emerges as an exemplar. Its compact layout, pedestrian-friendly streets, and accessibility to amenities create an environment that encourages walking as a primary mode of transportation. The integration of mixed-use zoning ensures that commercial, residential, and recreational spaces coexist harmoniously, diminishing the need for long commutes. By studying VlietZone's walkable infrastructure and the symbiotic relationship between historical preservation and sustainable development, urban planners and researchers can glean invaluable insights into the nuances of creating livable, resilient, and environmentally conscious urban environments (The Editors of Encyclopaedia Britannica, 1998). In Figure 6, it is clear that the width of the street is relatively large for the design of urban elements.



Figure 6: VlietZone main street (Khajehpour, 2023)

According to Figure 7 and 8, there are very few traffic elements. As it is clear in these two photos, proper traffic elements such as pedestrian lanes, traffic signs, traffic lights are not available in the street, and since it is one of the busiest streets in the city, these elements should be identified and

increased. And if the concept of walkable city is implemented, the elements related to the structure of walkability must be implemented (refer to stage 4 of the framework).



Figure 7: Traffic elements and urban green space (Khajehpour, 2023)



Figure 8: Traffic elements and urban green space (Khajehpour, 2023)



Figure 9: Traffic elements and urban green space (Khajehpour, 2023)

According to Figures 7 - 9 of the urban green space of the shown street in VlietZone, there are only a few trees that are spaced far apart. As it is clear from the pictures, the main street is almost far away from urban elements for the welfare of citizens and rest. It is clear that sunlight radiation on objects and solid surfaces causes energy storage and increases the internal heat of objects. On the other hand, as shown in Figure 9, due to the lack of green space, this heat and temperature rise is a natural thing. If the increase of green space in the city will reduce the temperature of the street and also reduce greenhouse gases. On the other hand, according to Figure 8 and the calculation of the distance between the trees, there is a tree almost every 8-9 meters, which is naturally not enough. And finally, according to Figure 7-9, as is clear, there are no urban comfort elements for citizens to sit or rest on the street, and for this reason, citizens did not give a good score to the existing green space and urban elements in the questionnaire.

On the other hand, when several members of the municipality went to the university and gave a conference and explanations about the VlietZone area, it became clear that there is a special supervision regarding this area from the point of view of the government and the municipality.

1.4. Research Objective

According to the explanations given in the field of population increase and urbanization expansion as well as its destructive results, including endangering the health and well-being of the citizens, the city of Leeuwarden is a leader in establishing sustainability (AlleCijfers.nl., 2022). On these grounds, the main topic of the present research is to check the possibility of and subsequently explore the implementation of the walkable city concept in this city (Leeuwarden, VlietZone). The specific research objective is thus to investigate the potential of the walkable city concept in VlietZone. This has been achieved with the aim of implementing walkability in this neighborhood, and among the various goals and issues, three items that were more important were selected using literature review and the study of previous works, and finally a questionnaire collected data from the people of the city about the current conditions, existing issues and future goals. As mentioned

in the previous sections, with the expansion of the population in an area and without proper policy, it causes urban damages. One of those urban or individual damages will be the increase of GHG greenhouse gases in the region. One of the approved solutions from the point of view of urban management is the implementation of the concept of walkable city. The intention of the walkable city is to increase urban interactions, increase the level of city cleanliness, and increase citizen interactions.

This thesis will therefore firstly review the relevant literature on the walkable city, along with connected sustainable city elements. It will then briefly zoom into the climate change mitigation benefits of the concept before developing an application of the walkable city concept in the VlietZone area of the Dutch city of Leeuwarden. Finally, the thesis develops and deploys a questionnaire to understand the local residents' views on the implementation of the walkable city concept in their area, before concluding with design recommendations by using the environmental design framework as the format for these recommendations.

1.5. Research Questions

1.5.1. Main Question

What characteristics of the walkable city concept can be implemented in the VlietZone area of the city of Leeuwarden?

1.5.2. Sub-Questions

- Sub-question 1: What are the physical characteristics of the walkable city concept?
- Sub-question 2: How does the walkable city mitigate urban GHG emissions?
- Sub-question 3: What form can walkable city solutions take in the VlietZone area?
- Sub-question 4: What are the citizens' perspectives about the walkable city concept if applied to VlietZone?

The first question includes a general analysis of the VlietZone region's physical structure in connection with the relevant knowledge about what elements does a walkable area contain, from a physical design viewpoint. The objective is to identify the physical prerequisites for converting the area into a walking city. In contrast, the second query examines one of the expected effects of VlietZone becoming a walkable city, namely the reduction of greenhouse gas emissions. We must use a certain approach and framework in order to reach these objectives.

Some explain about the second sub-question is, a walkable city is a type of urban design that prioritizes pedestrian activity and makes it easier for people to walk from place to place instead of relying on cars or other forms of transportation. One of the most important ways that a walkable city may reduce urban GHG emissions is by reducing car use. Making walking more easy and safe may encourage more individuals to opt for walking over driving, which may result in fewer car trips and reduced carbon emissions. Further reducing greenhouse gas (GHG) emissions, walkable communities frequently encourage alternative forms of transportation like public transportation, biking, or carpooling. Walkable communities can help to lessen the damaging effects of

urbanization on the environment by promoting environmentally friendly methods of transportation and decreasing reliance on cars.

The third sub-question specifically focused on identifying the forms or types of solutions that could be implemented to make the area more pedestrian-friendly. Possible solutions might include building more sidewalks, crosswalks, and bike lanes, reducing car traffic, promoting public transit, encouraging mixed-use development, and creating public spaces that are designed for pedestrian activity. The environmental design framework seems to be an appropriate approach for the thesis' tasks, because it makes it feasible to translate abstract spatial goals into concrete design principles. This concept is especially helpful since it can represent a holistic approach to urban planning by taking into account environmental, social, and economic concerns. Because it can transform general spatial objectives into particular design principles that are based on ecological considerations, the EDF is effective in urban design. This is significant because it guarantees that resilient and sustainable design principles are included in urban spaces. Additionally, the method can be used to develop practical urban design principles. Urban planners can use the EDF to determine a site's primary ecological characteristics and functions and incorporate them into the structure of the urban area. This covers elements like biodiversity, water management, and green space and finally approaches new urban structures suitable for walking. Overall, the EDF is a good method for urban planning because it gives designers the ability to build resilient, sustainable cities that strike a balance between human, natural, and economic demands. In this research, preliminary studies were conducted and the characteristics of walkable city and how to implement it and the limitations were investigated, thus aligning with stage 1 of the EDF. The desired goals, which were health, transportation, and urban elements, were identified and selected. In stage 2, using the results of the literature review and use all the sub questions and the initial overview field in the neighborhood, related questions were prepared for the questionnaire and the questionnaire was asked to the people and the results were summarized. (For example, increasing people's health by increasing exercise and walking). In stage 3, using the obtained results and their analysis, as well as comparing the answers, solutions and suggestions were presented in this stage. The solutions that, if walkable city is implemented, will be effective for increasing health and people's willingness to use public transportation and urban elements. And finally, in stage 4, the goals to reach a walkable city are shown by presenting examples of the three cases (health, transportation and urban elements).

2. LITERATURE REVIEW

According to the preceding introduction to the topic of the walkable city, most of the issues that have been raised revolve around goals of climate change, the impact of this concept on the health of people, on the structure of public transportation and vice versa, and the role that urban elements have in achieving the goal of the walkable city. For investigating the walkable city approach, this section therefore categorizes and summarizes the available literature in three categories: health, transportation (effects on GHG), urban elements. We then summarize the reviewed literature to delineate the challenges and opportunities of applying the walkable city concept in VlietZone.

2.1. Health

Pearce, (2021) note that a city's walkability directly affects the health of its residents. The study emphasizes the vital function that well-designed cities play in encouraging inhabitants to lead active and healthy lifestyles. The article's author emphasizes how walkable cities directly affect people. According to him, cardiovascular problems are more common in urban areas with high private car usage and low levels of physical exercise. Additionally, increased usage of private vehicles causes pollution levels to rise, endangering public health and accelerating greenhouse gas emissions and global warming. Among the results of their investigation in the United Kingdom about having cities with walkable cities are:

- Residential density
- Access to public transportation
- Density of retail
- Access to GPs, schools and public amenities
- Street level movement
- Access to green space (Pearce, 2021).

It creates very important criteria for attractiveness in the further expansion of walkable city and the presence of more people in the creativity of urban situations. Creating a healthy, dynamic and stimulating society, the joy of living in a peaceful society is beneficial for both individual health and the health of society. The advantages of creating a walkable city include:

- Reducing the dominance of cars in the city and reducing traffic
- Increasing commercial-entertainment functions
- Improving human mental and physical health
- Protection of green space
- Development of social environment (Leyden, Hogan, D'Arcy, Bunting, & Bierema, 2023).

Leyden et al., (2023) discussed the effect of walkable city on individual health in different age groups. They showed that with an experiment in the city of Dublin and its suburbs, the direct and indirect effects of the walkable city affect people's health, happiness and mobility. so that personality items such as health and trust; They are satisfied with the appearance of the city and neighborhood. They showed that among the 1064 cases examined, walking has a direct effect on the happiness of people aged 36-46 and to a lesser extent for people aged 18-35 (Leyden et al., 2023; Speck, 2018).

According to this paper, walkable cities have several positive effects on health. Here are some of the effects mentioned:

- Physical work out:

Walking is a type of physical activity that can help you stay more healthy and fit. Cities that are walkable have the facilities and infrastructure that make walking an appealing and practical means of transportation, enticing individuals to engage in regular physical activity.

- Obesity and chronic diseases:

Living in a city that is walkable can help fight obesity and lower your chance of developing chronic conditions like diabetes and another disease, heart disease, and some types of cancer. Regular walking for transportation can help with weight control and general health.

- Mental health and well-being:

Walking in cities with good pedestrian traffic can improve one's emotional and physical well-being. It offers chances for stress relief, unwinding, and exposure to urban and natural environments, all of which can enhance mood and overall mental health.

- Social challenge and relation:

Community involvement and social connection are encouraged in walkable cities. A sense of community and social cohesion can be created by using walking as a mode of transportation since it promotes chance encounters and interactions with neighbors and other walkers (Conticelli, Maimaris, Papageorgiou, & Tondelli, 2018; Guan, Keith, & Hong, 2020).

According to this paper, claims that urban walkability is associated with improved public health and higher levels of security and safety. Low-intensity exercise, such as walking, is linked to healthier populations and decreased rates of obesity, diabetes, and cardiovascular diseases. Additionally, communities that are more walkable had reduced incidences of childhood asthma and other respiratory diseases. Additionally, by fostering social capital and a feeling of community, which enable those with better resources to band together and act to support their communities in times of need, walkable neighborhoods can improve security and safety (Baobeid, Koç, & Al-Ghamdi, 2021).

According to this paper, a strong correlation between public health and walkable cities, as well as increased security and safety. Walkability is linked to stimulating physical exercise, which has several positive health effects. It promotes walking as an alternative to driving, which reduces air pollution and improves cardiovascular health. Additionally, accessible goods and services like food stores and medical facilities are available in walkable cities, which can improve general health. In terms of security and safety, constructing inviting and safe streets and roads is strongly related to walkability. Well-lit places, secured crossings, and less traffic volume all contribute to a safer environment for pedestrians. With factors like perceived safety, the absence of potential hiding places, and well-kept surrounds, walkability also resolves worries about crime. These security features can make cities more secure for pedestrians by lowering the likelihood of accidents and crime. Overall, by encouraging physical activity and facilitating quick access to necessary services, walkable cities have the potential to enhance public health. By constructing

settings that are built with pedestrian safety in mind, they also help to boost security and safety (Forsyth, 2015).

2.2. Transportation

The "15-minute city" (FMC) survey was used in this study by Glock & Gerlach (2023) to evaluate the resilience of urban infrastructure and spot urban anomalies in Berlin and Dresden. The study involves surveying people and towns and conducting interviews. The researchers discovered that while certain neighborhoods showed support for the FMC the hypothesis due to the presence of sufficient transport options, others voiced displeasure in regions with a less robust transportation system. The suburbs of these cities were the main focus of the poll. Results revealed that the most often expressed issues in the surveys and interviews related to personal health, reducing the effects of GHGs, and environmental pollution (Glock & Gerlach, 2023). In their investigation of the direct effects of GHG on the environment, urban life, and space in Wuhan, China, Guo et al, (2023) looked at the idea of a walkable city as an urban design unit. To examine the topic of how urban life and human traffic, urban heterogeneity, and the city's environmental space can affect GHG generation, they conducted surveys and interviews. The excessive use of vehicles and improper, heterogeneous urban planning, according to the researchers, can lead to the uncontrolled emission of GHG. They argued that cities with walkable layouts produced fewer greenhouse gases (Guo, Cheng, Liu, Zhang, & Yang, 2023).

According to this paper, that transport is greatly affected by how walkable a place is. The term "walkability" describes how simple and convenient it is to walk around a city. When a city is planned to be walkable, it means that the built environment, including elements like sidewalks, pedestrian crossings, street décor, and street trees, is friendly to pedestrian movement.

A city's walkability can impact transportation in a number of ways:

- Reduced congestion:

Congestion decreases because a walkable city promotes people to use walking as a means of transportation, which helps keep fewer cars on the road and eases congestion.

- Environmental advantages:

Walking is a "green" means of transportation because it produces no noise or contamination of the air. A city that is walkable can lessen the environmental effect of transportation by promoting walking.

- Health Advantages:

Walking is a physical activity that enhances wellbeing. People can incorporate walking into their daily routines in a walkable city, which can improve their cardiovascular health, lower their stress levels, strengthen their bones, and improve their cerebral and creative faculties.

- Social equity:

The majority of people, including youngsters and the elderly, can utilise walking as a form of transportation. Everyone has access to transport alternatives in a city that is walkable, regardless of their socioeconomic situation. (Forsyth & Southworth, 2008)

related to this paper, A city that is walkable has a number of impacts on travel, claims the study. One result is a decrease in the use of personal vehicles. According to the study, people are more

inclined to use public transportation, bicycles, or walking in cities that are walkable. Because fewer cars are on the road, traffic congestion is reduced and the air quality is improved.

The study also mentions the promotion of active transport that walkable cities have. According to the study, when cities are made to be walkable, it encourages residents to exercise by biking or walking. By encouraging activity and discouraging sedentary behaviour, this improves public health. The research additionally emphasizes how walkable cities might result in decreased travel distances. People can simply walk or cycle to their destinations instead of relying on motorised transportation because amenities and services are conveniently located nearby. This not only shortens travel times but also helps create a more effective and sustainable transport system.

The paper's overall thesis is that developing walkable cities can have major advantages for transportation, including decreased reliance on automobiles, an increase in active transportation, and shorter trip times (Guan et al., 2020; Salleh, Naharudin, Halim, & Ruslan, 2021).

2.3. Urban elements

Zhao et al. (2021) investigated into the environmental factors influencing Hong Kong's urban elements and developed a score system based on feedback from the public. Identifying the most practical and available communication lines for a walkable city was their aim. The researchers came to the conclusion that roadways with walking features are optimal for walking regions by using neural network analysis and urban information processing. These streets had 92% higher walking scores than the national average. The most common public walking routes were discovered to be sidewalks and streets, followed by footbridges and communication lines. The study makes the case that while choosing walking routes, people should take into account the system and structure of urban elements and that the urban environment is vital in encouraging an FMC (Zhao, Sun, & Webster, 2021).

Zumelzu et al. (2021) how urban features affected mental health in a particular area between 1975 and 2020, and they found six factors—walkability, density, spatial design, ambient noise, green spaces, and social interaction—that have an impact on mental and psychological health. Their study, which concentrated on these determinant factors' effects in Latin American nations, demonstrated the paucity of research on factors that affect mental health in the Southern Hemisphere, notably in Latin America. The majority of studies on mental health variables, according to the authors, were conducted between 2020 and 2075 in affluent nations like the UK, the US, Australia, Canada, Germany, New Zealand, and China. This review demonstrates that research on built environments and mental health is still in its infancy, particularly in Latin America, where only a very small percentage (Figure 10) of studies relate to thematic axes like walkability, green space, and spatial design. These countries include Chile (0.64%), Brazil (0.64%), and Colombia (0.64%) (Zumelzu & Herrmann-Lunecke, 2021).

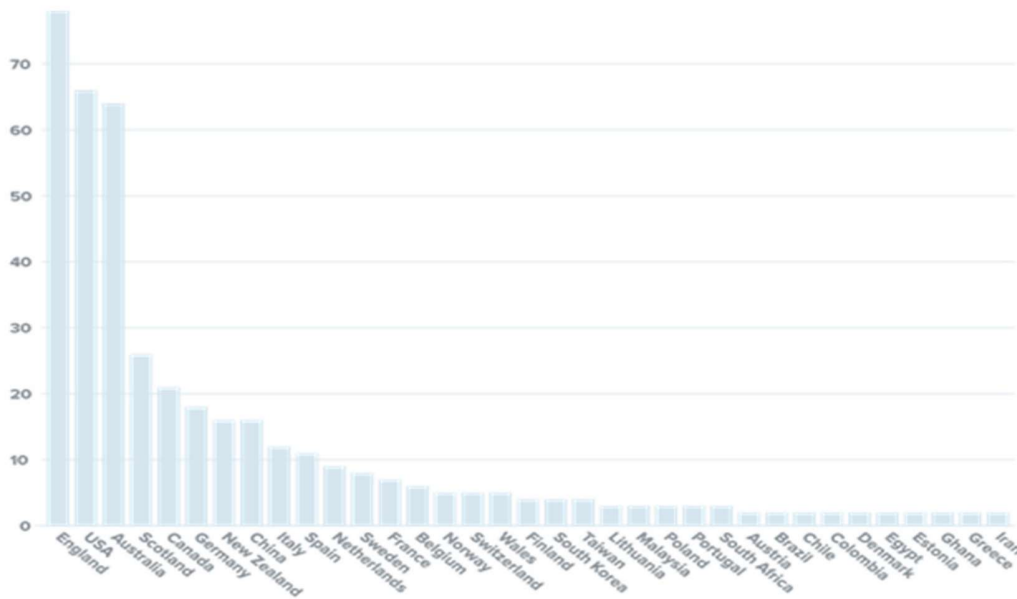


Figure 10: Countries with the highest scientific production and research in the topic of urbanization and health.

Yu, Andrew (2021) focused on developing walkable neighborhoods and turning them into walkable cities. The study primarily looks into the health and wellbeing of senior citizens in these regions. The research population comprises of adults who are 55 years of age or older, with a sample size of 257 participants and an average age of 71.78. The study concluded that senior people's mental and environmental demands should be taken into account while designing walkable cities, particularly in nations where historical beliefs and traditions have shaped people's behaviors (Yu, 2021).

A city's ability to be pedestrian-friendly depends on a number of key things. First off, a key element of sustainable urban development is the compactness of urban functions. Second, increasing accessibility to public transportation can encourage greater walking. Thirdly, building dedicated bike paths and maintaining rider safety can also improve the allure of pedestrian-friendly communities. Fourth, creating parking lots and promoting their use in busy places can help further the cause of pedestrian-friendly neighborhoods. The creation of pedestrian-friendly urban spaces, including places for relaxing, conversing, and shopping, is also crucial (Múgica González, 2022). They investigated how the people of the region interact with environmental factors and their surroundings. They focused on people of different ages. Initial investigation focused on the interactions of the intended individuals. For example, older people referred to the environmental structures to carry out their activities due to more interactions and more energy, and on the other hand, older people referred to the safer and more walkable area and environmental factors of the city. The subjects tested were 45 young people and 90 elderly people. The results of the presented statistical analysis provide strong evidence that young and older people understand the physical environment and prefer public open spaces. Safe environments come first (Layne, 2009).

An element, an urban symbol, or a physical the arrangement that, in the course of construction, incorporates the internal qualities of volumes and geometric shapes, vertical or curved plates,

fundamental components, cables, putters and frames, and, in general, everything that can have a decorative and constructional aspect. The items mentioned previously are employed collectively. In addition, this composition has a stable and beautiful mathematical and balance system that, while displayed in the city, draws attention to itself and preserves people's attention for a considerable amount of time in the desired area. It's possible that the mind would unconsciously envision the required components after the unique features of that place serve as one of the city's qualities. This feature is vital to locating a certain metropolitan area, characteristic, and unique emblem of that place. It is crucial for visitors and those who frequently travel to the desired area. This symbol is significant to the understanding of the area; it may have its origins in a particular historical incident that occurred in the targeted location; it designates a particular spot there; and it is linked to history. In some manner, one of the purposes of the elements might be to inform and introduce a particular region in terms of history, geography, culture, and the unique traits of the people of that place, or it could refer to a significant event or incident in the said location, all of which aid in communication. Better connections and commuters who are successful in the desired area. After some time, perhaps this emblem will stand the test of time and gain notoriety in other cities. These elements come in a variety of shapes. These buildings are referred to as monumental buildings. However, another characteristic of such symbols is that they infuse cities with a lovely and artistic ambiance, taking the monotony and repetition out of different urban areas. Each area of the city gains a unique identity and feature as a result. The city's soul resides there, and it most critically provides urban environments a biological and human scale. A person may breathe more comfortably in an environment where there is art present because everyone is innately drawn to excellence and beauty (Bahrainy & Bakhtiar, 2016). One of the mayor's concerns is the health and safety of the citizens. As a result, additional attention should be paid to the urban furniture, lighting, and flooring that promote pedestrian movement. This is vital in a city that supports the needs of the young and the old. Installing benches at regular intervals is vital to ensuring their comfort. For those who are unable to walk continually due to physical limitations, these benches offer a place to relax (Litman, 2003).

A note about the difference between Element and Statue: Unfortunately, false views, poor management, and, to some extent, a lack of understanding and awareness of these two categories have led our managers of urban planning and architecture to treat the aforementioned problem very casually, mundanely, and, as it were, by erecting a few monuments. They misunderstand the situation due to the names of the primary fields. Therefore, they cannot hold the audience's attention for a single moment of time, and of course they cannot have a long-lasting impact and become a defining feature of the area. This is especially true of sculptures that express their meaning in a direct manner without inspiring thought or attraction in the viewer (Baobeid et al., 2021; Lang, 2006).

2.4 The Sustainable City

A sustainable city is a city that must have many elements. One of the important elements for a city to be called a sustainable city is that it follows health and public transportation and the beautification of the city with appropriate urban elements. And be able to convince the people of

the neighborhood or city to walk or ride a bicycle or use public transportation. In this thesis, some aspects of the city's sustainability are examined. To achieve this modern concept, the following features are necessary:

1. Intensive development model:

With the development of proper urban densification as well as the development of investment opportunities, better living conditions will be provided with suitable facilities. These expansions increase people's interactions in the community and on the other hand, it increases people's sense of responsibility towards the development of this concept (sustainable city).

2. Sustainable transportation:

Sustainable transportation means that the people of a region or city minimize their dependence on private vehicles. And this item is established when the level of public transportation is advanced. And on the other hand, with proper infrastructure, it will encourage people to use bicycles or walk. The result of this discussion are physical-mental health, GHG reduction, and more social interactions of people.

3. Use of inner-city lands:

This issue is important, because with the proper use of the spaces and lands of the region or neighborhood, the investment opportunity for the environmental program (plan) or industrial development increases, and this makes people feel the growth in their neighborhood.

4. Revising old buildings:

Using old buildings to develop and expand culture and attract tourists has been a strong point. In this way, by reviving the destroyed lands, rehabilitating them and even handing them over to the private sector, the issue of tourism can be strengthened.

Another important discussion in sustainable cities is the principles and foundations of sustainable city development. In such a way that the local people or tourists accept the concept of walking or using bicycles or public transportation and do it. Another basis of sustainable cities is paying attention to the use of buildings and public spaces.

introduced three different models for a sustainable city:

- The idea of a compact city, cities with controlled size and population.
- The idea of urban villages,
- The idea of designing urban ecology and the idea of multiple decision-making poles in big cities (in big cities, creating separate poles for better control and coordination.).

A list of 10 main points that local governments should follow in local transportation plans and make sure that people pay attention to urban development and reaching sustainable cities. These 10 points that are mentioned below are the points that governments are recommended to include in their long-term or short-term plans:

1. Vision:

In order to develop a local transportation plan, it is necessary to have a local vision for the region that includes a long-term or short-term strategy and ten-year or five-year implementation plans.

2. People's participation:

From the results of people's participation, we can mention the existence of various transportation programs and the use of the talent potential of the people of the region, as well as the flexibility of these programs, which can be adapted to the needs of users. And these things cause people's active participation in this process and on the other hand, this sense of dynamism gives new ideas to the planners.

3. Focus on access:

The transportation plan should not be presented as a goal alone and should include an analysis of easy access to the desired places or public transportation stations. On the other hand, people's ability to access local services in critical situations should also be considered and a sense of security should be instilled in them.

4. Promotion of walking:

During the surveys carried out in the central area of big cities, about 75% of the trips end with walking distances of less than 1.5 kilometers. The importance of walking as a decent form of transportation should be emphasized and people should preferably use walking. As a result, governments should inculcate this feeling among the people.

5. Paying attention to the quality of walking paths:

The quality of walking and even cycling paths should be improved and restored. And also with monthly and annual inspections, the defects should be removed. Also, by using new technologies and using guide signs, a safe path for pedestrians and even cyclists will be created.

6. Communication with healthcare centers:

Communication and access to healthcare centers is one of the special things for people's sense of health and financial security. In stable cities and especially the parts that are walkable, due to the concentration of the population and the location of this concept in the main and busy centers of the city, as well as the existence of many shops and stores, proper access and specific routes for the passage of emergency vehicles are essential.

7. Creating value from small and large projects:

Small projects with low cost can have big impacts. Adequate investment in walking and cycling in the public transport program should be considered and maps of walking and cycling routes in different parts of the city should be prepared for the public and people can easily access these maps anywhere in the city.

8. Focus on results:

The expected result of the transportation and traffic plan is to increase the number of people who walk. Government policies should change and give more value to the development of walkable culture.

9. Attention to quality:

It is necessary to pay attention to the quality of transportation programs. The number of services provided to people is less valuable than the quality of services provided. For example, quality routes with modern facilities are more acceptable than increasing the number of walking or cycling routes with normal facilities.

10. Non-exclusivity:

In local transport plans, it is necessary to cooperate with other local government departments and public institutions to avoid monopoly in the local transport plan and to involve various stakeholders (Bahrainy & Bakhtiar, 2016).

From a systemic point of view, on the one hand, walkable is directly related to the structure of the city, the use of routes, transportation system, facilities system, green space system, and on the other hand, it has a direct relationship with the urban context, environmental and social conditions, and urban management. Therefore, in planning and organizing walkability, the mutual relations between pedestrians and other areas of life should be identified and analyzed. On the other hand, global studies and experiences show that sociologists also play an effective role in the emergence of this new approach, in addition to urban planners and environmental designers. For this reason, the planning and design of walkability is not only about physical or traffic aspects, but is also associated with broad social and cultural goals (Bahrainy & Bakhtiar, 2016; Speck, 2018).

The fields and areas of walkability planning and design are:

- Physical studies:

Transportation system, urban service system, quantitative and qualitative pedestrian traffic statistics, road safety status, urban scenery, urban furniture, sanitary services, traffic status of people with special conditions (such as the disabled and the elderly).

- Road and network engineering studies:

Details of implementation, network of facilities, engineering of urban structures and their implementation, planning and control of surface water, marginal green space, etc.

- Social and cultural studies:

Establishment of local urban vendors, walking culture, walking indicators, rights and regulations of sidewalks, management of sidewalks are some of the things that should be studied.

- Environmental studies:

Investigating the effects of climate on sidewalks and other urban elements and the impact of climate conditions, for example, sunlight and the advantages and disadvantages of its radiation, environmental pollution, and the role of vegetation in reducing or improving the environment (Bahrainy & Bakhtiar, 2016). From a systemic point of view, on the one hand, walkability has a direct relationship with the city structure, land structure, transportation system, facility system, green space system, and on the other hand, it is influenced by the existing contexts, environmental and social conditions, and urban management (Bahrainy & Bakhtiar, 2016; Speck, 2018).

(Conticelli et al., 2018; Lang, 2006) Physical features and the concept of a walkable city, as discussed in this paper, refer to the specific elements and characteristics of the built environment that help create a pedestrian-friendly urban environment. These characteristics are important because they can influence people's attitudes toward walking and their overall experience of walking in the city. Some of the very important features that this concept must have are briefly mentioned below;

- Access:

This shows how easy it is to walk to different places in a city. This requires considering the proximity or distance to important places such as homes, workplaces, parks and shops, and healthcare centers. A well-developed network of pedestrian routes that provide quick and easy access to key locations is essential to a walkable city.

- Density and intensity of development:

An area in a walkable city should have a sufficient number of amenities. It includes all kinds of living, working and recreational areas. Increased density and construction can increase walkability by minimizing the demand for long-distance trips and creating a lively urban environment.

The integration of several uses in a neighborhood or area is known as mixed use. This requires having a wide range of nearby services and activities, including proximity to residences, work or office environments, retail, entertainment, and public areas.

- Pedestrian infrastructure and sidewalks (walking and cycling):

Having the motivation and motivation to walk depends on having enough and well-maintained walking paths. They provide areas where people can feel safe walking or cycling away from traffic. By increasing safety and accessibility, other pedestrian facilities, including crosswalks, pedestrian bridges, and underpasses, can also improve accessibility.

- Connection to the street network:

This is important for a walkable city because it makes it easy to get around and navigate. The different arrangement of streets and the existence of several different and modern routes to the destination, and the arrangement of a network of streets are examples of these cases. Thanks to the street network, shorter walking distances and more options are available.

- Safety and security:

These are important components of walking. In a walkable city, there must be security measures to ensure the safety and security of pedestrians. This includes having well-lit streets, legible signs, traffic calming techniques, and security guards or surveillance equipment. People walk more and feel more confident when their environment is safe.

- Beauty and comfort aspect:

Walkability is also influenced by the aesthetic appeal and comfort of the pedestrian environment. The walking experience can be enhanced with features such as street furniture, public art, landscaping and trees. If pedestrian paths are equipped with facilities such as seating, shade, and amenities, people may prefer to walk.

- Transparency and human scale or body scale or public privacy:

Physical specifications should be adjusted to accommodate the size and movement of pedestrians. This includes consideration of street furniture, pavement texture, and building size and design. Transparency is the capacity to recognize and see what lies beyond the boundary of a street or other public area. Human scale and transparency both help create a pleasant and comfortable environment for pedestrians (Speck, 2018).

These elements, when used in urban planning and design, can greatly increase the walkability of the city. Cities may promote walking as a form of transportation, improve accessibility, improve public health, and make cities more vibrant and livable by designing environments that are more hospitable to walking (Conticelli et al., 2018; Lang, 2006). The ways of creating concept of walkable city in small towns (such as Leeuwarden) can be different according to local conditions, needs and people's reflection on this concept. Here are some scenarios and methods mentioned in this article (Baobeid et al., 2021; Conticelli et al., 2018):

- Suitable infrastructure for pedestrians:

Cities with small population or small area can help to develop and strengthen pedestrian facilities to develop this concept. For this purpose, it must be ensured that the streets or neighborhoods

considered for the walkable city concept are large enough and accessible to people with disabilities or the elderly.

- Complete streets:

A complete street means a walkable city street with access to other streets and parking lots and public transportation stations. By fully enforcing street rules, small city streets can be repurposed to help make the walkable city meet the needs of all users, such as cyclists, pedestrians, and public transit. This may require moving traffic lanes to make room for larger sidewalks, adding bike lanes, implementing pedestrian-friendly traffic signals, and installing adequate lighting and signage.

- Community participation and education:

In order to create a small town that is walkable and takes into account the concept of walking or cycling, the participation of the residents of the neighborhood in the planning and design process is essential. Public workshops, surveys and consultations can help gather local people's opinions and suggestions (Baobeid et al., 2021; Conticelli et al., 2018).

According to this article, the purpose of these features is to create an environment that is desirable and practical for walking, encouraging exercise, social contact and social feeling. This research emphasizes the importance of taking seriously not only the actual physical components of the built environment, but also other elements that can affect walking, such as planning, pricing, and policies. These physical features support the idea of a walkable city discussed in this article:

- Sidewalks:

Pedestrians can walk safely and comfortably on well-maintained sidewalks. and increase the attractiveness for walking.

- Pedestrian crossings:

Clear pedestrian lines and well-designed design make it easier for pedestrians to safely cross roads and intersections.

- City signs:

By using clear and useful signs, pedestrians can easily navigate the city and reach their destination without losing their way.

- Traffic calming methods:

Technologies such as speed bumps, elevated crossings, and vehicle deceleration methods help make pedestrian environments safer.

- Street trees and plant buffers:

For pedestrians, green spaces along streets provide shade, aesthetic appeal, and a sense of comfort. In addition to making the air healthy and helping to reduce GHG, increasing the green space creates a sense of calm among the citizens and even makes people walk in these areas with modern street markings and attractive urban elements to reduce mental challenges. Most importantly, they should have a beautiful urban green space.

- lighting:

The correct placement of light, especially at night, makes people feel comfortable and safe while walking. By creating a pedestrian-friendly environment that is safe, cozy, and aesthetically pleasing, this paper hopes to convince more people to choose walking as a mode of transportation (Baobeid et al., 2021; Guan et al., 2020).

2.5 Walkable city Elements

Recent research has highlighted the multifaceted benefits of walkable cities. Pearce (2021) underscores the link between walkability and health, showing how well-designed cities encourage active lifestyles and combat cardiovascular issues. The study also emphasizes the environmental impact of reduced car usage in walkable areas. Examining the components of walkable cities, Pearce (2021) identifies factors like density, transportation access, retail availability, amenities, and green spaces. These elements shape attractive and healthy urban communities. Leyden et al. (2023) further confirm the positive impact of walkable cities on mental and physical health across different age groups. Transportation and walkability are closely intertwined. Glock & Gerlach (2023) introduce the "15-minute city" concept, emphasizing resilient infrastructure and efficient transport options. Guo et al. (2023) demonstrate that walkable urban designs correlate with lower greenhouse gas emissions. Urban elements contribute significantly to walkability. Zhao et al. (2021) find specific street features that enhance walkability, while Zumelzu et al. (2021) identify determinants like walkability, density, spatial design, noise, green spaces, and social interaction that impact mental health. Yu (2021) highlights the need to cater to senior citizens' mental and environmental needs in walkable city designs. Table 1 below shows the summary of the above sections from 2.1 to 2.3.

Table 1: Summary of walkable city elements, goals and results.

ELEMENTS	GOALS	RESULTS
Health	<p>Researchers have shown that people's walking and mobility have a direct impact on people's health. And it encourages people to live an active and healthy life. They showed that among the factors of creating this concept are: walking paths, suitable green space, suitable urban location and urban density.</p>	<p>And the results are: Reducing the dominance of cars in the city and reducing traffic.</p> <ul style="list-style-type: none"> - Increasing commercial-entertainment functions. -Improving human mental and physical health. -Protection of green space. -Development of social environment. -Having the best quality of health and Safety and security for people: as mentioned in the 2.4 Sustainable City section.(see before section “9. Attention to quality and Safety and security”).

<p>Transportation</p>	<p>The direct effects of greenhouse gases on the environment, urban life and space, and in some studies, they were dissatisfied with the lack of public transportation. Also, research was conducted on the heterogeneity and irregularity of urban design to provide better public transportation. And also, designing suitable routes and stations for better access to service centers. and installing Traffic Calming Methods for better traffic control. (see 2.4 sec.,)</p>	<p>And finally, they showed that the following goals can be achieved with the development of basic transportation:</p> <ul style="list-style-type: none"> - Reduced congestion. - Environmental advantages. - Social equity. - Health Benefits. <p>And also to develop tourism and social interactions.</p> <ul style="list-style-type: none"> -Achieve to Complete streets. <p>(see 2.4 sec.)</p>
<p>Urban elements</p>	<p>They showed the effect of suitable spaces and urban furniture on mental health. And they also showed that walking, along with walking, have the appropriate urban elements to encourage and show people's willingness to walk. They also showed that with proper green space and proper design to reduce noise, social interactions and people's desire will increase.</p>	<p>As a result, according to the researchers' survey, most of the people agreed with the use of beautiful and geometric designs that have the same meaning with the culture of that region, as well as elements that are suitable for all people, especially the disabled, the elderly, and children. Such as suitable places for people to pass, suitable seats, suitable places for toilets, creating suitable parking spaces for bicycles.</p>

3. METHODOLOGY

3.1. General research approach

The purpose of this research is Investigating the physical characteristic potential of Walkable city in VlietZone, which is carried out according to Figure 11.

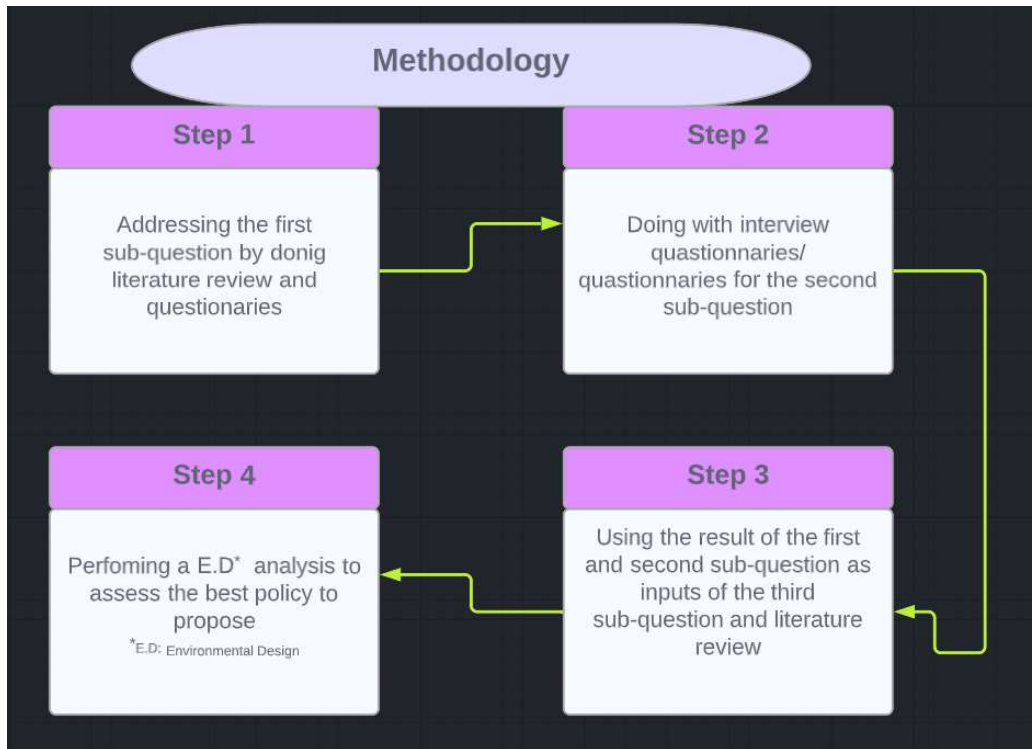


Figure 11: Analytical steps

The methodology for this research is divided into several sections:

The first section involves researching and consulting with stakeholders, who provided explanations about the problems in the VlietZone area. A walkable city structure was chosen for the target area, especially the main street of VlietZone, based on their suggestions.

Data gathering for the second part takes place from interviews with inhabitants and the municipality (if needed) in addition to questionnaires distributed to locals. The data review's goal is to learn how eager and satisfied the residents of the area are to see changes to the street design. The environmental design framework is used as the main planning framework in the third part, including data analysis utilizing software. After the questionnaires have been prepared, they are sent to the university for ethical research approval. By following this established process, the study hopes to collect thorough information and comments from diverse stakeholders, which will help design a walkable city plan for the VlietZone area.

And the fourth part, based on the analysis and review and evaluation of the results obtained from the answers of the people of the region in the questionnaires and the implementation in the framework of the environmental design framework (EDF), the evaluation and evaluation of the

results of the project will be done.(Kaplan, Haider, Cohen, & Turner, 2007). It is noted that the fourth sub-question is the basis for preparing and implementing questionnaires.

3.2. Environmental Design Framework (EDF)

A structured method for developing and assessing the spatial design / architectural performance of buildings and urban environments is the Environmental Design Framework (EDF). It offers a set of standards and instruments that designers, architects, and urban planners can use to construct built environments that are ecologically responsible and sustainable (Kaplan et al., 2007).

As it is clear from this framework, it helps to improve and solve the problem by using the theories of urban design and recognizing the problems, then implementing the goals and finally presenting the result with an example. The basis of this framework is to eliminate defects and maintain maximum elements. For example, (Kaplan, 2007) during a research showed that in many families that have small children and the kitchen is independent and large, there is a concern for the person who is in the kitchen and on the other hand has to cook and from Take care of the child. Researchers using the principles of this framework and through a literature review and interviews with householders as well as a review of maps, provided recommendations as a result, one of which, for example, changing the height and interior furniture decoration between the kitchen and the hall to have more view to protect their childrenn. One of the advantages of this framework is that it does not limit the type of data collection or research model (for example, it can be used in social issues, urban design, architecture, civil, etc.).

3.3. The four phases of EDF

Experiential/Life Quality Domains:

The environmental performance is evaluated at this stage. This entails assessing the site's current state and determining its environmental sustainability strengths and weaknesses. The examination may include a number of topics, including biodiversity, waste reduction, water management, and energy efficiency. They support the objectives or goals that can be implemented to implement this framework.

Related Design Principles:

This item determines some basic features and structures and scope of application and purpose. Following analysis, the next step is to devise a plan for creating a building or urban area that is environmentally sustainable. Setting project goals and objectives and choosing the best design and construction methods to achieve them are also part of this process.

Design Concepts:

In the third stage, the design concept is assessed to see if it satisfies the project's environmental objectives and performance standards. This includes evaluating the project's energy efficiency, water efficiency, indoor environmental quality, and other important performance indicators utilizing simulation tools and other performance measures. Summary of this part, the application of structural-physical strategies for the intended purpose.

Design Applications:

This includes keeping track of the project's environmental performance and assessing the extent to which it meets its environmental goals. Examples and comparisons to various designs are included in this section. As a structural design, this framework needs to be compared in order to be verified.

Table 2: The Environmental Design Framework (EDF) (Kaplan et al., 2007).

Experiences/Domains of Quality of Life	Related Design Principles	Design Concepts	Design Applications
Objectives or goals that support the overarching goal and are crucial for achieving a desired solution.	Key attributes and characteristics of a domain of QOL. They constitute the basis for design concepts and strategies.	Strategies to achieve the design principles, as applied to the physical and organizational environments.	Selected design examples that best illustrate the design concepts, including both "success stories" and sometimes "negative" examples.

3.4. How this research sub-questions help implement the four stages of the EDF

The EDF approach is used in this thesis as a general inspiration for providing the final recommendations about how the concept of the walkable city can be related to the context of the VlietZone area. Nevertheless, there is also a more systematic alignment with the research questions, which should be noted.

The physical qualities that are pertinent to the first and second problems have been defined in the literature study and include street strategies, building layouts, and public space designs. Regarding the second investigation, strategies to lessen greenhouse effects were discovered, including limiting transportation and boosting urban decoration and green space (objectives and design principles).

According to the objectives stated in the first and second questions, researchers developed a solution for the third issue that is specifically tailored to the VlietZone region by examining its unique characteristics (produces design concepts). In order to recommend measures to make the area more walkable, such as the creation of new pedestrian pathways, a reduction in car traffic, and enhancements to public transportation, this required obtaining pertinent data through surveys and research reports.

The fourth question and final EDF step confirms the earlier sections using local residents' views and creating a prototype of a walkable city. Based on the examples provided in the earlier sections, design concepts were created.

(1) Steps to check the following sub-questions:

Sub-question 1	Literature review and Questionnaires
Sub-question 2	Questionnaires or if needed Interview
Sub-question 3	Literature review, Questionnaires
Sub-question 4	Questionnaire from the people of the region, both residents and workers (or employee) in VlietZone

(2) Details of the review and implementation of questionnaires or interviews from related individuals or organizations:

Since this movement is for the region and the type of urbanization of the people of the region, and the opinion of the people should be respected, the questionnaires of the second question (2) will be from the people of the region and by analyzing their views on the types of urban analyzing their views on the types of structure, changes in urban furniture to improve life and if necessary, we will interview with specific people in the region or with municipal officials. For the first question (1), most of the information and data collection will be in the form of literature review, and also by using the analysis of the second question, it can include some items of the first question. And finally, for the third question, it will be done by using literature review and research among the articles and how the structure of EDF is and how it has been done in successful cities. Also, as in the previous section, by using the analysis of questionnaires presented among people, this framework can be used for VlietZone in a useful implementation and structuring type.

3.5. Research strategy

The main strategy in this research is based on the EDF framework. Based on the sub-questions, the elements or defects (problems) are identified, then with the data collection methods that were used in this project, 1-literature review and 2-questionnaire, so that both the literature review and the questionnaire are based on sub-questions. And after the literature review and field research, the goals are identified (in this project, health, transportation, and urban elements were identified) and in the third stage, solutions and suggestions are presented, solutions that can be implemented and in line with people's routines life and not create The challenge of the people of the neighborhood is with the government organizations. And finally, to show the feasibility, examples are provided with photos. (for more information you can see Table 2.)

This research is based on research and conducting a questionnaire and communicating with the people of neighborhood and going among the people of VlietZone in Leewarden city and conducting a questionnaire among the people which is prepared based on the Environmental Design framework. Because this research was done by the normal people (not expert or academic people) of the VlietZone area (whether residents of the neighborhood or those who worked there), and not by people who are experts in the fields related to walkability (such as municipal, government, or university officials), For this reason, the level of the questions should have been chosen in such a way that they were close to the concept of walkable or walkable city according to the framework. Due to the explanations mentioned above, this research has focused more on the centrality of urban space design, the impact of urban elements on health, and the impact of these elements on the new urban structure. For the convenience of citizens and their easy communication with the concept of Walkable city or Bikeable city, the preparation level of the questions has been designed to the following 3 levels:

- Current status of VlietZone

The questionnaire asked about the current structure and street layout of the area and the facilities available in it. The questions of this section were about the level of satisfaction or lack of satisfaction of the people of the region with the infrastructure, facilities and urban elements, as well as the amount of green space in the target area.

- Benefits of walkability

In this section, questions were asked about the concept of the impact of walkabbling or bikabbling among people and their desire, and the impact of these 2 items on people's health, urban and environmental health, etc.

- Solutions for walkable VlietZone

In this section, practical solutions for implementing these concepts have been asked from people by asking useful, concrete and familiar solutions.

3.6. Data collection

The concept of walkable city is a problem that due to the expansion of urbanization, the expansion of technology and people's use of more urban services for greater prosperity and as a result the expansion and concern of increasing the production of greenhouse gases (for example, the use of private cars, etc.) In addition, many damages to the environment and endangering people's health, the concept of walkable city is a vital and very important issue. that this concept can be brought closer to urban-environmental health and sustainable urban development by informing and creating a very precise culture on the part of the government and on the other hand, the acceptance of this issue by the people. This research was conducted in Leeuwarden, one of the oldest cities in the country, and fortunately, this concept of walkable city is a concept that is accepted among some cities in this country (such as the capital of Amsterdam). Among the reasons for choosing this walkable city concept for the city of Leeuwarden, especially the VlietZone area, the following reasons can be mentioned.

- During the meetings that the municipal and administrative members of the city of Leeuwarden had with the students of the master of environment and energy management entering 2022 in the case project course, the focus of these members was on the urban issue and some urban problems in the VlietZone area. And on the other hand, since our group exercise in this case project lesson was about circular economy in VlietZone, it was decided to introduce this walkable city parameter and to investigate the neighborhood of this concept in this area.

- During an overview and general survey on King Day and with a regional survey of the places considered for walking, and fortunately, the theory that the Dutch people are compatible with the concept of walking and less use of personal vehicles was proved, and the people of the city Leeuwarden took part in this big walk that day, following the urban concepts.

The number of questionnaires asked was calculated using the Solvin equation (Tejada & Punzalan, 2012). Also, according to the site (AlleCijfers., 2022), the population of the VlietZone area is around 5000 people, and the acceptable margin of error was considered to be around 0.11. And by calculating this formula and the mentioned data, about 80 people were selected to complete the questionnaire. However, it is worth noting that, in order to examine the urban elements and place the walkable city in VlietZone, focus more on residents or shopkeepers and employees on the outskirts of this main street of VlietZone HSJ. So the target population will naturally not be 5000, but the whole population of VlietZone is considered for the regional investigation without problems. The VlietZone area, includes the following areas:

- Zeeheldenbuurt (750 inhabitants)
- Indische buurt (1225 inhabitants)
- Molenpad (1290 inhabitants)

- and Welgelegen (1650 inhabitants).

The total population of the 4 neighborhoods equals 4915 people (AlleCijfers., 2023)

3.7. Data analysis

The data prepared based on the explanations in the previous sections was conducted in the form of a questionnaire among the people and shopkeepers of VlietZone neighborhood. This questionnaire was prepared electronically on the Qualtrics website. The data was collected in the form of statistical data collection (questionnaire) and the analysis was done as a quantitative analysis. Quantitative research should be considered as a systematic and scientific research method based on the collection of data and information from the investigated phenomena. In this research method, after categorizing and preparing information for processing, statistical, mathematical or computational techniques (software such as Excel) are used to model the behavior of phenomena. By the way, the basis of this review is the opinion and scoring rate of the mass of people and the review of their direct opinions according to questionnaire questions. Quantitative research considers a part of the target statistical population by using sampling methods and collects the desired information by sending survey forms (online or manual) in the form of questionnaires, etc. And as for this research, the remarkable thing in this questionnaire is the significant number of women to answer the question.

As it is clear from the process of thesis and questionnaire and literature review:

Based on the mentioned methodology, by using the first and second questions and understanding the concepts of walkable city and urban infrastructures, needs, deficiencies, and strengths according to the third sub-question, we investigated this concept in a city like Leeuwarden, and finally, using EDF framework has been evaluated and analyzed and we have come to the conclusion that with the changes in urban structures and infrastructures and according to the opinion of the people, this concept can be implemented and on the one hand, the effects of greenhouse gases are reduced and public health is increased, and on the other hand Jobs and workplaces of the people of the region are also interacting with this concept.

3.8. Research ethics

This study guarantees an unbiased and transplant perspective, without any commercial affiliations or associations that could potentially result in conflicts of interest The data was collected from reputable academic sources, questionnaire conducted with respondents (people of VlietZone) which consent with the ethical rules of the ethics committee of the Faculty of Behavioral, Management, and Social Sciences of the University of Twente (Appendix 2; Ethical Approval).

4. RESULTS

This chapter describes the results of the questionnaires and literature review outcomes. According to the previous chapter, we prepared a questioner with 18 questions and asked the VlietZone residents to answer these questions. These questions were divided into three categories includes: (1) Current status of the walkable concept in VlietZone area, (2) the advantage of the walkable city for this zone and (3) the best methods for implementation of walkable requirements in this area. As briefly these three stages are:

- **Current status of VlietZone**
- **Benefits of walkability**
- **Solutions for walkable VlietZone**

4.1. General Questions

Regarding visiting the VlietZone neighborhood and sending the questionnaire (Appendix 1; Questionnaires), about 80-84 people showed their desire to fill the questionnaire about 1.7-2% of 4915 population of VlietZone. Figure 13 It is worth mentioning about 80-84 people responded to this survey that 54 of were male and 30 people were female. Also, the age range of the respondents was shown in Figure 14.

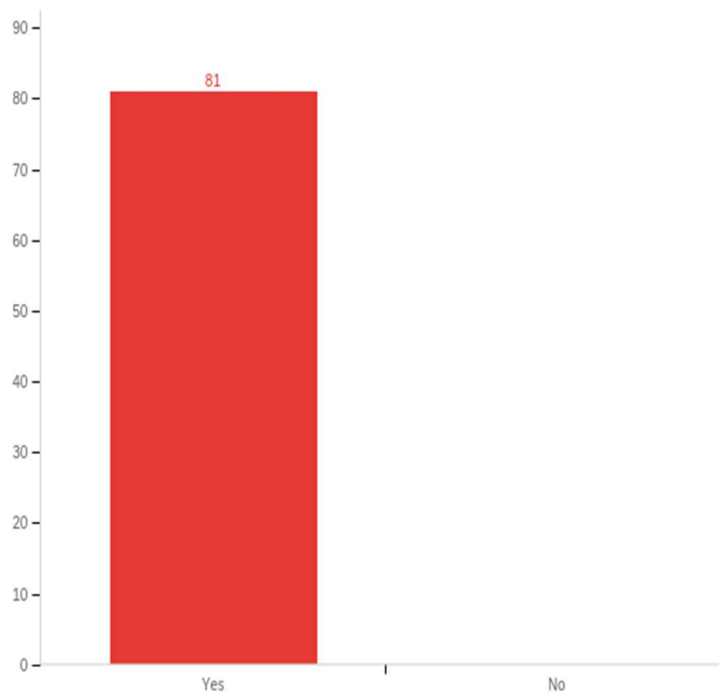


Figure 12: participants in the survey.

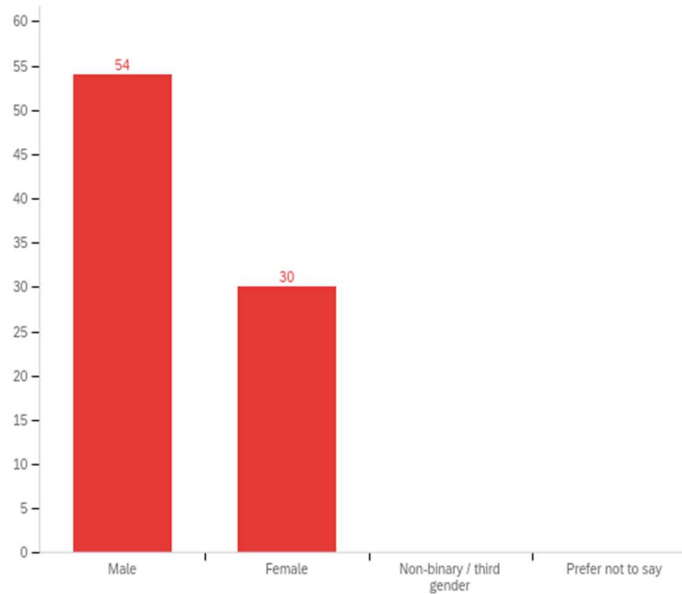


Figure 13: gender of participants.

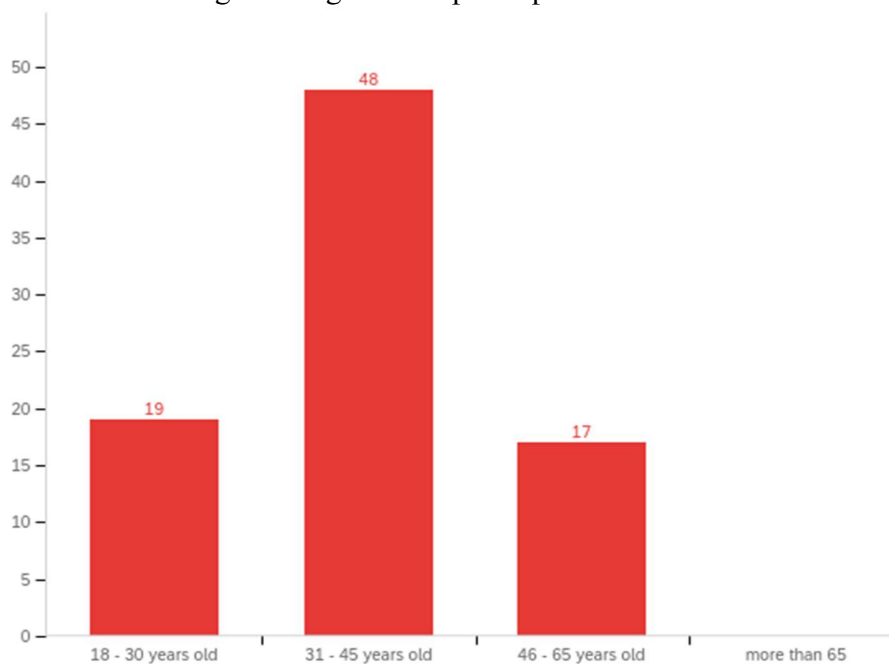


Figure 14: Respondent's age range

The criterion for selecting the target population is about 80-85 people to fill the questionnaire, using the Solvin method (Tejada & Punzalan, 2012). Slovin's formula is calculated as:

$n = N / (1 + Ne^2)$, where:

n: Sample size needed

N: Population size

e: Acceptable margin of error

The number of population or N is 4915 people. The error was considered to be around 0.11-0.15, and the average number of n outputs for the errors of 0.11-0.15 was around 75 people. In the end, about 84 people responded. According to Figure 14, most of the respondents were in between 31 and 45 years old and people more than 65 years old did not tend to participate in this survey.

As explained in the previous sections, the questionnaire has been divided into 3 sections for ease of work and communication of people with the concept of walkable city and participation in the rest of the questions:

- Current status of VlietZone
- Benefits of walkability
- Solutions for walkable VlietZone.

The overview of the number of participants is that about 84 people appeared to fill the questionnaire. 64.3% of them were men and 35.7% were women. Also, 22.6% of the participants were in the age range of 18-30, and 57.1% in the age range of 31-45 and finally 20.3% in the age range of 46-65 years.

4.2. Current status of VlietZone

4.2.1. How much is your awareness and information about concept of a "walkable city" or "city with high and advanced urban facilities for walking or cycling"?

Figure 15 reveals the level of knowledge of people living in this area about the "walkable city" concept. Regarding to this figure, around 81% of people contributed in this survey did not sufficient information about walkable city and also the benefits and disadvantage of this concept. Fortunately, after brief explanation of this concept for them, the respondents were willing to participate in this survey.

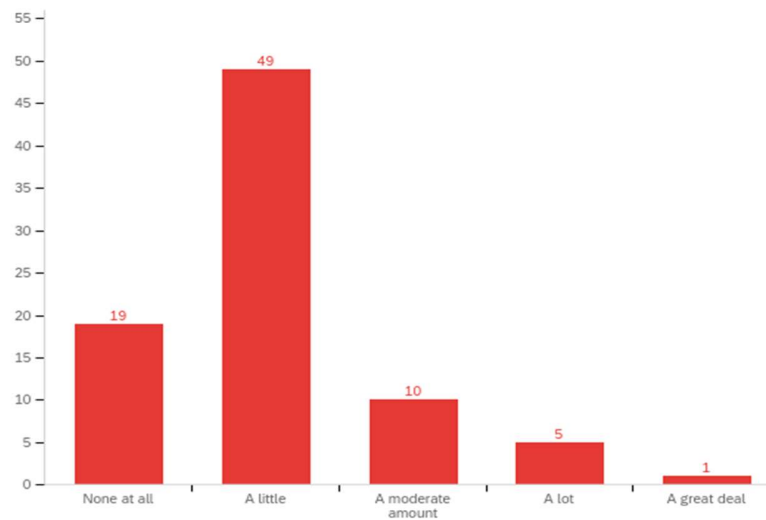


Figure 15: Knowledge level of people toward the "walkable city" concept

4.2.2. From the following items, which item/s are suitable for increasing walking and cycling (implementation of the walkable city concept) in the VlietZone area?

Based on the literature review, we extracted 5 proper options for increasing the tendency of the residents to walk or cycle in this neighborhood as one of the main element of the walkable city. "A suitable bench for sitting (1)", "Increasing urban comfort for walking and relaxing (2)", "proper access to the urban services (3)", "Beautifying of the city (4)" and "changing urban infrastructures (5)" were proposed as the main items. The public attitude toward this question depicts in Figure 16. It should be noted that the answer and evaluation of the people of the region is given from 1 to 5 points. 1 is the lowest and 5 is the highest.

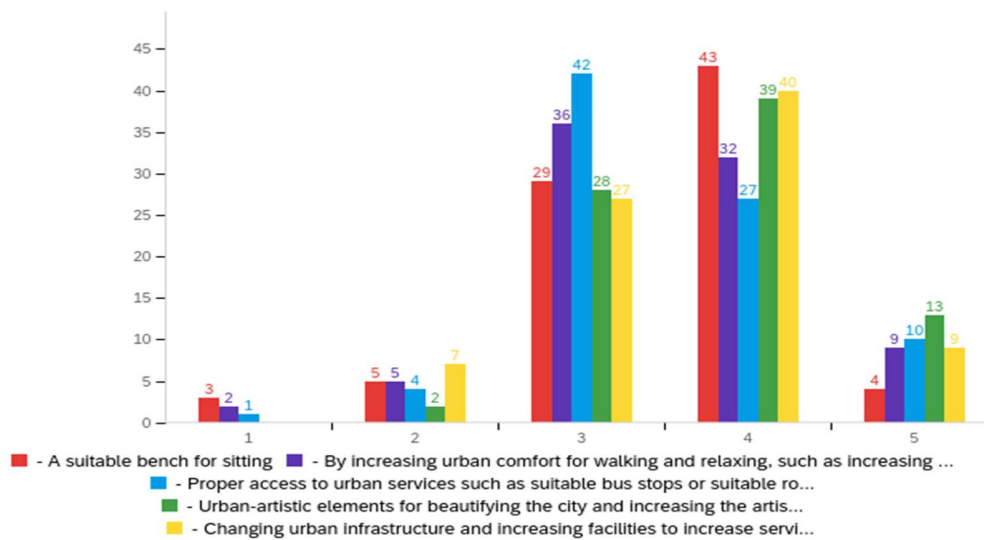


Figure 16: Best options for increasing walking and cycling potential

According to the results obtained in the Figure 16, due to the clarity of the results and the huge difference in the given scores, the least answered item is (score 1) and the most answered results are (scores 3 and 4). The highest answer was given to option (1) with 43 votes, followed by mode (3) with 42 and then modes (4 and 5) with 39 and 40 respectively. In the lowest score provided for answering, i.e. score 1, no one has given a score to items (3 and 4) and the highest number of votes is 3 people for item (1). As a result, the most answers given for criterion (1) were 43 answers that chose a score of 4 out of 5. After this response rate, the criterion (2) was selected and the response rate was 42 responses with a score of 3. Of course, criteria (4) and (5) were placed in the next positions, respectively, 39 and 40 respondents gave a score of 4 out of 5. In addition, a total of 6 people have chosen the lowest score. And according to the response rate, most of the respondents to the five criteria of this question have chosen scores of 3 and 4, which is a high score. And this shows that the majority of people consider the solutions offered to increase the amount of walking and cycling appropriate.

4.2.3. Currently at now, how much you rate to the urban infrastructure in VlietZone Street for being suitable for the concept of walking or walkable? (Score 1 to 5)

Evaluation of the current urban infrastructure for implementation of the walkable city in this was the main target of this question. Figure 17 shows the outcomes of this question.

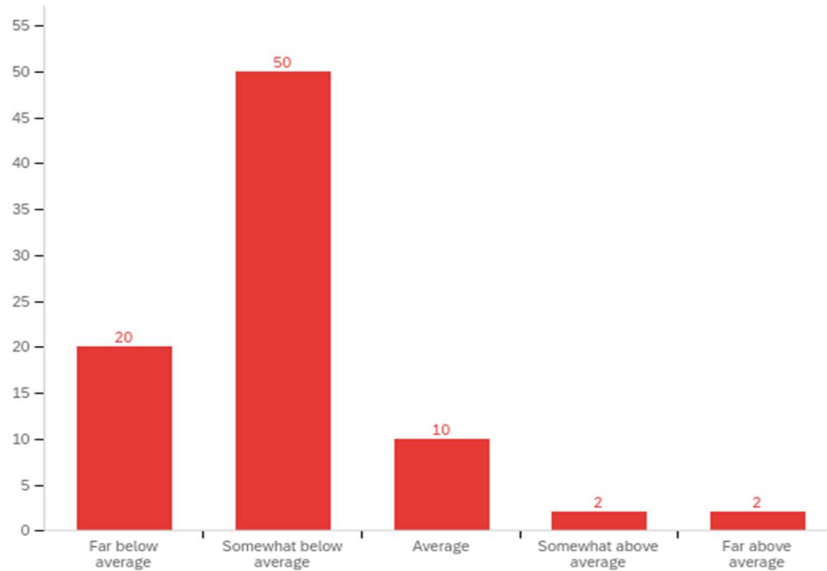


Figure17 : Current urban infrastructure for implementation of walkable city concept in the VlietZone

According to the above question, the number of people answering this question was about 84 people, the most answer is related to the option "Somewhat below average" with 50 answers and after that the option is "Far below average" with 20 answers. This shows that in total about 83% of the respondents were dissatisfied with the existing urban infrastructure in the target area to reach the walkable concept and do not consider these infrastructures suitable for implementing this concept. And according to the total number of 84 answers, the average score for this question is 2 out of 5.

4.2.4. Currently, how much do you rate your neighborhood area services and facilities (Urban Furniture, Professional Sidewalk or cycling line, traffic signs,...) provided by the municipality, suitable for walking or cycling?

The main goal of this question was the assessment of current municipality services for implementation of walkable city in VlietZone area (Appendix 1; Questionnaires). The opinion of the people in this district was shown in the Figure 18.

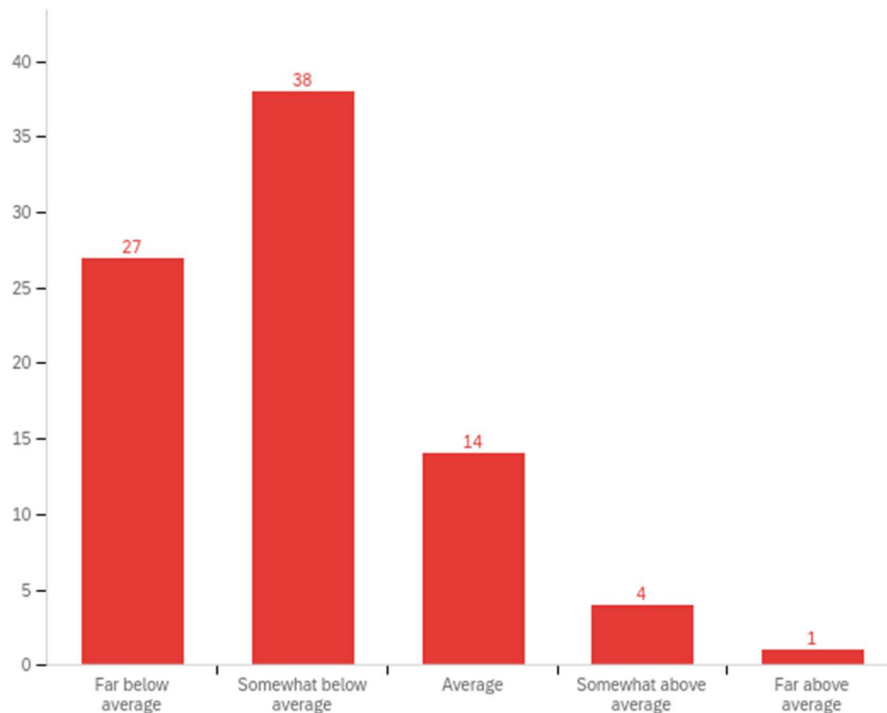


Figure 18: Current municipality services

The results obtained for this question are almost similar to the results of the previous question and currently, most of the people do not have a positive opinion about the services provided to become walkable or bikeable. Moreover, they are not satisfied and do not consider the services provided for walking and cycling very suitable. Additionally, most of the respondents, 38 people have chosen "Somewhat below average" option and 27 people have chosen a "Far below average" item. According to statistical calculations, for 84 respondents, the mean score of this question is 1.98 out of 5, which is lower than the average.

4.2.5. How much do you rate the green space of VlietZone Street?

In this question asked people to declare their opinions about green environment in the VlietZone street. Figure 19 displays the public attitude towards the rate of the green space in this area.

As it is clear from the results, about 81% gave a lower than average score to the amount of green space available. This is a sign of people's relative dissatisfaction with urban green spaces. Also, the average score (Mean Score) of all respondents is 2.21 out of 5 that showed the people of the city were a little more satisfied with this urban element.

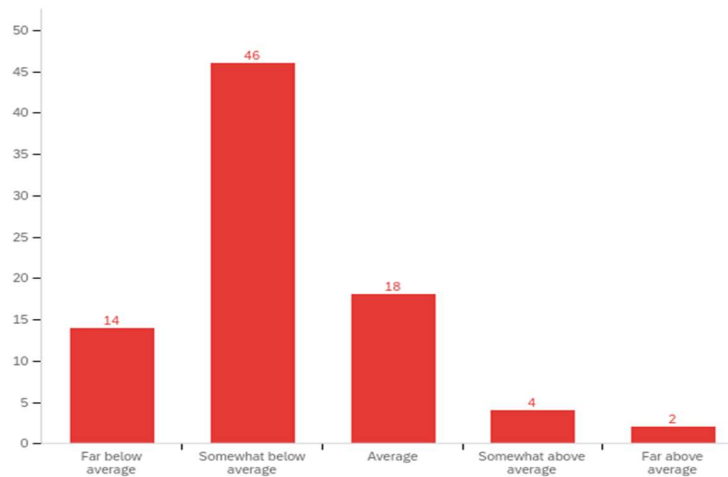


Figure 19: Current green space rate in view of the residents

4.3. Benefits of Walkability

4.3.1 How do you think it would help to reduce urban greenhouse gas emissions by making VlietZone a walkable neighborhood?

This question designed to determine the effect of the walkable city on greenhouse gas emission.

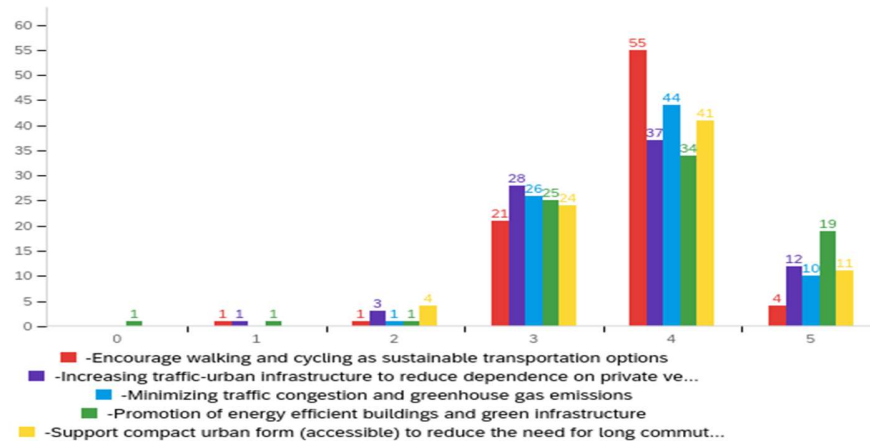


Figure 20: effect of walkable city on greenhouse gas emission

Regarding to the literature review, we proposed 5 main related elements to the Walkable city that could reduce the greenhouse gas emission in each area. These methods includes "Encourage walking and cycling as transportation (1)", "Decrease dependence to the private vehicle", "minimizing the traffic congestion", "Energy efficient building" and "support compact urban". The results showed in figure 20.

About 81 people have given a score to all 5 presented solutions (totally about 400 answers have been selected by these people). According to the above diagram and the type of responses of the citizens, the highest score given to the above options is 4 out of 5, and in this score, 55 people answered to option (1). And then option (3) that 44 people chose. Of course, according to the diagram, other options have a high number of answers in grade 4, and finally, in about 210 answers out of 400 answers, the amount of answers is grade 4 and includes 52.06% of the total number of answers. After score four, the highest score given to the suitable options for reducing greenhouse gases is score three. And as it is known, it has been selected by 81 people almost equally and out of about 400 answers given, 124 answers correspond to score 3.

4.3.2. How do you rate the spread of the walkable city concept in the neighborhood and the increase in public health?

Evaluation effect of walkable city on public health is the substantial aim of this question.

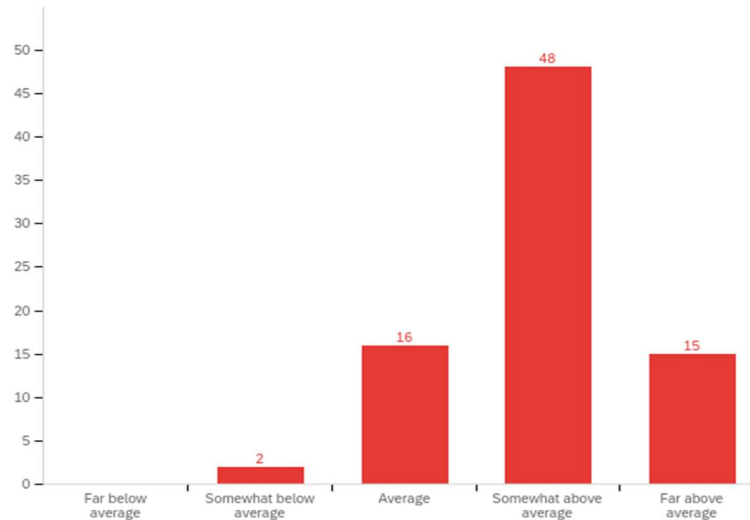


Figure 21: Impact of walkable city on public health

After the explanation and relative familiarity with the concept of walkable city, from this part onwards, people have answered the questions a little more easily. As it is clear from the result of at Figure 21 and the question raised, about 81 people have answered this question and with a decisive and clear vote, they have voted positively for the effect of expanding the walkable city concept in increasing public health, and about 48 people have chosen option 4 out of 5 (around 59.26%). Of course, 18.52% of respondents chose 5 out of 5 options that walkable city has a direct impact on people's health and 3 out of 5 options that have a moderate impact on health (about 19.75%).

4.3.3 How much does the concept of walkable city help to increase urban safety and security?

In this question, the evaluation of effective solutions and options for the effect of walkable city on increasing safety and security in the VlietZone region is the target. 3 options (solutions) are:

- a- Increase social interaction (1)
- b- Increasing environmental security and health (2)
- c- Reduce the traffic hazards (3)

The results of this question depicts in figure 22.

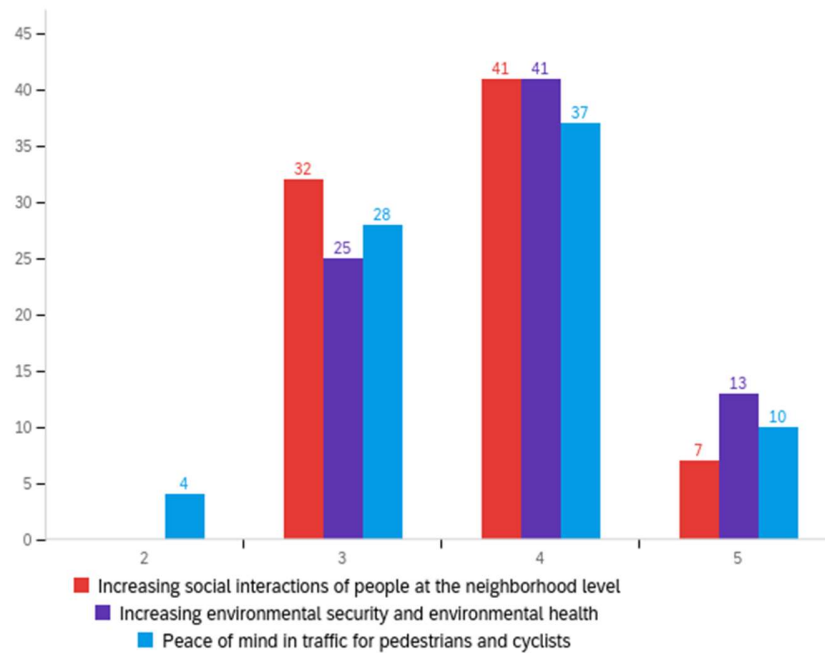


Figure 22: Impact of walkable city on safety and security

About 80 people have given a score to all the solutions presented, and a total of about 240 answers have been selected by these people. As it is known, the convergence of the answers to the impact of this concept on increasing safety and security is clear, and most people have chosen a score above 4 out of 5 for all 3 solutions (about 119 answers out of 240 answers and about 50%). It is noteworthy that no one has chosen the effect of this concept on increasing the safety of the minimum score (score 1). The next selected option, which received the highest number of answers, is a score of 3 out of 5 (about 85 answers and about 35%).

4.3.4 Walkable city or Bikeable city, is it a viable and useful concept for people with special conditions? (Old people, children or people with disabilities)

In this question, the evaluation of effective solutions and options for the impact of walkable or bikeable city on whether this concept can be useful for people with special conditions from the people's point of view. 3 options (solutions) are:

- a- Laws and principles (1)
- b- Infrastructures (2)
- c- Communication (3)

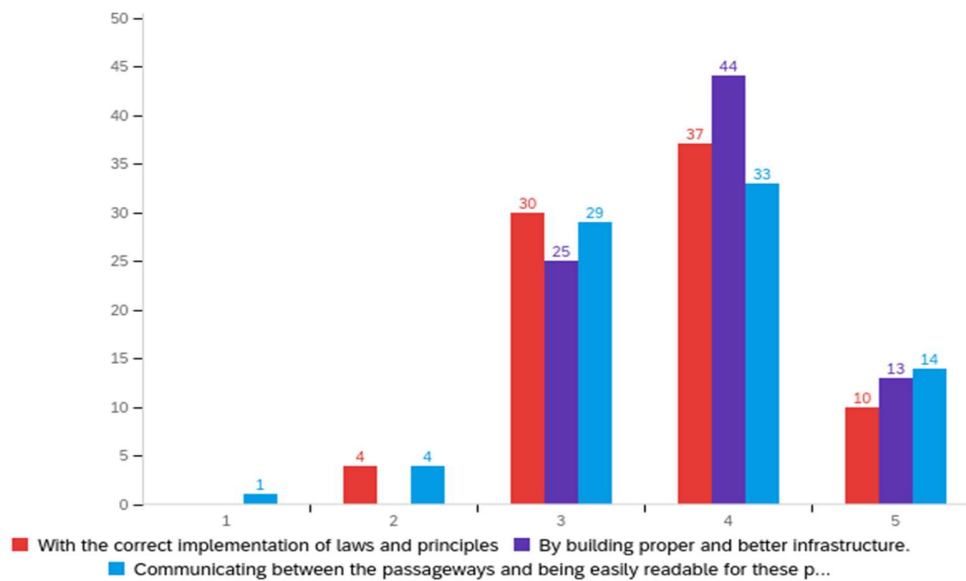


Figure 23: useful concept for people with special conditions

According to Figure 23, people's views on this question and the answers to the solutions have chosen a score of 4 out of 5. The largest share of score 4 was assigned to solution number (2) with 44 answers to score 4. Of course, this result was predictable, because the most important solution that is useful for people with limited abilities is providing useful and safe infrastructure. Two other solutions that received a significant number of answers, with the number of answers 37 and 33 respectively. For this question, about 81 people have answered all the options of all three solutions, and about 240 answers have been given. 114 of the 240 answers are related to the solution with a score of 4 (about 46.69%).

4.3.5 By implementing this urban model, how will it increase the tourist attraction and ultimately increase the number of tourists?

In this question, the evaluation of solutions and options that can be implemented to increase tourists using the concept of walkable city. 3 options (solutions) are:

- a- Building modern infrastructures (1)
- b- Traditional texture (2)
- c- Tourism organization (3)

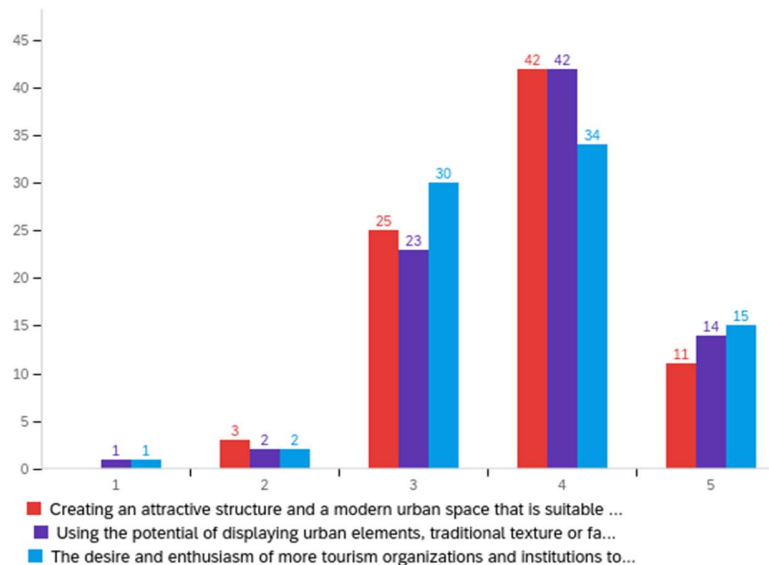


Figure 24: The impact of walkable city on tourism industry

According to Figure 24, the number of people who answered the three solutions of this question is about 82 people, which is about 240 answers in total. And as it is clear from the above diagram, with a big difference compared to the scores provided, these 3 solutions have been given a score of 4. A total of 84 answer to solutions (1) and (2) and 34 answers have chosen a score of 4 out of 5. The next score, which is significant and is in the second place, is score 3 out of 5, which solution number (3) has the most answers of option three (30 answers). And this is a good sign because almost most of the respondents consider the suitability and provision of the VlietZone area to increase tourism and tourists as a suitable approach. And according to the number of answers with scores of 3 and 4 out of 5, most of the respondents are interested in the modernization and renewal of the urban space and suitable infrastructures, as well as the appropriate design of urban elements with a beautiful effect.

4.4. Solutions for walkable VlietZone

4.4.1 How much do you agree with the payment of subsidy for the cooperation of business owners or residents in the implementation of this walkable city concept?

The allocation of governmental subsidies to the building walkable city requirement in this area was the main purpose of this question. (Outcomes depict in the Figure 25). According to the question asked about the satisfaction of the people or business owners living in the desired neighborhood, regarding the payment of subsidies to facilitate and quickly carry out this concept, most of the respondents have chosen the third or middle option. In addition, the choice of this option is very different from other options and it can be a sign of incomprehensible amount of subsidy and lack of knowledge about the type and model of subsidy. And this third option has 46 answers assigned to it (about 54.76%). The total number of voters is 84, and the mean score is 3.02, which shows that most of the answers are 50-50.

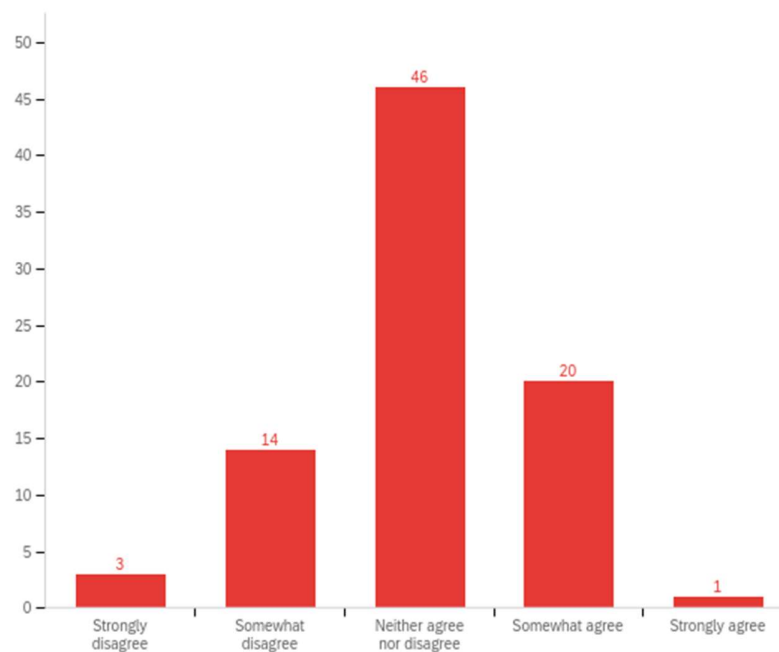


Figure 25: Public attitude towards allocation of subsidies

4.4.2 How much do you agree with changing the structure of the street or moving some existing businesses in the neighborhood and moving them to places to provide more safety for pedestrians?

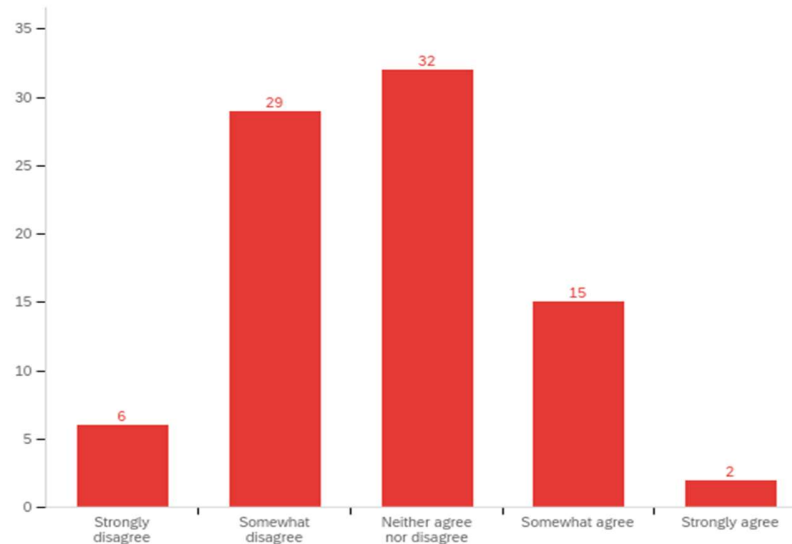


Figure 26: opinion of people to changing the street structures

Most of the respondents did not approve this solution almost with a decisive vote and voted to reject and disapprove this question. Regarding the question that focuses on the relocation of some businesses located on VlietZone street, many business owners or people living in the neighborhood or because of staying in the neighborhood have voted against the relocation of businesses. This attitude from the citizens of the neighborhood almost shows a kind of intellectual unity and unity between people, residents and business owners. On the other hand, more suitable solutions for this issue should be provided by the government or opinion holders. Of course, due to the lack of clarity about the relocation model and the amount of distance from the place for the new place and what jobs require relocation, many people have chosen the middle option. As it is known, 84 people have answered this question and the most votes are neither for nor against with the number of 32 votes and after that 29 votes for the somewhat negative option. The calculated mean score is 2.74, which indicates the vote against this question.

4.4.3. How much does the public transportation system help to spread the acceptance and help to implement the walkable city concept?

In this question, the evaluation of solutions and options that can be implemented to increase the acceptability and solution of this concept using the public transportation system. 3 options (solutions) are:

- a- Control the traffic
- b- Reduce greenhouse gas emission
- c- Less use of private vehicles

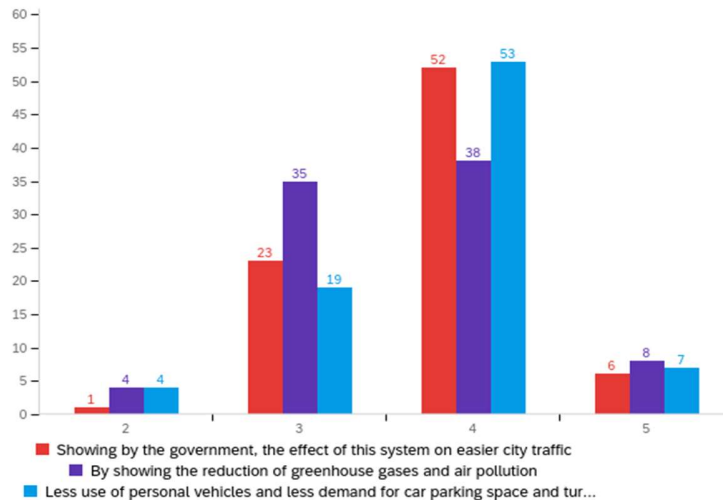


Figure 27: Effect of public transportation on walkable city implementation

According to Figure 27, The number of respondents is about 84 people, and these 84 people have registered their opinion and responded to the 3 solutions provided. The total number of registered answers is about 250 answers from 84 people. As it is known, the highest score given to these three solutions is 4. The most answers to the first and third solutions are 52 answers and 53 answers respectively for a score of 4. The answers to this question on score 4 are also interesting. One of the most common responses to score 4 is increasing work and social responsibility by the government, and the other most common response to score 4 is confirming that people themselves can use private cars less, and as a result, the acceptance of public transportation increases. Finally, one of its results is the decrease in the allocation of car parking spaces.

The number of people who responded to all three strategies with a score of 4 was 143, which is 57.33% of the recorded responses.

4.4.4. What is the best comfortable methods taking part in the implementing the walkable city concept idea in the VlietZone region?

The last question and the answers provided are about suitable and convenient ways to establish the idea of a walkable city in the region and the type of information and awareness. 246 answers have been registered (each person could choose 1 or more options). According to the above results, except for the last option which did not provide a precise way, most of the people have given a high vote of about 70 answers to all 3 first and third options in order to know and be informed about the processes of establishing this concept. There is a little bit of the third option, that is, by using people's meetings with focus groups or NGO's, the most response is 73 responses. Of course, the second option, which is in the form of questionnaires and online and offline interviews, has the second place with 72 answers.

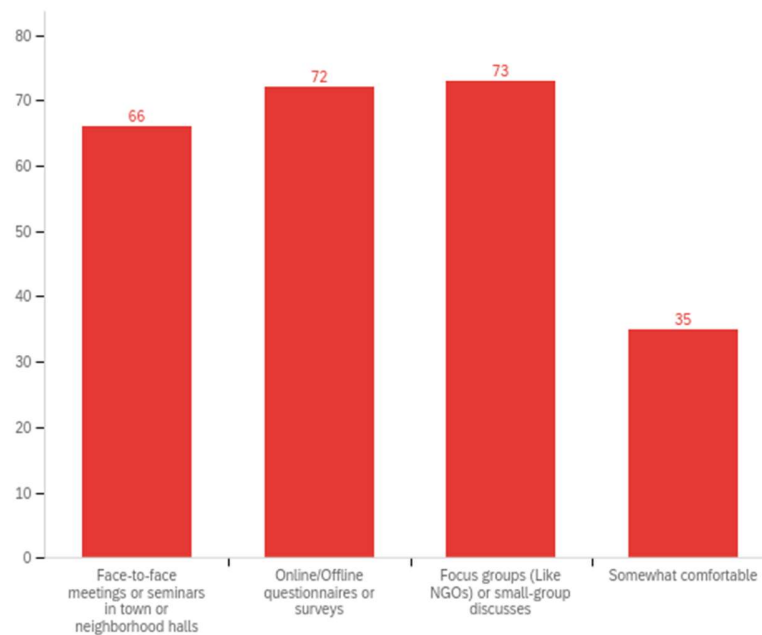


Figure 28: Best methods for people participation on implementation of walkable city.

5. Discussion

The importance of the walkable city concept and implementation of this new idea in cities is the main goal of this research. To perform the walkable city concept in the VlietZone area in Leeuwarden, some fundamental modifications in the current situation of this area is required. These changes include a series of fundamental modifications in urban structures, transportation and urban elements. The growing of public transportation leads to the use of fewer personal vehicles by VlietZone residents and it has positive effect on not only the people but also environment condition. Using less personal automobile equals to more walking and cycling that has a direct positive impact on mental condition of people and decrease the rate of the health problems such cardiovascular problems and diabetes. In addition, the walkable city concept results in expanding of public transportation which leads to less GHG emission in the atmosphere (Leyden et al., 2023). However, to encourage people to use more public transportation or bicycle, it is necessary to create appropriate urban design and elements such as specific bicycle lines, fast and 24/7 bus routes and special lines for emergency services (Lang, 2006).

However, before providing the infrastructure for implementation of the walkable city, the VlietZone residents should be informed of positive influences of walkable city in their area. The results of the questionnaire shows that most of the people in this area did not have sufficient information about the walkable concept and it is probable that VlietZone residents resist against the this idea in their district (Question 4 of questionnaires). There are several ways to increase the knowledge level about among people such as using NGO, influencers/ social media and face-to face meetings, but the NGO would be accepted as the practical method in this area (Question 17 of questionnaire). In addition, implementation of walkable city has positive effect on economic condition of this area. The results from other walkable cities show that these areas are potential to attract a lot of domestic and foreign tourists. The walkable city concept have this chance to become more green and providing infrastructure for festivals, concerts and exhibition is easier than other areas and it is attractive for tourists to visit this area (Bahrainy & Bakhtiar, 2016). Also, due to the lack of cars the walkable city zones are more safe than other areas and therefore the tourists encourage to stay in hotels or use the restaurants in these areas. Thus, the money transaction increase sharply in these area and it helps to the local economy of this area, but in some cases it resulted in increasing the shop and house rent price that could be controlled by the local government. Also, the outcome of the questionnaire revealed that the VlietZone residents motive to attract more tourists to this area if the government reconstruct the old buildings, increase urban furniture and provide the security of this area.

And on the other hand, they showed that by encouraging people to use less vehicles, the public transportation system can be expanded, and one of the important results is the reduction of GHG. The mental and social health of people is another important result. In addition to the effect of becoming walkable on people's health, the effect of public transportation and walking and cycling routes was investigated, and people showed with their answers that these things have a direct impact on urban health and preserving the environment. With the results obtained from people's answers in the questionnaires, the people of the region show their satisfaction about promoting the walkable culture and cycling in the VlietZone neighborhood. Of course, the people of VlietZone gave the lowest answer to the change of infrastructure, and this lowest score to this question is probably due to lack of familiarity with the possible changes. In response to the question of the impact of the walkable city on public health, more than half of the participants (approximately 59.26%) gave the idea a score of 4 out of 5, indicating public approval. And also 18.52% have

given it a score of 5 out of 5, which shows that this number of people have the most trust. However, according to the questionnaire outcome, the people in VlietZone area were ambiguous about implementation of walkable city idea in this area due to lack of information. For instance, the shop owners in this area did not agree to relocate or change their shops. Also, it was unclear for people how the government wants to implement the walkable city elements in this area. But according to the results of the questionnaire, the people of VlietZone were uncertain about the implementation of the idea of a walkable city in this area due to lack of information. For example, shop owners in this area did not agree to relocate or change their shops. It was also unclear to the people how the government wants to implement the elements of a walkable city in this area. In the other part of the questionnaire, which asked about the use of subsidies to implement this concept, people gave an average answer, which shows that they need more information. Overall, the results show that most people agreed that the concept of a walkable city can improve urban safety and public health and agree with this concept. But it needs clear education about subsidies and their benefits so that people can better understand how these measures can improve the city. And finally, almost as many respondents were opposed to moving jobs. Because the people living and working in this area showed with their answers that the walkable city concept can be implemented without changing the business.

6. CONCLUSION AND RECOMMENDATIONS

Today, the emission of greenhouse gases as well as the rapid climate change is a major concern of many countries in the world, so they conduct studies and research and thus spend a lot of money to reduce this dangerous phenomenon. Some of the implications of these climatic changes are drought, extreme heating, and floods. According to the Paris COP21 agreement, the countries present in this meeting agreed to limit the increase in global warming to 2 degrees Celsius by 2030 based on a series of frameworks and laws. One of the very important and doable solutions, compatible with human life, low cost, and also having beneficial results for human health, and finally, a very efficient way to reduce greenhouse gases, is the issue of establishing a walkable city or 15-minute city. And, a problem that can exist is changing the mood (life style) of the people of the neighborhood from using walking and public transportation instead of personal vehicles.

One of the control solutions to increase the physical and mental health of people as well as to reduce GHG gases and their effects is a concept called walkable city, which aims to reduce the use of private cars and also increase personal health and mental health, develop modern transportation, beautify Urban elements can be used in big cities. Another advantage of this concept is people's participation in neighborhood or city development. That this participation increases the spirit of responsibility of the people of the region towards the neighborhood or the city.

This concept is now being implemented in big cities as one of the attractive and advanced options to achieve the mentioned goals. This strategy focuses on creating neighborhoods where residents can easily access all their daily needs, including schools, supermarkets and medical services, by walking or cycling. According to the reports presented in the previous paragraphs, with the expansion of urban life and the increase in the risk of people's health and safety, and to reduce these risks, the spirit of avoiding urban life should be spread among the people. The spirit of people's social interaction with each other, as well as less use of private cars and replacing it with walking, causes more interaction between people in the street and increases social-sports activities. According to the explanations given in the previous sections, a literature review was conducted to establish this concept and the items (health, transportation, urban elements) were examined to establish this concept. Then, by writing or posing the main question and sub-questions, the investigation was done for the three items raised. And then, by creating a questionnaire and asking the people of the region, the level of participation or awareness and agreement or rejection of this concept was asked. Finally, the obtained answers were analyzed using the EDF framework.

The EDF approach is used in this thesis as a general inspiration to provide final recommendations on how the concept of a walkable city can be linked to the context of the VlietZone area. This research has used EDF to relate the concept of the walkable city to the VlietZone area. EDF helps urban designers translate spatial goals into concrete design principles and improve the concept of a walkable city by taking into account environmental, social and economic concerns. This approach transforms spatial goals into design principles that are based on ecological principles and makes it possible to create flexible and sustainable cities that have a balance between human, nature and economic needs. This research has been divided into different stages.

In stage 1, a literature search was carried out and the features of the walkable city, its implementation and limitations were examined. Objectives that include the elements of **health**, **transportation** and **urban elements** were identified and selected.

In stage 2, using the results of the literature review and exploratory information obtained from people and their attitudes, questionnaires were prepared and their results summarized. For example, the attitudes toward increasing people's health through exercise and walking were investigated as well as increasing the urban green space. In the third stage, by analyzing the results and comparing the answers, solutions and suggestions were presented that are effective for increasing people's health and willingness to use public transportation and urban components and elements. In the fourth stage, this section presents examples of implementing the three objectives (health, transportation and urban elements) in VlietZone, illustrating how to achieve the goals of a walkable city in this area. And finally, the results of this research, which were examined with the EDF framework, are shown in Table 3. According to this framework, by identifying the elements in Stage 1, and with literature review and questionnaire to determine the objectives was mentioned in Stage 2. The results to be achieved for each element in Stage 3 are specified. And finally, to show the implementation of this result in Stage 4, schematic photos are displayed.

A summary of the results is reported next, followed by suggestions for the future:

Summary of results: In this research, the impact of becoming a walkable city or the implementation of the concept of walking in the city of Leeuwarden was investigated. The survey was conducted in the form of a questionnaire from the people of VlietZone neighborhood, and the questions were designed as comprehensible and convenient questions.

According to the obtained results, most people agree with the solutions asked to increase the amount of walking and cycling. Of course, they don't consider the existing facilities, whether infrastructure, services or urban green space, suitable for the implementation of this concept, and they answered these three questions with an average score of 2 out of 5. On the other hand, the people found the proposed solutions to reduce greenhouse gases appropriate and approved with almost a high score (52.06% of the people chose a score of 4 out of 5 for the solutions) and this is a sign that this issue is of concern to the people. Of course, regarding the impact of walkable city on security and safety, people gave almost a high score with a little doubt. About 50% chose a score of 4 out of 5 for all solutions, but about 35% gave these solutions a score of 3 out of 5, which can be an average score or a doubtful score. People's feedback and answers to the question of what their evaluation of walkable city can be for certain people, answered almost the same as the previous question, and the share of a score of 3 out of 5 is impressive. The effect of walkable city on the increase of tourists is positive from people's point of view and about 35% chose 4, about 17% chose 5 and almost 32% chose 3 out of 5. According to the number of answers with scores of 3 and 4 out of 5, most of the respondents are interested in modernizing and renewing the urban space and appropriate infrastructures, as well as the appropriate design of urban elements with a beautiful effect. One of the very important questions that people voted positively for its solutions is the effect of the public transportation system on making the region a walkable city. About 57.3% of people gave the solutions a score of 4 out of 5. Another point from the results of this question, the share of social responsibility for placing this concept between the people and the government was considered equal. And this means that the people and the government have equal responsibility. And according to the last question, people have a very positive opinion about cooperation, the type of announcement, familiarity, cooperation and learning from the relevant institutions.

As mentioned in the previous sections, to establish this concept in a city like Leeuwarden and the VlietZone neighborhood, it was necessary to design suitable questions. On the other hand, the main topic of this thesis is about the walkable city concept and its implementation and how to place or establish this concept. For this purpose, at this stage, the appropriate framework was chosen with the concept of the thesis. Then, the target elements (health, transportation, and urban elements) were selected by literature review. The results obtained from the analysis, either the literature review or the results of the questionnaire, were very interesting and close to each other.

- according to the first sub-question;

A literature review was conducted, and the first 5 questions of the questionnaire “4.2. Current status of VlietZone” were also designed and asked based on the concept of this sub-question. The interesting thing is that in the first question of questionnaire, the people of the neighborhood were not very familiar with the concept of walkable city, but after explaining and showing examples in other cities, they understood the concept and answered the questions willingly. The interesting point is that they answered questions 4.2.3 and 4.2.4 by discussing and comparing with other cities.

- according to the second sub-question;

Which investigated one of the goals of walkable city, namely GHG. In the literature review, the positive effects of this concept were examined from different aspects, and in the questionnaire in section “4.3. Benefits of walkability” This question was answered. In this section, in addition to GHG, questions about health and safety also asked. The interesting thing was that while filling the questionnaire, they emphasized that this concept is very useful for people's health and urban development.

- according to the third sub-question;

The answer to this sub-question was implicit in most of the questions of questionnaire. For example, a model that has good public transportation or a model that represents higher safety for disabled people and children. And the result of this question is displayed in stage 4 of the framework.

- according to the fourth sub-question;

The answer to this sub-question, like the previous question, is provided implicitly in most questions of the questionnaire. At first, people were not familiar with the concept, but with very little explanation, they agreed to implement this plan in the area, especially establish this concept at main street of VlietZone. Or for example, by answering the question they agreed about attracting tourists. Most interestingly, almost more people were against moving jobs or store for implement this concept. Also, the people shown high level of participation in answer the last question, in learning, helping, promoting for implement of this concept in neighborhood. After this research, I am more sure that the people of each region are the most caring people for that region. Because they consider that neighborhood as like their home (not their house).



And finally, a very important point that I learned in this research, if elderly and disabled people and children of neighborhood having fun time and be safe while walking or playing around the area (neighborhood), that area (neighborhood) is the healthiest, safest and most advanced neighborhood.


Suggestions for the future:

- It is suggested to establish neighborhood councils in different regions for the purpose of familiarizing more people with urban-social concepts, especially the effects of climate change.
- It is suggested to establish at least 2 walkable areas for all cities in the Netherlands, and as a result, the Netherlands will be a leader in this field and a specialized producer of this science.
- It is suggested that a comprehensive integrated system be implemented for more coordination in the implementation of these concepts for cities.
- It is suggested that, in today's world and due to the development of technology and artificial intelligence, the required parameters of walkable city should be controlled and measured by intelligent systems, and on the other hand, to evaluate the level of satisfaction of the people with the application of these artificial intelligence technologies, in regular time periods. People should be asked in the form of a questionnaire or an interview.

In conclusion, Table 3 provides a synthesis of this thesis' findings and recommendations in the format of the EDF framework. The Table's propositions revolve around the three principles of health, transportation, and urban elements, and propose design principles and design concepts for each, providing illustrative examples that could work for the VlietZone neighborhood.

Table 3 : Summary of the EDF framework for target items.

EDF stage 1 Experiences/do mains of quality of life	EDF stage 2 Design principles	EDF stage 3 Design concepts	EDF stage 4 Design applications
Health	Increase opportunity of general health among people, increasing public athlete	More pedestrians, bicycle line and public sport. More Mental health, More people interactions	 <p>(Etchie, 2020)</p> <p>(Skidmore, Owings & Merrill (SOM), n.d.)</p>
Transportation	Increase opportunity of public transportation, Increasing urban traffic order	More bus stops, more bus line, Tram line, Clear urban signs (sidewalk, rest area, parking area, etc.)	 <p>(StackPath, n.d.)</p>

			 <p>(Sydney, 2023)</p>
<p>Urban elements</p>	<p>Increase social activity, Increasing visits to the region (both as tourists and as investors) because due to increased safety and security</p>	<p>More urban furniture- more public toilet, Comfortable chairs for disabled people, water features or urban beautification elements according to the culture and history of the region.</p>	 <p>(Storey, 2023)</p>

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Appendix 1; Questionnaires

Questionnaires:

A walkable city strategy for Vliet Zone: key principles, the role of local dwellers, and the strategy's climate change mitigation benefits.

My name is Ebrahim Khajehpour and I am currently student at University of Twente at master of energy and environmental management. I am writing my final thesis about feasibility of concept of walkable city strategy concept for Vlietzone of Leeuwarden. Walkable city is a practical and physical concept that can be seen concretely in the society. This is a concept to be defined in the urban environment, which is designed with the aim of prioritizing walking and cycling as the main method of transportation and other purposes. This concept has suitable infrastructure for pedestrians (sidewalks, crossings, etc.) as well as increased safety and comfort for people to pass through crossings and intersections. The walkable city plan can be considered for the following purposes. Goals such as increasing physical activity, using less cars, reducing traffic, increasing public transportation, and as a result, reducing (GHG) Green House Gas (Figure 1).

Aim of the study: The purpose of conducting this questionnaire among the people of Vlietzone is (a)to investigate the existing conditions in Vlietzone to check the ability to become a walkable city and (2)the benefits of becoming a walkable city and (3)finally the solutions for a walkable city in Vlietzone.

Ethical consideration: All of the collected data from the survey is stored securely and they will be deleted after the 45 days.



Figure 1. Concept of Walkable city

Your willingness to participate in the survey?

- Yes
- No

What is your gender?

- Male
- Female
- Non-binary / third gender
- Prefer not to say

What is your age range?

- 18-30 years old
- 31-45 years old
- 46-65 years old
- mor than 65

How much is your awareness and information about concept of a "walkable city" or "city with high and advanced urban facilities for walking or cycling"?

- None at all
- A little
- A moderate amount
- A lot
- A great deal

From the following items, which item/s are suitable for increasing walking and cycling (implementation of the walkable city concept) in the vlietzone area? (According to your preference, rate the following options from 1 to 5, and You can select one or more Items)

- A suitable bench for sitting
- By increasing urban comfort for walking and relaxing, such as increasing shade
- Proper access to urban services such as suitable bus stops or suitable routes for emergency services.
- Urban-artistic elements for beautifying the city and increasing the artistic appeal of vlietzone street
- Changing urban infrastructure and increasing facilities to increase services easily accessible by foot to increasing walking or cycling

Currently at now, how much you rate to the urban infrastructure in Vlietzone Street for being suitable for the concept of walking or walkable? (Score 1 to 5)

- Far below average
- Somewhat below average
- Average
- Somewhat above average
- Far above average

Currently, how much do you rate your neighborhood area services and facilities (Urban Furniture, Professional Sidewalk or cycling line, traffic signs,...) provided by the municipality, suitable for walking or cycling? (Score 1 to 5)

- Far below average
- Somewhat below average
- Average
- Somewhat above average
- Far above average

How much do you rate the green space of Vlietzone Street?

- Far below average
- Somewhat below average
- Average
- Somewhat above average
- Far above average

How do you think it would help to reduce urban greenhouse gas emissions by making Vlietzone a walkable neighborhood? (According to your preference, rate the following options from 1 to 5, and You can select one or more Items)

-Encourage walking and cycling as sustainable transportation options

-Increasing traffic-urban infrastructure to reduce dependence on private vehicles and promote the use of public transport

-Minimizing traffic congestion and greenhouse gas emissions

-Promotion of energy efficient buildings and green infrastructure

-Support compact urban form (accessible) to reduce the need for long commutes

How do you rate the spread of the walkable city concept in the neighborhood and the increase in public health?

- Far below average
- Somewhat below average
- Average
- Somewhat above average
- Far above average

How much does the concept of walkable city help to increase urban safety and security? (According to your preference, rate the following options from 1 to 5, and You can select one or more items)

Increasing social interactions of people at the neighborhood level

Increasing environmental security and environmental health

Peace of mind in traffic for pedestrians and cyclists

Walkable city or Bikeable city, is it a viable and useful concept for people with special conditions? (Old people, children or people with disabilities) (According to your preference, rate the following options from 1 to 5, and You can select one or more items)

With the correct implementation of laws and principles

By building proper and

better infrastructure.

Communicating between the passageways and being easily readable for these people

By implementing this urban model, how will it increase the tourist attraction and ultimately increase the number of tourists? (According to your preference, rate the following options from 1 to 5, and You can select one or more Items)

Creating an attractive structure and a modern urban space that is suitable for only walkable and bikeable,

Using the potential of displaying urban elements, traditional texture or facade of neighborhood buildings

The desire and enthusiasm of more tourism organizations and institutions to introduce a neighborhood with such potential

How much do you agree with the payment of subsidy for the cooperation of business owners or residents in the implementation of this walkable city concept?

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

How much do you agree with changing the structure of the street or moving some existing businesses in the neighborhood and moving them to places to provide more safety for pedestrians?

- Strongly disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Strongly agree

How much does the public transportation system help to spread the acceptance and help to implement the walkable city concept? (According to your preference, rate the following options from 1 to 5, and You can select one or more Items)

Showing by the government, the effect of this system on easier city traffic

By showing the reduction of greenhouse gases and air pollution

Less use of personal vehicles and less demand for car parking space and turning the car parking space into a bicycle parking space

What is the best comfortable methods taking part in the implementing the walkable city concept idea in the Vlietzone region?

- Face-to-face meetings or seminars in town or neighborhood halls
- Online/Offline questionnaires or surveys
- Focus groups (Like NGOs) or small-group discusses
- Somewhat comfortable

Appendix 2; Ethical approval

Status: Approved by commission

The BMS ethical committee / Domain Humanities & Social Sciences has assessed the ethical aspects of your research project. On the basis of the information you provided, the committee does not have any ethical concerns regarding this research project. It is your responsibility to ensure that the research is carried out in line with the information provided in the application you submitted for ethical review. If you make changes to the proposal that affect the approach to research on humans, you must resubmit the changed project or grant agreement to the ethical committee with these changes highlighted.

Moreover, novel ethical issues may emerge while carrying out your research. It is important that you reconsider and discuss the ethical aspects and implications of your research regularly, and that you proceed as a responsible scientist.

Finally, your research is subject to regulations such as the EU General Data Protection Regulation (GDPR), the Code of Conduct for the use of personal data in Scientific Research by VSNU (the Association of Universities in the Netherlands), further codes of conduct that are applicable in your field, and the obligation to report a security incident (data breach or otherwise) at the UT.