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Master's Degree Thesis

Accessibility in Transit-Oriented Development (TOD) Areas: A Case Study of the Copenhagen Metropolitan Area

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Abstract:

Urbanization, a defining aspect of modern economic development, reflects humanity's growing tendency to seek connection and opportunity in urban spaces. Cities, as centers of social, cultural, and economic life, attract individuals with promises of access to education, work, green spaces, and essentials that foster well-being. However, rapid urban growth raises critical concerns about equity and inclusivity, particularly in ensuring all residents can access the resources they need to thrive.

Transit-Oriented Development (TOD) is an innovative approach to urban and transport planning, harmonizing land use and transportation systems to promote public transport and create more livable environments. By prioritizing walkability, cycling, and public transit, TOD fosters connected communities, reduces car dependency, and promotes sustainable lifestyles. TOD can create equitable, resilient urban spaces that focus on the well-being of residents, moving beyond infrastructure to prioritize the lived experience.

This thesis, based on my internship at DTU University in Copenhagen, explores TOD's potential in the Copenhagen metropolitan area, focusing on access to education, green spaces, and residential areas. These elements are essential for meeting basic human needs while fostering social equity, community, and belonging. By examining access to education, green spaces, and homes within TOD zones, this study evaluates how well the Copenhagen area, as a TOD case, ensures access to these urban features.

Using Geographic Information Systems (GIS) for spatial analysis and multi-criteria decision-making, the research identifies significant challenges. Many educational centers, despite their role in empowerment, are outside walkable distances from transit hubs, hindering access. Green spaces, essential for well-being, are unevenly distributed, leaving some neighborhoods without places for recreation. Residential areas often lack connections to transit and essential services, limiting their potential to create integrated, walkable communities.

The findings show how TOD influences access to educational centers, green spaces, and residential areas. Educational centers are more accessible in areas with efficient transit, while others face challenges like longer distances and limited connectivity. Green spaces are unevenly distributed, with some areas having ample space but poor access, while others lack natural spaces. Residential

areas also vary, with some well-connected to transit and services and others remaining isolated, limiting their potential. These findings stress the need to design TOD to improve access to education, green spaces, and residential areas, leading to more inclusive and sustainable urban environments.

In conclusion, this research offers policy recommendations to bridge gaps in accessibility. These include redesigning urban layouts to bring educational facilities within walking distance of transit hubs, expanding green spaces, and better integrating residential areas with public transit networks.

Keywords:

Transit Oriented Development (TOD), Accessibility, Educational Centers, Green Area, Residential Area

Contents

CHAPTER ONE: INTRODUCTION

1.1. Overview

Nowadays, due to the massive urbanization and alignment with economic advancement in cities, Transit-Oriented Development (TOD) serves as a novel urban planning strategy that fosters sustainable enlargement of cities by merging highly populated and dense areas with mixed-use development around transit station hubs (Khaderi, Bakeri, & Abd Shukor, 2021). This approach became an effective tool for sustainable moving and migration from suburban and low-density areas to city centers and more developed places. Individuals in search of a better quality of life prefer to live in areas that facilitate comfortable access to their fundamental needs, such as education, healthcare, and economic opportunities. The TOD plays a vital role in shaping and upgrading urban life because it focuses on making cities more alive for the community by improving the environment and equipping it with the best transportation options to address urban sprawl and by providing amenities in the proximity of the transit hubs crates equal and integrated situation for all people. From the past until now, the primary means of traveling was rail transport, which plays an essential role in facilitating people's traveling, providing connection between rural areas to the core part of the cities where important resources, the ability to use services, and various opportunities are well connected and accessible. This approach can enhance walking in station-surrounding neighborhoods, decrease dependence on private vehicles, and encourage the community to use public transportation as a practical way to create an inclusive and accessible urban environment. Today, it is evident that TOD has positive impacts on reducing air pollution due to the higher use of public transport; meanwhile, by producing a pedestrian-friendly environment, it is successful in attracting the community to walk more, and the significant drop down in urban sprawl is the result of proper Tod implementation. In terms of urban spaces, it may cater to development patterns around transit facilities (Cervero et al., 2004).This thesis scrambled to deeply find out the concept of TOD on accessibility, specifically in this context, how many educational centers and green and grey urban areas are reachable. TOD is always designed to boost the urban experience by creating fair access to primary services and spaces that are integrated into a better quality of life for all human resid in cities. However, this study faces many obstacles in certain TOD areas, where the reachability to educational facilities is inconsistent because of insufficient public transport, insufficient walking infrastructure, and poor access to required services for residents. Moreover, this thesis focuses on the importance of open spaces encompassing transit stations, which are critical locations for improving the living environment

and making it safe and sustainable for all. The proximity of suitable green and grey spaces has social, psychological, and cultural value as it can be a practical instrument to welcome community engagement, reduce urban stress, and improve overall well-being. By utilizing spatial analysis through GIS data, effective use of multi-criteria decision-making (MCDM), and comprehensive examination and investigation of different stations that seek to find potential locations for TOD factors enhancement as well as evaluate how TOD can create a balanced and equal relationship between transport system and land use to build social and environmental sustainability.

Through assessing stations by transit-oriented development characteristics this study tries to understand how TOD area with 800-meter buffer zone focuses and pedestrian-friendly infrastructure has a critical effect on human accessibility, movement, and mobility. Also, the social connectivity thesis aims to uncover the potential of TOD areas and stations to transform urban spaces. It is momentous to point out that this thesis not only tries to forecast how these areas cooperate with the physical mobility of people but also their social dynamics and continuity. Furthermore, it will recognize the advantages and challenges of TOD, all recommend and suggest insightful and practical ideas to inform future urban planning strategies that target reaching more justice and inclusive within sustainable societies.

1.2. Aim of study:

This study pointed out the role of Transit-Oriented Development (TOD) in increasing accessibility to educational centers and umlaut green and grey urban areas in the city of Copenhagen Metropolitan Area. In this case, green areas are defined as all types of vegetation from grass to parks and gardens, and the grey area is understood as residential zones that consist of houses that play as shelter for humans in urban structures. The next emphasis of this study is centralizing on active means of mobility, most importantly by foot, which is the first and most comfortable equipment for transport to recognize the potential to address how access to fundamental resources would be ameliorated while the portion of using the private car is reducing because of appropriate TOD area.

While the selected stations in this case study were examined, the research looked to uncover TOD characteristics, advanced accessibility, pedestrian routes, and integration of green and residential areas in the urban framework. The pervasive aim is promoting urban development which is not

only sustainable but also socially inclusive and equitable, increasing the quality of life and bringing up a more powerful sense of the community. It should be mentioned that another parameter that will be measured in this thesis is how many people have convenient access to green and grey areas because these selected stations are mostly located in suburban areas and imbalanced divisions of green and grey areas may result in poor access.

1.3. Research Objectives: The thesis is structured around four primary objectives:

1-Evaluate the Accessibility of Educational Centers:

This thesis aims to understand how Transit-Oriented Development (TOD) has a special impact on access to educational centers in Copenhagen and its suburban areas. This attempt identifies that the community specifically students in the Tod areas can walk to their schools, universities, and other types of educational institutions with comfortable time, and these facilities are well situated to create equitable access for individuals to reach their demands and also try to comprehend these highlighted areas are in highest needs to improve the TOD concept in critical factor to contribute and resulted in fairness educational landscape.

2-Assess the Integration of Green and Grey Spaces within TOD Areas:

The other main goal of this thesis is to text and investigate the green and grey areas in TOD zones. Green areas are fundamental open spaces that are a pivotal part of the urban environment that must be a direct connection with grey or residential neighborhoods because these two important elements frame urban areas. Additionally, they are core points of human needs in the cities. Regarding the importance of these spaces, this study aimed to assess the accessibility to these areas and analyze how well mixed with urban fabric is also in contact with TOD development and its impact on the community's well-being. This study follows the main objective of the TOD approach which is the perfect integration of land use and transit stations in terms of how green and grey

areas are merged and its access to the transportation system. This part of the thesis seeks the best TOD structure for designing balanced green and grey areas in urban spaces.

3-Investigate the Role of Walking in TOD Area:

The key aspect of this thesis is exploring walking as a practical means to experience urban life mostly in TOD zones. With this consideration thesis tries to examine how TOD characteristics can support individual mobility in the cities and how a walkable environment would encourage humans to walk and reduce reliance on private cars. Movement in the TOD area on foot serves as a sustainable and inclusive mode of transport that fosters access to resources and promotes healthier and more connected communities. It is seen in many studies that safe and proper stations surrounding can invite people to walk more and this action influences socializing and makes health full society.

4-Examine TOD Characteristics and Their Impact on Station Selection and Overall Development:

This research concentrated on how TOD characteristics can shape the frame of these selected stations and advancement in transit hubs. This action will be feasible by analyzing various features in TOD areas which include transit accessibility, safety and security, several types of development and services, design of the area, and other factors with the goal that the result provides details about the role of each selected station in sustainable urban growth. Also, identifications of areas that have a high potential for development, by this concept that TOD factors not only can address the required needs of transportation but also participate in the structure of urban social patterns and defend human fundamental rights.

1.4. Research Questions

This thesis explores the urgent need to improve urban mobility, walkability, and sustainability through Transit-Oriented Development (TOD). Cities like Copenhagen that ensure well-planned

TOD strategies seamlessly link public transport pedestrian pathways to provide efficient and accessible urban movement. The importance of these strategies cannot be overstated, as they directly impact the urban experience of students, faculty, and the broader community, making the audience feel the urgency of urban development. A well-designed TOD framework must also balance built and natural environments, integrating green and gray spaces to support environmental sustainability and urban resilience. Some challenges in urban areas cause problems for pedestrians, such as safety, accessibility, and reachability to infrastructure and mobility. However, the potential of TOD in reshaping active mobility is inspiring, as it can address these issues and more, making the audience feel inspired by the potential of urban planning. This thesis explores using multi-criteria decision-making (MCDM) and geographical information systems (GIS) to support effective TOD planning. Planners use these tools to evaluate station areas, which are the immediate surroundings of public transport stations, prioritize development in these areas, and investigate connectivity to ensure the capability to create sustainable urban integration of these elements. Also, this thesis provides a cohesive framework for creating walkable, well-connected, and environmentally sustainable elements.

The research questions are:

1- How does the TOD strategy improve walking accessibility to the Copenhagen Metropolitan Area educational centers?

2-How are green and gray spaces correlated within TOD zones, and how do they impact urban sustainability?

3-What challenges to walkability exist in TOD areas, and how can they be addressed?

4-How can MCDM and GIS-based methods identify stations for TOD improvements?

1.5. Significant of study

This thesis tries to understand the deep implications of the cities that are involved with a greater view of sustainability and human-centered spaces. Though considering Transit-Oriented Development (TOD), that sheds light on the transforming opportunities to merge public

transportation, pedestrian-friendly design, and mixed land use. In doing so, the study tries to underscore the importance of urban development that supports fairness and accessibility to resources and services because one of the key elements to reach sustainability and comfortable access to daily needs in urban areas. To achieve this goal by tackling individual disparities in access this thesis advocates urban planning practices that focus on social justice and inclusivity and certify that all members of society can benefit from sustainable development. The emphasis on walking as the primary mode of transportation that is aligned with efforts to reduce environmental impacts also empowers community connections and a good lifestyle.

By employing GIS-based methods and multi-criteria decision-making (MCDM) which is used to provide novel and innovative approaches to evaluate TOD areas. These methods offered insight into the various dynamics of urban spaces and assisted in determining opportunities for practical interventions. Focusing on Copenhagen metropolitan areas as a case study helps the research to better assess transit station performance and uncover potential stations where the TOD characteristics are not well applied, and which are the best situation to improve and update specific factors that make a change and perfectly can serve the community.

1.6. Organization of thesis

This thesis is planned into five chapters which are interconnected, and each section of the thesis participates to cater to a significant understanding of the role of Transit-Oriented Development (TOD) in enhancing sustainability and justice in urban environments.

The chapters are all organized as follows:

Chapter 1: Introduction:

This chapter is about the structure of the thesis, defining the background and the TOD concept that is the core focus of the text as well as its importance as a novel urban planning strategy. This step encompasses from objective of the thesis, issues, and questions the emphasis on how TOD can improve accessibility to the educational centers also the integration of the green and grey spaces which are the backbones of the livable and reach place to live.

Chapter 2: Literature Review

This part of the study is undertaking a mindful exploration of the thesis concept that engages with key theoretical frameworks and ideas. The first section is about defining and exploring the central topic of the research which is Transit-Oriented Development (TOD), accessibility in TOD areas, and the significance of access to educational centers then an explanation of the approachability to green and grey areas that formed the urban environment. In the next part review and investigate, the role of walking as the main means of transportation within TOD areas and recognize the opportunities to foster sustainable mobility. Furthermore, pointing to the importance of the GIS-based analysis and multicriteria decision-making (MCDM) tool, particularly in assigning weighted score modeling. This chapter focuses on the comprehensive academic conversation and fulfillment of the literature review to identify critical gaps and explore knowledge about TOD and its different roles and dimensions in a broad way and try to address them.

Chapter 3: Methodology and Case Study Analysis

In this thesis, chapter three is the most important part of the research because it consists of a methodology framework that guides the study, then provides an in-depth description of each step of the analysis and how the method used to find the case study selected station whiten Copenhagen Metropolitan Areas. By integrating GIS-based analysis and calculation with multicriteria decision making (MCDM) this step aimed to determine the tools and equipment to assess the performance of the selected station with TOD characteristics as the reachability of the public space like green areas and review the proximity of residential zones whiten TOD buffer area, mentioning variety of TOD as best urban planning practice in different concept and countries as international examples and at last ensuring a comprehensive examination and investigation of the TOD implementation and its outcomes.

Chapter 4: Results and Discussion

The discussion chapter reflects the analysis and calculation to illustrate the findings directly related to the research objectives. It caters to an insight into the TOD approach that created the urban structure of the case study and its influence on the residents' lives and daily experiences in urban

areas. This step critically addressed accessibility in urban environments that must be equitable and inclusive. Moreover, in this step, findings were integrated into the whole concept, and some implications and further urban planning practices were introduced by considering challenges and opportunities that appear from the case study and analysis. It should be mentioned that some policies and approaches were investigated to foster the situation and solve the lack of the TOD factors in specific stations, these solutions are the most essential actions that can be taken to enhance the TOD area with accessibility matters.

Chapter 5: Conclusions and Recommendations

The conclusion chapter is the part that shows the thesis findings, with a broad view that offers a reflective analysis of the case study about the TOD approach and how to improve selected stations in the Copenhagen Metropolitan Area. It proposes unique recommendations for enhancing the availability and accessibility of the transit system with land use integration, most importantly green and grey spaces in TOD areas, and it prioritizes walking as the primary means of mobility in transportation.

CHAPTER TWO: LITERATURE REVIEW

2.1. Chapter overview

This chapter consists of a deeply explained literature framework on Transit-Oriented Development (TOD), and it investigates its practical significance, effects on active mobility, and role in shaping sustainable urban environments. TOD is a practical approach in urban planning that aims to decrease reliance on motorized vehicles, increase public transit usage, and foster pedestrian-friendly urban areas. Another significant point of this thesis is TOD's capacity to approve walking accessibility, designing a walking environment as a primary mode of active mobility. This approach encourages communities to rely on healthier lifestyles, contribute to sustainable cities, and recognize the advantages of walking for individuals and the environment. In this thesis, multi-criteria decision-making (MCDM) methods enable urban planners to evaluate various factors, including accessibility, infrastructure quality, and land use patterns. By combining MCDM into urban planning and authorities capable of pinpointing areas needing urgent TOD improvements, prioritizing development efforts, and ensuring the built environment facilitates effective and sustainable transit systems. The connection between land use and TOD is examined, focusing on the equilibrium between grey spaces and constructed environments, particularly in this case study of residential areas and green spaces (natural and all forms of green cover within the urban fabric). Effective TOD zones incorporate these elements to generate more sustainable and pleasant living environments. Integrating green and grey infrastructure is supper efficient in TOD areas because it promotes ecological resilience, connectivity, and human well-being, contributing to the long-term sustainability of urban regions. Beyond land use issues, the chapter also explores the crucial topic of accessibility and reach to essential destinations, such as educational institutions. Access to education is critical in TOD areas since it can influence the family preference for living in TOD areas and reduce poor and unequal access to education. A well-integrated TOD area grantee that students, families, and staff can conveniently walk or use public transport to reach these institutions; by doing so it can improve the overall effectiveness and accessibility of the urban landscape. Population density within TOD regions was also discussed in this thesis because greater population densities improve urban aliveness and transit-oriented communities, making public transportation more efficient while reducing reliance on private vehicles. This density encourages sustainable urban development, ensuring that TOD areas are well-connected and capable of offering various activities and services.

2.1. Introduction to TOD

Transit-Oriented Development (TOD) was introduced as an urban strategy aimed at integrating densely populated areas with diverse land uses near major public transportation stations to enhance public transport usage (Xiaohong, Li., Qiming, Xiao., Yadi, Zhu., Yuting, Yang, 2022). This approach establishes a well-structured connection between land use typologies, including residential, commercial, and recreational facilities, with close accessibility to transport stations. The objective is facilitating movement, improving livability, and promoting economic resilience (Dittmar & Ohland, 2003). Additionally, TOD plays a crucial role in reducing reliance on personal vehicles, thereby minimizing traffic congestion and environmental pollution (Mohammad, Reza, Rezaimoghadam., Nooradin, Dabiri., Seyed, Rasoul, Davoodi, 2022). Demographic changes have significantly influenced the necessity of TOD implementation. By 2018, over 55.3% of the population at a global scale resided in urban areas, and it is anticipations that this percentage will increase to 60.4% by 2030 (Transport Research Center [TRANSyT], Universidad Politécnica de Madrid, n.d.). This shift has been driven by individuals moving from rural areas historically reliant on agriculture—toward urban centers characterized by industrial development and service-based economies. People have migrated to pursue better job opportunities, improved education, and well-structured transportation systems, seeking enhanced living conditions and socioeconomic benefits (Yuji, Murayama., Ronald, C., Estoque, 2020). Moving from rural to urban areas has been influenced by multiple factors, including high demand for new employment opportunities, inadequate infrastructure for development, and inadequate and poor access to essential resources such as healthcare and education. A critical component of the TOD framework is establishing connectivity between suburban, rural, and urban regions through efficient public transportation networks. Properly planned transportation systems can reduce the number of personal vehicle trips, leading to decreased driving times, lower congestion levels, and a reduction in the negative environmental impacts of traffic emissions (Mohammad, Reza, Rezaimoghadam., Nooradin, Dabiri., Seyed, Rasoul, Davoodi, 2022). It is a functional approach that to reach this aim, the transportation system must be saved, maintained, and perfectly managed because high-quality services and infrastructure are essential to guarantee individual demands and maintain urban development. Living in cities with many difficulties and massive populations aligned with managing transportation to be more practical and effective. With TOD as a novel urban planning strategy, many urban planners can design cities to be more sustainable. This action can be feasible

by boosting reachability and access of residences to urban spaces with good plan TOD areas, which are characterized by proper factors that foster urban development, and people are more satisfied because of easy access to their primary needs by well-integrated transportation options. This structured approach improves mobility and connectivity and results in long-term resilience and sustainability in urban environments.

2.2. Transit-Oriented Development (TOD) Concepts and Definitions

The concept of the Transit-Oriented Development (TOD) was defined by Peter Calthorpe in the late 1980. This concept is the place-based approach, which holds the goal to provide advancement in urban areas with a focus on the pedestrian-friendly design that attracts the community to walk more also points to the mixed-use development that caters to all types of service and facilities for individuals in proximity to transit stations (Zhao, Hu, & Zhang, 2024). From previous studies, it has been explained that (TOD) is a practical solution to change auto-oriented urban structures to less associated with motorized vehicles and design urban areas more sustainably, which is proper to use sustainable modes of transport (Yen, Mulley, Chen, & Chiou, 2024). With considerable attention to green transportation such as walking and cycling, TOD aims to provide an eco-friendly walking environment within close distance to the transport station to improve the pedestrian experience that is safe and well embedded by area, this method updates the public transport efficiency also empowered land use toward reaching sustainability. It is proved that Transit-Oriented Development has been able to give locals a better living standard of living with lower transportation costs as well as provide a balanced situation in mixed-income neighborhoods that make its effect less on the environment and offers accessible alternatives to traffic jams (Dittmar & Ohland, 2003). The expansion and development in urban areas have had a direct relationship with different types of transportation and changes in modes of transportation have substantial effects on the urban spatial pattern. In one hand, if the use of public transportation needs to be improved Transit-Oriented development has shown its practical responsibility to build an environment made by diverse uses and facilities to adequately serve communities' demands and encourage them to use transport types that are not imposed problems for environments like an electrical train, light train, electrical bus, and non-motorized instruments like scooter, bikes and of course, walking, this action can reduce energy utilization and increase the air quality (Jun, 2023).

On the other hand, providing community essential resources and services in proximity to transport stations and stops can establish an environment that welcomes and invites individuals to search the area This has the potential to improve the vicinity in an area that is beneficial for all age groups because the access to amenities could be solved (Yu, Cui, Liu, Luo, & Tian, 2022) also boost their social interaction and make the neighborhood integrated by green transport which is walking to enhance pedestrian accessibility and reach to (TOD) goals because one of the TOD consideration is better walking in the area. One of the fundamental objectives of Transit-Oriented Development is reinforcing the land use practicality and public transport operation efficiency within the areas that consider coordination of various transport modalities in the foundation of the built environment structure that results in sustainable mobility in urban areas. TOD as a planning approach can create linkages between individuals and land with different uses like residential, commercial areas, workplaces, and recreational zones to benefit communities that are resid in suburban and urban areas. However, the big issue is how much the area is populated this method response and works better. Furthermore, this strategy applies to a wide influence on travel manners, market value, choosing the proper location for housing, the pattern of the urban areas, and communal movements (Scheraga, 2003). It is important to point out that TOD structure can contribute to promoting urban areas to become compact and more populated with relationship to mixed-use development around transit station hubs and result in convenient accessibility for communities that live in TOD areas (Cervero et al., 2004) in contrast to this concept due to deep focus on the TOD area many people feel excluded from this development because high demand of living in an area close to transit hubs can increase the property value and this contributed to gentrification, also affordable housing which located in TOD zones cannot be efficiently used by vulnerable individuals (Thomas & Bertolini, 2020). Also, regarding other studies that when all facilities and resources are provided for specific locations such as TOD areas, some people with low-income levels also located in scattered areas may be hurt and are not able to use these resources, become socially excluded and may endure pressure to live father from welfare and their mobility only fulfill by car which leads to greenhouse gas emission (Rodier, Alemi, & Johnston, 2015). Overall, effective TOD as a positive approach not only holds components that can cater to human needs in relationship to different uses of land and transport modes align with comfortable accessibility but also maintain social well-being in terms of health, safety, and proper landscape (Yen, Mulley, Chen, & Chiou, 2024) however as result of improving property value residence may

face affordability challenges, gentrification and social displacement which can inadvertently harm vulnerable populations and bring about greater inequality and environmental challenges that may be solved by equitable planning and prioritizing existing residence main needs.

This figure is the Transit-Oriented Development concept that identifies different land uses in the vicinity of the transport station and shows the appropriate walking distance to accessibility to reach these facilities.

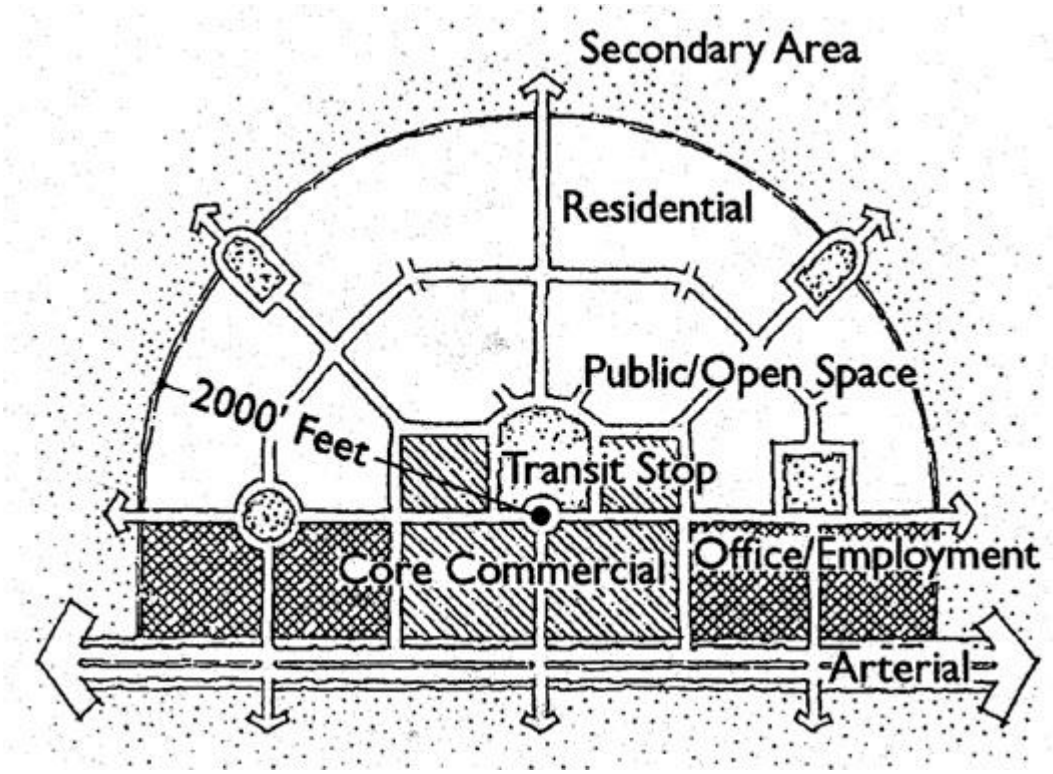


Figure 01, TOD model, Source: Calthorpe, 1993. P.56

2.3. TOD as best practice

TOD acts as the city's backbone because it has the ability to promote and create sustainable cities. The functional aim of the TOD approach is to make the built environment and transport perfectly integrated and connected. It also focuses on improving urban mobility near stations by providing walkable spaces and directly positioning primary needs and services to meet humans. Many countries around the globe use this method as a positive and doable structure, and many challenges emerged due to the complex interrelations between different terms, which influenced the successful implementation. This section analyzes TOD projects to understand if the structure is successful or performs better than mentioned, which factors and criteria play significant roles in the TOD success, and various obstacles that must be addressed to achieve urban development and equal community.

This table determines the TOD strategy across different concepts and case studies and analyzes articles to evaluate whether TOD serves as the best practice and in which contexts. It also investigates whether the success of TOD depends on certain key factors.

Articles	TOD as best practice	Successful TOD depends on
(Ibraeva et al., 2020)	TOD is generally considered a good practice because it promotes sustainability, decreases car dependency, and effectively integrates land-use and transport planning.	The thriving of Tod depends on several factors, including socioeconomic conditions, urban form, and policy implementation. While this approach is promising, its effectiveness varies depending on execution.
(Yen et al., 2024)	TOD, as an urban planning approach, concentrates on urban mobility, specifically green modes of transport such as walking and cycling. It mentioned that TOD can be reached by appropriate walking infrastructure and pedestrian experience, planned built environment and existence, and improving multiple modes of transportation that are practically integrated into the city structure.	This article explains that successful TOD relies on three urban dimensions: dense and populated areas, diverse and mixed-use neighborhoods, perfect urban settlement plans, and transportation design. By prioritizing pedestrian walking areas as central elements of active and green transportation, bike use, and stakeholders' intervention, proper TOD can be achieved.

(Knowles, 2012)	In the case study of Copenhagen, Denmark, the strategy has been a best practice since 1947 as a finger plan model to enhance urban expansion in the proximity of rail stations. This method proved that the best TOD, by cooperating with the metro line, can improve economic growth in the residential and commercial areas.	The primary TOD requirements in urban areas are accessibility to public transportation, compact urban areas, well-planned land use, and a proper strategy between modal shifts. Also, the interaction of metro lines in TOD areas helps to cover areas with various developments and green transport planning.
(Hrelja et al., 2022)	The Swedish concept of TOD is promising, but there are helpful and challenging circumstances. Achieving TOD has two dimensions: success in Stockholm and Malmö due to the well-integrated situation and difficulty gaining success in locations characterized by low density, inadequate policies, and stakeholder disagreements.	To create successful TOD in suburban and semi-rural areas, there are essential needs to be set by government policies regarding high-quality transportation and regional planning. Also, the collaboration of the stakeholders is beneficial because transportation implementation depends on elements like location, density, and transportation infrastructure. It is very critical to consider market demand, too.
(Jacobson & Forsyth, 2008)	TOD is the best practice in these seven USA cities because it emphasizes proper urban design to foster public transportation and integration with walking. The appropriate implementation of TOD results in well-designed urban areas, placemaking, and development processes.	Effective TODs prioritize walkability, transit accessibility, and vibrant urban spaces. TOD's success depends on urban density, pedestrian-friendly infrastructure, mixed land-use development, community engagement, governance, and economic policies.
(Martha & Handayeni, 2014)	TOD addresses the most important factors: reducing greenhouse gas emissions, reducing vehicle travel kilometers, and improving air quality. It positively merges the built environment with the transport system, resulting in successful urban development and improved transit usage.	In this case study, successful TOD depends on regional planning, functional governance, and the supportiveness of institutions to ensure its implementation. Additionally, mixed-use advancement in the proximity of the Transit station, pedestrian- and bicycle-friendly infrastructure, and supportive policies
(Singh et al., 2017)	In the case of the Netherlands (Arnhem-Nijmegen City), 21 train stations were accessed, which is proof that TOD is the best practice in this concept. By creating a perfectly combined public transition with land use and motivating the community to use it, car dependency decreased, and walking as a means of active mobility was promoted.	Some aspects are the main criteria for successful TOD. In this case, compact and diverse land use, proper spaces for walking and cycling, the capacity for economic development, parking facilities, accessibility to transport hubs, User Friendliness, and the potential for transit utilization are the most important factors that resulted in TOD's success.

(Berawi et al., 2020)	This study focused on the 4 TOD projects in Jakarta, Indonesia; it explores the integration of land use to maximize transit ridership. This is an appropriate TOD approach because of the amount of ridership. As a result, traffic congestion was reduced remarkably, and the urban areas' framework experienced an improvement in sustainability.	This case study identifies some factors that affect functional TOD. Obviously, diversity in land use and density plays an important role in TOD's success, but inclusive community accessibility is individuals' primary need. Also, an emphasis on the best TOD design can impact economic feasibility.
(Hardi & Maatouk, 2023)	This article investigates the concept in California, the USA, China (Shijiazhuang, Guangzhou, and Shenzhen), Qatar, and Indonesia (Jakarta & Jabodetabek Region - Bogor, Depok, Tangerang, Bekasi), which contributes to sustainable, accessible, and efficient urban development. Moreover, in this case study, TOD can merge transportation and land use to create efficient, livable, and environmentally friendly cities. The results illustrated that TOD reduced transportation costs and increased transit ridership, congestion in urban centers decreased significantly, and TOD strategies improved pedestrian-friendly environments. Additionally, the connectivity between suburban and urban regions increased, too. In doing so, TOD promotes social interaction through well-designed public spaces, encourages inclusive urban development, and ensures access for all. Reduces socioeconomic disparities by providing affordable mobility options and cater better infrastructure in non-motorized mobility means like walking and cycling. TOD increases property values and attracts business investments. Also, many job opportunities are created, and local economies face development, while TOD supports real estate growth around transit hubs.	This case study shows a successful TOD strategy embedded in regional planning and urban design. At the macro level, the best TOD depends on strategically locating TOD in dense, populated areas to support land use policies. Also, to have an efficient TOD area, providing access to all transportation modes like metro, BRT, and commuter rail is essential. This action can ensure good connections in urban spaces. The best local level today can be achieved by mixed-use developments, pedestrian-friendly infrastructure, and well-designed road networks that encourage public transit use over private vehicles. Case studies from California, China, Qatar, and Indonesia highlight the importance of balancing policy, transport integration, appropriate planning in land use, and designing urban areas to create sustainable and efficient urban environments.

(Carlton, 2009)	It is considered the best practice in urban planning because it supports environmental sustainability, reduces congestion, and fosters vibrant and mixed-income neighborhoods. This approach was examined in Laguna West (Sacramento, CA), the first project to emphasize increasing the capacity for economic growth in proximity to transit hubs. With regard to these benefits, it can promote walking and make a livable community.	In this case, successful TOD implementation depends on strong planning policies that create opportunities to meet people and market demand; achieving practical TOD depends on how much public-private collaborates to offer better situations and also by focusing on appropriate infrastructure investment, most importantly walking it can motivate the community to be more active and healthy and in overall the local societies which armed by best TOD become a green hub for individuals.

Table 01, TOD concept in different countries, Source: Elaborated by Author

2.*4.* Transit-Oriented Development *Principals*

To make an immense shift in individuals' travel behavior, TOD is capable of motivating people to use public transportation more instead of relying on their private cars for daily needs. At the same time, in many studies, it is seen that the TOD strategy could improve air quality within the specific zone, and traffic congestion dropped as a result of this action. also, most importantly, another outcome of the best TOD practice is economic advancement at the local level, which leads to community engagement and sustainable development in urban areas. TOD principles are the primary characteristics in an urban framework that need to be considered to transform areas toward inclusive communities; these factors are high-density and populated urban areas, affordable and cost-effective land use, especially housing, public spaces, and proper infrastructure to encourage non-motorized mobility such as walking and cycling, various modes of public transportation, accessible and reachable public green areas and open space which leads to enhance social interaction .regarding to these principals Calthorpe (1993) has introduced seven primary TOD principles that considered human demands in the urban fabric these tenets are:

1-In the regional level, a compact urban environment and transit support must be maintained.

2- It is crucial to design and plan housing, commercials, workplaces, and parks for civic use in the vicinity of transit stops, which are accessible by walking.

3-Pedestrian-friendly networks in streets should be directly connected by local destinations.

4-Land use must contain a mix of housing with different types, costs, and densities for the community.

5-Preserving specific habitats, reach and high-quality open spaces, and the riparian zone is essential in TOD areas.

6-Public open spaces are required to be located in accessible connection by buildings and daily movement in the neighborhood.

7-In existing neighborhoods of the TOD areas, redevelopment and advancement can emerge within transit corridors.

2.5. Advantages and disadvantages of the TOD Principals

TOD policies and frameworks have proved beneficial and helpful in improving health care, the environment, the economy, and society (Higgins & Kanaroglou, 2016). It is claimed that Transit-Oriented areas can produce less air pollution (Loo et al.,2017). Walking and cycling as green modes of movement are economically worthwhile and less costly than using public transportation for communities (Victoria Transportation Policy Institute, 2010). TOD is an advantageous approach consisting of flexible modes of transportation; it can boost public safety due to the more activity in neighborhoods, the decrease in energy consumption, and the practical adaptation to the environment. Moreover, one of the valuable consequences of TOD is affordable transportation and housing preference for people, providing efficient transportation services with various modes that lead to better air quality. Regarding the social aspect, TOD showed that due to economic development, the community is more integrated into the urban fabric, and social homogeneity is ideally determined, resulting in a healthier society, and people are more willing to connect with others to improve their sense of inclusion. Development and accessibility to services and resources because of the TOD make the local communities more alive (Li J.,2018; Cervero et al., 2004; Hess & Lombardi, 2004). TOD tends to enhance a sense of community, which produces social benefits.

TOD is one of the most important models of urban development, a situation with a majority of sustainable goals that try to address the needs of current and future generations through met environmental protection, social advancement, and economic wealth fare in human life (World Commission on Environment and Development, 1987; Payda et al., 2017). By establishing a well-connected network and providing easily accessible areas in the proximity of the station, public transit usage was optimized (Medved, 2016).

It is worth mentioning that while the TOD approach has many positive results, there are a set of drawbacks that need to be pointed out. It is not practical to put priority on the physical design regardless of paying attention to the demands of civic society. In the United States, TOD is criticized due to the increasing population density in those areas, which is higher than people can tolerate (Gilat & Sussman, 2003). Some studies pointed out that most TOD projects are planned for new suburban or greenfield sites, which may lead to population reduction and less development in inner cities. Also, more stress in station surroundings might create a situation where these areas are separated because all accessibility and resources are in proximity to the stations, and people who live far behind these areas feel excluded. Due to the focus on the neighborhood, most of the development and construction have emerged in these spaces because investments in these TOD zones are less likely to bring risks and disadvantages for investors.

2.6. Pedestrian Isochrones and Service Areas: Relationship with TOD Areas

The concept of the pedestrian isochrones and service area is the main focus of the TOD area in this thesis that provides efficient insights toward accessibility and walking in the urban area. Pedestrian isochrons are significant in improving urban mobility because they represent a specific time and distance from transport stations within their surroundings to facilitate and evaluate access to services and other amenities for individuals. This method provides a comprehensive structure about walking a person in an area and how components of the TOD areas are connected to each other. From different research, the performance of the pedestrian isochrons depends on how much the area is proper for walking by considering the availability and easy access to pedestrian facilities like zebra crossing and sidewalks (Irawan & Mulyono, 2023) as walking speed which is different for any person, high quality walking infrastructure like a pathway, another important point is an

urban design that illustrated how streets are connected and areas are suitable for walking and the size of the blocks. The framework of the pedestrian isochrons is outlined areas accessible, designed typically ranging from 5 to 10 or 15 minutes of walking which is the feasible time for all age groups also it should be mentioned that all required infrastructure must meet the needs of all pedestrians specifically the ones with disability this important issue should be considered to create inclusive urban areas (Inderadi, Widayati, Priyomarsono, & Hendra, 2022). This approach can be demonstrated via Geographic Information System (GIS) to clearly analyze and show these walking areas which are pivotal terms in TOD areas because it can identify which urban habitants have comfortable access on foot to use public transport. Another consideration of this thesis in TOD areas is the service area which is 800 meters from transport stations to neighborhoods close distance and this measure is used in many studies as a vital metric in TOD planning, which is widely recognized as a 10-minute walking distance (Bejleri, Steiner, Fischman, & Schmucker, 2011). The 800-meter service area plays an important role in the Transit-Oriented Development structure because it is considerably categorized areas that are reachable on foot and provide a framework for the community if they have easy access to public transport then they use it otherwise this community relies on other means of transportation. The 800-meter service area which is equal to 10 minutes walking distance to reach to the station or from stations (Lukman & Singh, 2014) is a feasible walking distance that may change because of the transportation tape, Routh characteristics, and also personal properties (El-Geneidy, Tétreault, & Surprenant-Legault, 2010). This amount of walking distance is a common measure that is used as a standard in many studies, but it is crucial that the real walking time can vary due to some factors like climate, urban design, street layout, cultural attributes, human behavior, and environmental obstacles. Urban planners always use this structure in Transit-Oriented Development to find the best walking coverage to improve accessibility to public transportation and plan better strategies to address the community's demands and make urban areas and transportation more sustainable.

2.7. Multi-Criteria Decision Making (MCDM) and Its Role in TOD

One of the key aspects of this thesis is Multi-Criteria Decision Making (MCDM) which is a fundamental skeleton regarding improving areas to become more human-centered specifically in Transit-Oriented Development (TOD) areas. By serving as a systematic method for appraising and

deeply focused on prioritizing station areas, MCDM combined technical analysis with the social and cultural structure of the city. This method can help planners balance different needs, also ensuring that TOD areas give profit to communities by pointing to how the area is accessible, how much is sustainable, and trying to make a connection with the city's framework.

2.7.1. Application in the Case Study:

In this case study, one of the practical methods of the Multi-Criteria Decision Making (MCDM) used was the Weighted Scoring Model (WSM). This method was utilized to evaluate and analyze stations by 11 Transit -Transit-oriented development characteristics which are core points of the TOD areas to understand their performance. This approach has two types of categories, the first group is stations that have lower scores which are identified as location that needs immediate improvement in TOD factors, these station offers an opportunity to foster their functionality, and the second group that has higher scores is defined as locations with suitable TOD factors. These characteristics make the area better and try to create an area with good integration between the social and urban fabric.

2.8. Accessibility of Educational Centers in Transit-Oriented Development Areas:

Transit-oriented development (TOD) is known as a practical urban planning tactic that has the objective of improving sustainability and creating a human-centered urban environment. This concept is based on accessibility that focuses on the community demands and design and crate area align with these needs and the key aspect of this strategy is prioritizing walking as the main means of mobility in the cities to connect and integrate land use and transport system. One of the key services in cities is educational centers that offer all types of education and accessibility and availability of educational areas within TOD areas is crucial because families prefer to live in an area that is located in proximity to schools and accessibility to this destination must be possible by transportation or most importantly by walking. The TOD area is required to be safe and path and also distance needs to be comfortable because the journey from school to home is a significant part of the education experience and only access to schools is not the aim. The TOD framework should

consider the demands of families and include access to high-quality schools, to promote equitable development (Green, 2017). In many Transit-Oriented Development contexts, pedestrian accessibility is evaluated. In this thesis access to educational centers highlights the important role in forming inclusive and livable spaces and TOD has the ability to expand educational opportunities by making connections and linking between families, schools, and the public transit system (Bierbaum, Vincent, & McKoy, 2010). One of the achievements of accessibility of education centers in TOD areas is, that it can shape social communication and schools can serve as hubs for families and communities to interact and develop their social lives also engaging the transport system with schools and individuals may bring about a powerful socialize, improvement in local business and attract the community to participate in different plans and in overall leads to integrated and inclusive urban areas that create equality in an urban environment for all. Furthermore, by reducing the usage of private vehicles as a means of travel and movement in the cities to reach the transit hubs, many people can benefit from a healthier living environment and empower their physical activities. Educational centers must be located or established in Pedestrian -based TOD design the areas which perfectly proper and feasible for walking because TOD can provide easy access to schools for students and families and also boost the safety and quality of the environment for everyone, this approach ensures urban areas vibrant and equitable and make community resilience, where educational centers play an effective role in bringing development in an urban environment.

2.9. The accessibility to Green and Grey areas within the TOD area

In Transit-Oriented Development (TOD) areas accessibility to natural spaces as green areas which constitute all types of vegetation like parks and gardens is the remarkable aspect that should be considered in designing urban environments because it has direct effects on human daily life and experience. These areas are significant for improving sustainable, walkable communities that lead to boos residence well-being. Green spaces include public and private areas which means access to public green spaces is possible for everyone, but private green areas are only for specific users. Having a connection with green space has shown that these areas have positive impacts on individuals' health, and it can reduce the amount of stress and empower mental wellness (Ekkel & de Vries, 2017). Additionally, green spaces can strengthen social bonds, by creating opportunities

for people in the TOD area to contact and build community cohesion (Rahman & Zhang, 2018). Existing green spaces in TOD areas can maximize their importance because by designing areas like inviting places, the community is willing to make social interconnection, and this inclusive situation increases the sense of belonging (Rasidi, Jamirsah, & Said, 2018). The accessibility between public transportation and natural environments like green areas plays an effective role in their successful integration and it's a cost-effective approach to link people with these areas (Chen, & Chang, 2015). When it comes to the proximity of green spaces it is very important to locate these areas within a five-minute walk from neighborhood centers because green areas are frequently used and should be well-embedded by the residential areas and humans' daily life (Kemec & Abdalkarim, 2023). By sitting green spaces near transit hubs in TOD areas and along pedestrian pathways, natural areas can be accessible and be part of urban living also green spaces like parks and gardens are able to support health and social well-being. Moreover, these areas can contribute to maintaining biodiversity and creating a harmonious balance between urban development and the natural environment.

The context of grey areas is defined as residential spaces in this thesis, human settlements mean areas exclusively designed for individual habitation, such as homes, shelters, and apartments, and with entrances to urban areas. Transit-Oriented Development (TOD) aims to organize and merge land use with transportation systems with respect to sustainability to make urban areas livable and harmonized. The concept of the TOD areas must be compact and walkable, which persuades the community to reduce car usage and improve their activity. This method can reshape the urban experience. From previous studies, it is explained that how much residential is close to rail stations the car ownership may reduce, elements such as parking availability and dwelling types are the main critical aspects that influence the residential choice of living and travel behavior (Chatman, 2013). Residential areas access means individuals have comfortable access to transportation on foot, services, amenities, and daily needs which can be located in the vicinity of the transport hubs, these factors are the key elements in TOD areas. This design can promote sustainable areas proper for living and community demands can be met easily without reliance on cars (Borgers et al., 2008). There are many factors that have significant effects on household patterns and human activity, the configuration of the residential areas depends on community requirements, and their social and economic level also their daily routine and movement are important when people choose where to live (Zondag & Pieters, 2005). In TOD spaces there is well connection must exist between

transport facilities like rail stations, bus stops, and commercial spaces to ensure the community can easily access and flow among different functions. This interaction provides the ability for individuals to walk or use other types of public transportation to go to work or other essential destinations and contributes to reducing the amount of car usage and overall can foster convenience and accessibility (Purwantiasning & Kurniawan, 2017).TOD areas with higher TOD characteristics have shown that appropriate access between public transport and facilities results in improving property value (Arliani et al., 2024) also residential areas and household framework must be designed with consideration the equal access to public and private spaces because privacy and access must be maintained in urban areas (Abadi & Nugraha, 2020). Designing the TOD environment By prioritizing pedestrians and cyclists with a focus on the well-maintained pathway and comfortable and equal access to public transport many individuals are more likely to prefer to settle in these areas because it allows them to freely, safely, and sustainably move in various spaces without any limitation and ensuring communities are inclusive and it can foster the quality of life and but regarding some argues emphasis on TOD is not the best solution because it focuses on the needs of residence without dependence on automobiles the accessibility challenges are for the people who live far from transit node and balancing this issue is the most important for urban planning.

2.10. Role of Population Density in TOD Areas

The concept of Transit-Oriented Development is based on the area that is densely populated which is vital to serve a sustainable, human-centered urban environment. With attention to this issue that the population must be located in proximity to a transit station, TOD not only can consider the people's need to access public transportation but also the amount of auto reliance decreased. It is obvious that by considering the need for transportation in cities, a mobility system can promote a sustainable environment and enhance the efficiency and availability of urban transport networks. Many people prefer to migrate regarding to poor access to resources and services and due to this action effective resource management must be applied in urban areas to meet the demand of the community and also reduce environmental degradation. By higher portion of the population in urban spaces leads to encouraging efficient land use, reshaping urban landscape into compact and dense areas like residential, commercial, and recreational are equally embedded with each other.

With sufficient accessibility to transport hubs reaching neighborhoods that have low density is possible and this action replaces long commutes with convenient transportation modes in fragmented urban spaces. TOD is committed to sustainable urban planning due to the emphasis on density and prioritizing inclusivity, and cohesion in the urban areas which have poor access to land resources. Population density plays an important role in transforming urban areas to become vibrant and socially integrated, A neighborhood which characterized by compact and proper walking areas has the best potential for attracting the population that is mass necessary to sustain and maintain local businesses, cultural events, and community gathering in public spaces. This aims to foster social interaction and a sense of belonging. This liveliness is not the only result of physical proximity but also is the reflection of TOD's capacity to mix various elements in urban areas with the aim of establishing an environment that can be functional and inspiring. Having a practical relationship between population density and the transport system creates and powerful cycle for better function of the TOD. The high number of populations in the area can provide a mass use of the transport system and create a steady ridership trend. Also, more movement due to populated areas in TOD can improve walking and foster active mobility. These activities make the neighborhood feel alive, enhance economic sustainability, and may result in better management and controlling the service quality. As a result of this focus people who live a bit far from development are the potential population to address their demands regarding access to a proper walking area, access to public transport to improve the sense of included and equity otherwise lack services and high needs of the population with shortage in connection with developments hubs make them feel deprived and vulnerable.

CHAPTER THREE: METHODOLOGY

3.1. TOD as Research Framework

This research is specifically designed to explore the accessibility of land use, with a primary focus on educational institutions, in order to pinpoint areas that fall outside the reach of a 5- to 10-minute walk or are beyond the typical 400 to 800-meter distance from transit stations. Previous studies emphasize the importance of educational accessibility as a key indicator for evaluating fair and inclusive urban development (Ogryzek, Podawca, & Cienciała, 2022).

In this case study to assess and evaluate the areas in proximity to stations which are known as TOD areas, 11 key characteristics of Transit-Oriented Development (TOD) were introduced. These factors consist of land use, distance, density, diversity, design, accessibility, safety to public spaces, placemaking, and economic criteria that are vital for TOD areas. This study's main and strategic focus is accessibility to educational centers because it is a crucial aspect of urban environments. The second element is walkability in urban areas, and this thesis contributes to a wide conversation about sustainable urban planning. By using TOD principles also contributed to Multi-Criteria Decision Making, specifically weighted score modeling (WSM) and GIS-based spatial analysis, this thesis aims to provide a comprehensive understanding of the issue of how accessibility and active modes of transportation can provide equal, sustainable, and human-centered urban areas. This thesis utilizes the WSM method to understand how much environmental attributes, education proximity, landscape design, urban form, population, and accessibility to land use green and grey areas, and some other factors are important for selecting case study stations. This approach is a part of the MCDM framework and provides a situation to assign weight to each character due to how effective these factors are and align in TOD areas. This assessment enables the thesis to investigate the importance of each criterion and compare stations with a focus on their final result to meet the objectives of the thesis.

Additionally, this methodology tries to examine the accessibility in a case study by creating an 800-meter buffer zone from the station to its surroundings because this radius is commonly used in many studies as pedestrian-friendly zones, also in the analysis of accessibility there is a specific focus on the green areas which defined as all types of green spaces and the grey area that refers to residential areas. It is clear that land use has different typologies with diverse functions. This classification is important to determine spatial patterns and find connections between various applications, this action informs urban planners to make proper decisions. Regarding to this topic

one of the initial needs of the community in urban areas is residential settlements that offer safe places for humans to spend their time, these areas must be located in proximity to transport stations to reduce travel time for workers and be reachable for students. Due to these reasons thesis focused on this subject and as a matter of fact, this topic is special in the Demark and Copenhagen Metropolitan Areas because urban form and structure in some places have low density and population, and urban environments are scattered too. This issue is the key topic for applying TOD. Another significant subject in this thesis is accessibility to green areas because in urban areas there must be a balance between grey and green areas and humans need to access both these areas equally. the central point of this study is to focus on the role of active transportation in addressing accessibility to the "gray-green divide," a concept that came from research about the contrast between built environments which are defined as grey and green areas referring to all types of vegetation (Corbane et al., 2020). This divide is very important to evaluate the sustainability in urban areas and catering a balance between both spaces can create equitable and sustainable urban growth.

The community must live in an area that is located in the vicinity of transportation because exiting TOD areas that provide the best environment for walking can welcome residents to walk more and improve their physical activity also by appropriate public transportation people in far areas are willing to use public transportation rather than using private car. Accessibility in TOD areas is a fundamental aspect and most importantly equal access to grey and green areas and educational centers is the best solution for urban development, less access to green areas brings about mental and physical consequences, and due to low population people feel excluded from society. There is an issue regarding areas that are far from TOD advancement and this situation impacts the people they may feel deprived and segregated due to the poor access to these areas, also families with children are less likely to prefer to live in these zones because of the proper school deficiency, local business and economical situations are not well functioned and shortage of job opportunities may leads to partial immigration and land values decrease due to the development abandoned. In the framework of the city, it is a human right to have access to these services and resources and if the situation is not going to change social justice does not exist and there is an immediate need to improve the urban areas and provide community demands and create sustainable, equitable, inclusive urban spaces for everyone.

3.2. Research Design and Process

This part explains the structure of the thesis which involves selecting a case study, collecting data and information about the framework, following how analysis and assessment are fulfilled, and in the last part what the result of the calculation and discussing it. This process is finished with the conclusion to understand and define what the aim of this study is.

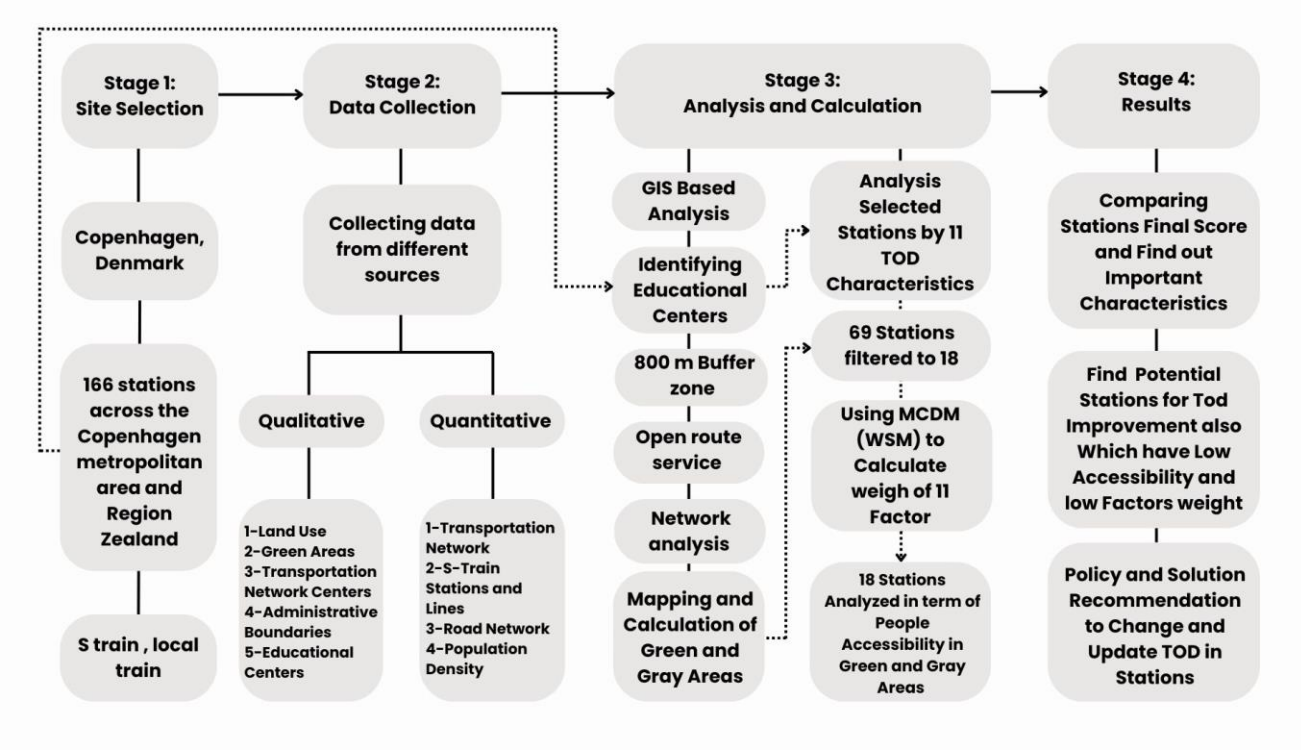


Figure 02, Methodology process, Source: Elaborated by Author

3.3. Data collection

This thesis is based on various data and information that were collected and used in a way to text and analyze accessibility in two concepts: 1- accessibility to educational centers, 2- accessibility to grey and green with integration of transportation within Denmark with a focus on promoting urban sustainability. As a result of limited access to the open-source GIS data in Denmark, some platforms were used to produce and collect specific datasets that contribute to the creation of relationships among urban spaces (grey and green), transportation, and community wellness.

- **Land Use Data:** Land use data is important to identify and understand urban fabric. This data is provided by Rejseplanen, a website with GIS data sources and information about transportation and urban planning.
- **Green Area Data:** The green area dataset was collected from GEUS website (Geological Survey of Denmark and Greenland); this data illustrates the available green spaces on the map.
- **Network and Public Transportation Data:** From Geofabrik, the data about transportation gathered, these data are the key resources about transit systems and movement patterns.
- **S-train Stations and Road Networks:** The source of this data is the Technical University of Denmark (DTU), which offers proper information about s-train stations, road networks, and transportation framework to this thesis**.**
- **Population Data:** Demographic data obtained from WorldPop, to investigate population distribution within Denmark. This data consists of valuable information about population trends.
- **Administrative Boundaries:** Information about planning and urban governance has been taken from iGISMap, this data provides insights about administrative division and boundaries in Denmark.
- **Educational Centers Identification:** To identify and access the accessibility of educational centers near transit system data gathered from OpenStreetMap, Google Earth, and QGIS, to facilitate the process and analyze and map within the urban context in the GIS platform.

In this thesis, two types of data were used, 1- qualitative data that consists of land frameworks and educational attributes sourced from Rejseplanen, OpenStreetMap, Google Earth, and QGIS. This information provides insight and a clear structure of urban landsacape. In the contrary 2- quantitative data contains details about green spaces from GEUS, population density from WorldPop, transportation information, and road network data provided by the Technical University

of Denmark (DTU)with consideration of measurable figures to make the analysis correct. With the combination of this data and information, there is potential to uncover improvement in urban environment and advancement.

Data Category	Data Source	Qualitative data	Quantitative data
Land Use	Rejseplanen	*	
Green Areas	GEUS	*	
Transportation Network	Geofabrik	*	*
S-Train Stations and Lines	Technical University of Denmark (DTU)		*
Road Network	Technical University of Denmark (DTU)		*
Population Density	WorldPop		*
Administrative Boundaries	iGISMap	*	
Educational Centers	OpenStreetMap, Google Earth, QGIS	*	

Table 02, Collected data from different sources, Source: Elaborated by Author

3.4. TOD as Technical Strategy

Transit-Oriented Development (TOD) is a valuable urban method that offers a new strategy to merge the transport system with land use and integrate this concept to obtain sustainable development in urban areas (Chachondia & Shukla, 2022). This strategy is structured to design urban spaces where public transportation is in proximity to neighborhoods to prioritize walking

and cycling and decrease the need for using private cars. In this research, the most significant attention is to walking as a basic means of active transportation in TOD areas to attract individuals' attention which tends to rely on public transportation and walking and persuade them to drive less compared with those who live far away from transit centers (Noland & DiPetrillo, 2015). In this situation, walking plays a vital role in promoting sustainability within TOD strategies. However (TOD) is a practical urban planning approach that can be used to analyze and optimize land use in close distance to transit infrastructure, this method has the ability to promote sustainability and design inclusive urban development. The core elements of Transit-Oriented Development emphasize a pedestrian-friendly environment that transforms the areas into convenient and comfortable urban spaces in the vicinity of transit stations. This approach strengthens the connection between transit stations and the land used in its surroundings and not only boosts accessibility but also reinforces the usage of public transport and overall supports a sustainable lifestyle. In this thesis, the main focus is on the accessibility to land use specifically educational areas within TOD areas also, in particular, pay attention to the connection between grey and green areas through proper walking .walking as an active transport mode is pivotal in this TOD project and it aims to make less the car reliance and improve urban efficiency and sustainability by pointing to movement on foot to change human lives towards healthy and active situation. It should be noted that having easy access to educational centers, also living in an area with a balance of grey and green spaces led to a better life because other studies proved that when people are in direct connection with green spaces they feel more alive because they are more likely to communicate by others and foster their social life also by walking to schools and transit hubs can be benefited from social inclusion and easy access to residential areas reduce their tiredness.

3.4.1. Methodology steps:

This diagram shows the steps of the methodology which is used to provide comprehensive analysis and calculation about accessibility to educational areas and grey and green areas within TOD areas. By using Geographic Information System (GIS) tools are used to identify educational centers and then fulfill service areas and as network analysis, through 11 Transit-Oriented Development (TOD) characteristics, the case study evaluated reachability to educational centers as the special factor to limit selected stations this approach is the part of Multi-Criteria Decision Making to prioritized

important factors in TOD areas regard to this steps analysis were done and final site selection concerning TOD factor scores accessed to understand which stations are the potential location for TOD improvement.

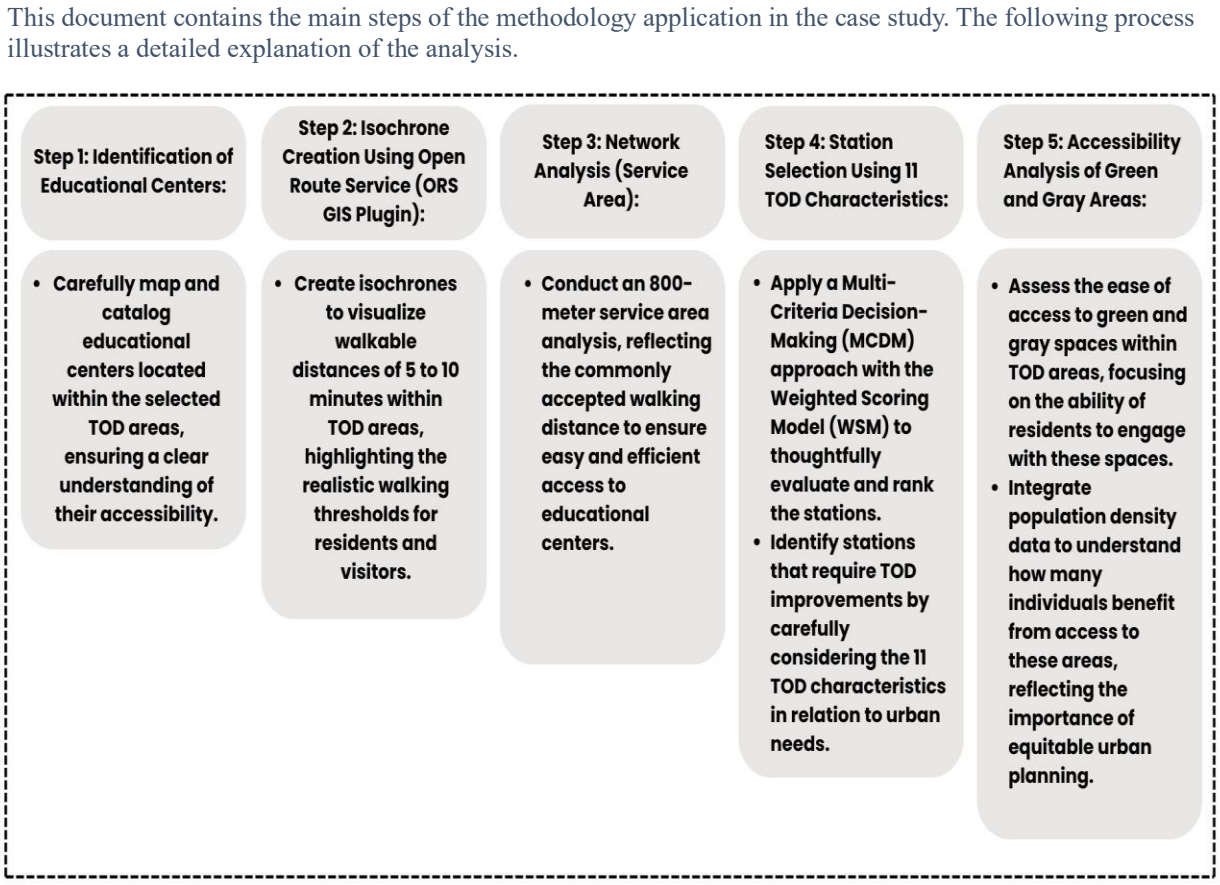


Figure 03, Methodology steps, Source: Elaborated by Author

3.5 Identifying Educational Centers Near Selected Stations

The first step of the methodology application in the case study is determining the educational center, due to the fact this GIS data was not available, and these steps were fulfilled manually in the GIS platform. This educational center data includes kindergarten, preschool, elementary schools, high schools, universities as well as some academic institutions. This detailed data is provided by OpenStreetMap, Google Earth, and GIS to illustrate the exact location of these areas. By this method, these school polygons support both visual and analytical demands and allow for a better understanding of the spatial distribution of these areas within the case study. Following this step, network analysis was conducted to assess the accessibility of the region along the station surrounding with a specific focus on the 800-meter buffer zone. These analyses were done to determine paths for pedestrian-friendly structures around stations and show their connectivity regarding educational areas. This step effectively displays the importance of walkability in urban areas, which is an essential element in improving accessible and sustainable urban development.

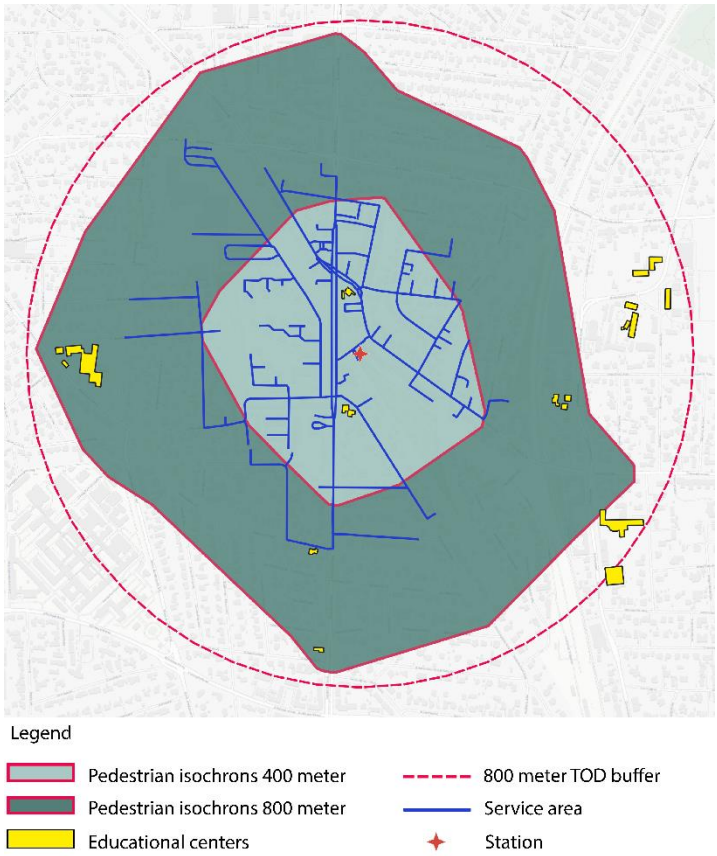


Figure 04, Case study sample of analysis, Source: Elaborated by Author

3.6 Creating Pedestrian Isochrones:

At this point in the thesis, pedestrian accessibility is designed and evaluated. This analysis is done by the Open Route Service tool which is the GIS plugin to identify how much of the area in proximity of the station is reachable on foot within specific time intervals from 5 to 10 minutes this time is considered as appropriate walking time in many studies (Bencekri, Lee, Ku, & Lee, 2024). Regarding this to determine the available walking path in the case study network analysis of the service area was done to evaluate 400 to 800 meters of the area as a practical walking threshold in urban framework especially when it comes to accessibility in schools because it can determine the area influence active mobility (Chica-Olmo, Rodríguez-López, & Chillón, 2018). It should be mentioned that however, this transit buffer with active commuting border instantiated in the case study but it may not be accurately achieved to true walking route that individuals pass to reach the transit stops (El-Geneidy, Tétreault, & Surprenant-Legault, 2014). Walking in the areas depends on path characteristics, climate, station, and landscape criteria, and human factors like age, gender, and abilities, and due to these factors walking time may take more or less time. By considering both time-based and distance-based analysis, the thesis tries to examine commuting based on active travel mode, in this case, particularly walking, to find out the pedestrian accessibility and its effective role in connecting educational centers with transportation hubs within TOD areas. This analysis can identify the walking gaps in the case study that is illustrated here as an example to show how much is important to have an accessible area on foot.

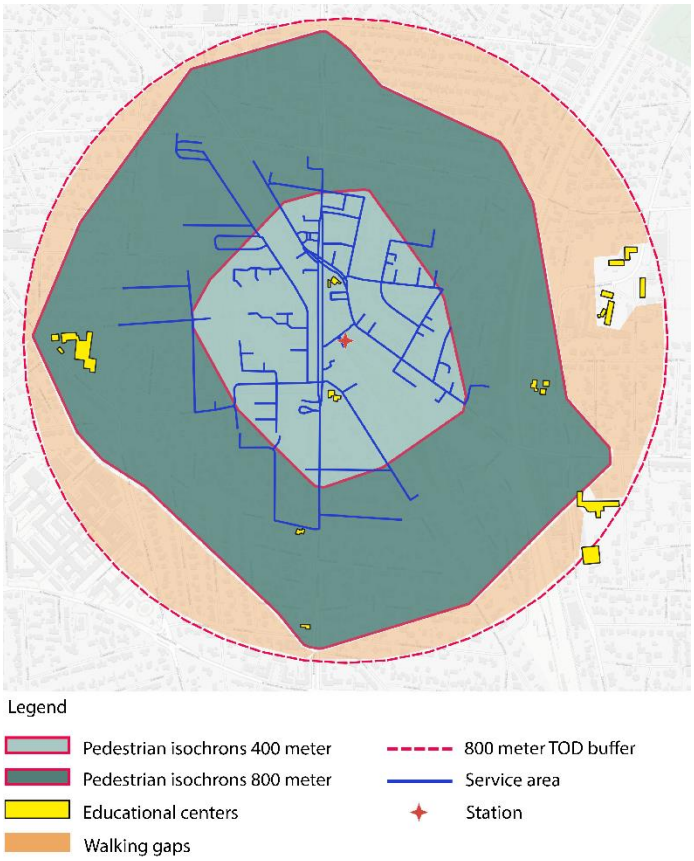


Figure 05, Sample of walking gaps in TOD buffer,

Source: Elaborated by Author

3.7. Analyzing Case Study Stations with Transit-Oriented Characteristics

This part of the thesis focused on providing a comprehensive analysis of the case study station based on considering 11 key TOD characteristics. These criteria were collected precisely as a structure to evaluate stations and assess their effectiveness regarding sustainable transit-oriented development by pointing to internal land use and transport systems. These factors are significant in investigating the station's performance and provide valuable information to find out which factor is effective in improving TOD areas.

3.7.1. Characteristics definition:

a) Land use: Reachable Educational Centers

Land is a valuable part of urban areas that plays a crucial in human life because it is a place where people can reside and contains a variety of functions and activities such as residential, commercial, agricultural, recreational, and educational purposes. This framework organizes land to meet human demands while balancing urban development and preserving natural environments. Educational centers, which include elementary schools, preschools, kindergartens, high schools, colleges, and universities, are calcified under institutional land use. These areas can offer educational and community services, contribute to the urban fabric's social and cultural structure, and are the most important element in the urbanization process. To create accessible and equitable and inclusive urban areas, it is very effective to combine urban areas with educational centers to improve development in the urban environment. Transit-oriented development principles emphasize family-friendly policies and providing high-quality education to improve cohesion and connection in urban neighborhoods, which leads to a sustainable urban environment in the long term (Vincent, Rollock, Ball, & Gillborn, 2012).

b) Land use: Not Reachable Educational Centers

Accessibility to educational centers in buffer zones that surround the transport stations is an effective element in urban development and public transportation usage because when schools located far from buffer zones bring challenges like long walking time, car dependency increment,

boring community for children, and in some cases limited access to proper transportation. This factor can debilitate the comfortability and affordability established by the foundation of TOD which TOD tries to foster it. When schools are in the vicinity of the transit station and access to this destination is feasible on foot the quality of life of urban residents may fostered. When considering educational centers in urban areas, it is valid to analyze neighborhoods, cater buffers around transit stations, and locate schools in these buffer zones to enhance accessibility for communities.

c) Design: Transit Accessibility

It is very important in urban spaces to be directly connected with transportation. Transport hubs that include rail stations, bus terminals, and commuter lines cooperate with each other to facilitate urban movement and integrate residential and commercial space within the urban environment. This practical combination can increase accessibility and connect the community with transport infrastructure that leads to developed and uniform urban areas (Purwantiasning & Bahri, 2019). With effective design, transit systems will not only be easily accessible for all but also it is able to invite community members, whether approached by walking, bicycle, or even car. To design an urban space close to transit hubs there are key elements that must be considered like clear signage, pedestrian-friendly paths, crossways, lights, also essential facilities that should be set in station proximity to meet human needs and simplify the navigation and access from urban areas to transportation stations. Integrating transit stations within the urban fabric and perfectly planned urban areas become the focal point in cities that can be used to gather community and make travel and movement in cities easy and accessible also reduces car usage and changes urban areas toward sustainability which interconnects individuals.

d) Density: Mixed-use Development

The main characteristics of Transit-Oriented Development are high-density and multi-functional development in TOD areas combined with residential and commercial areas within public transportation stations. This concept can be practical when access to these services becomes comfortable by walking. Having said that transit hubs such as rail or bus stations that are located

close to major activity centers like shopping malls and offices are the most important components of the best Transit-Oriented Development (TOD) (Bajracharya, Khan, & Longland, 2005). The integration of urban life with working, leisure, education, and health align with population leads to short travel time, feasible active commute, and accessibility increments towards public transportation. this action can bring about connected communities improve life efficiency and make urban life more convenient.

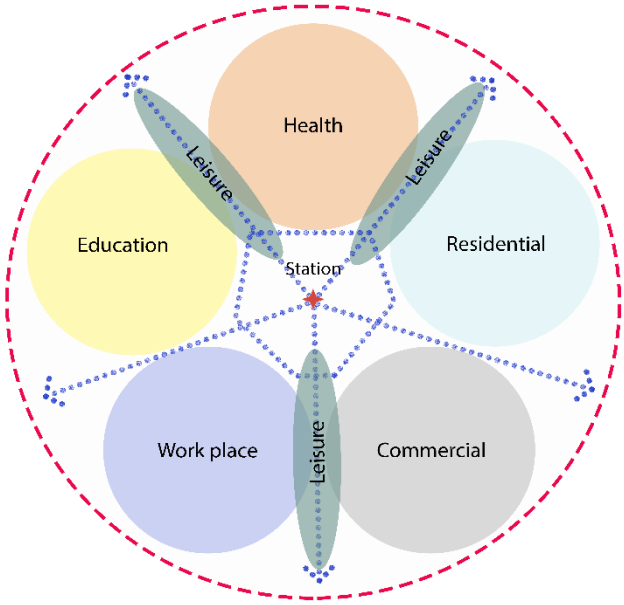


Figure 06, Sample of Mixed-development in TOD area,

Source: Elaborated by Author

e) Distance: Walkability

Walking in TOD areas is a fundamental aspect of reaching to sustainability and reducing automobile usage. It is obvious that walking can promote to active lifestyle and minimize environmental impacts. There are many factors that should be considered in walking areas, but the most important ones are connected pedestrian pathways and a safe and comfortable environment (Nahdatunnisa & Tahir, 2024); these factors encourage humans to walk. To ensure the best TOD concept, active mobility is a primary element that needs to be considered. Appropriate designs like sidewalks, shading, environmentally friendly infrastructure, benches, and safe access to a natural green environment enhance individual experience and result in promoting sustainably in urban movement. Also by increasing the amount of movement in urban areas a local business can benefit from this and improve their situation, more walking influences health and also due to the reduction

of car usage the quality of air becomes greater cities become more crowded by population movement and it can update the urban environment to be more alive.

f) Design: Good Lighting

In Transit-Oriented Development areas, it is very important to design and equip areas with appropriate lighting to make the urban spaces safe, light, and secure. lighting not only creates livable and welcoming spaces but also it gives a good impression to people to experience visible urban areas. Well-planned lighting can increase walking in public places and transit hubs because the area is visible, and individuals feel belonging to the area too. To foster the visual appeal and emotional atmosphere it is important to consider well-designed lighting in urban environments and spaces which leads to promoting accessibility. With stress on urban planning that offers streets full of adequate lighting, many people are willing to experience urban life more because they feel comfortable expressing themselves after dark. Also using energy-efficient lighting solutions, such as LEDs, is a functional approach because it works as an environmental solution to reduce energy consumption. To have successful TOD areas it is very workable to design urban areas with proper light to make areas vibrant and boost safety and accessibility these actions may result in a better life quality and a sustainable environment.

g) Diversity: Functional Diversity

In the concept of Transit-Oriented Development (TOD), having functional diversity is the key aspect to enhancing resilience in urban areas. The combination of good and proper services and activities in urban areas, important in TOD structure, can shape human mobility and boost economic development. Regards to this concept, access to different services and resources makes the urban space solve individuals' needs. However, in urban areas which are formed by active and densely structured, diverse land use and amenities are more likely to be safer, in some TOD areas with a middle population but reach in facilities, many people may face safety challenges (Zandiatashbar & Laurito, 2023). Due to these problems, there is in immediate need to carefully make a balance between density, diversity, and safety in planning the urban areas and designing TOD that ensures the urban environment is safe, vibrant, and secure for residents and also for visitors.

h) Accessibility: Multimodal Connectivity:

In the context of urban areas, accessibility is valuable mostly in the framework of Transit-Oriented Development (TOD) because it points to how communities can reach specific destinations and services. TOD aims to create composition among mobility and connectivity to make structure of daily life which helps to improve development in transportation and communication technologies (Macdonald & Grieco, 2007). Promoting accessibility TOD offers an equal opportunity to produce benefits specifically for marginalized groups to reduce their physical and logistical obstacles that impose them to freely move in urban environments. One of the TOD dimensions is integrating transit hubs within the urban spaces and structuring pedestrian-friendly urban areas which can enhance inclusivity. Some studies highlight the importance of multimodal connectivity that offers communities flexible urban areas that reduce risks, especially in urgent situations (Zimmerman, Restrepo, Sellers, & Kates, 2015). With the incorporation of multimodal connectivity which integrates different transportation options like trains, buses, cycling, and walking, this cohesive system not only can make daily travel and mobility easier but also it has the ability to empower urban resilience toward facing unexpected circumstances. Overall this type of connectivity can benefit vulnerable communities, also the socioeconomic situation of the people also station design that effectively can shape and change mobility decisions.

i) Safety and security: Dense vegetation

Safety and security are the most effective elements in Transit-Oriented Developments (TODs), also the existence of vegetation plays a crucial role in a visual environment, which has a significant impact on perceptions of safety. Natural landscapes and green spaces design environments and share positive impacts, as well as they can contribute to visual comfort and change the environment to be more welcoming to invite the community to use public transportation and walking (Dhini & Wonorahardjo, 2020). However excessive vegetation that is too dense and poorly conserved in the proximity of transportation stations could cause visual unsaturation that brings about the safety concern. The presence of hidden or inconspicuous zones in urban environments, specifically in TOD areas, may raise anxiety for the community, and individuals become reluctant to use public transportation or even walk in the surroundings. It should be investigated that the transit station and the open spaces attached to these areas must be visible and viable with a safe framework and

existing too much greenery can affect the human perception of being secure. Achieving this goal, which is the most important in TOD areas, is essential because TOD tries to make a dynamic and inclusive also accessible environment that fosters quality of residence life.

j) Public Spaces and Placemaking: Movement

The role of urban design is very effective in making successful Transit-Oriented Development (TOD) because it can put priority on accessibility, safety, and real daily movement. When these aspects combined with transportation surrounding and embedded with various destinations make situations that motivate individuals to walk and experience their environment. When TOD principles are integrated with placemaking which is the community-based approach, public transportation and open spaces close to stations are involved in this process to establish a situation where movement is high, and people are willing to walk and explore areas effortlessly also feel connected with others and the environment as a result of this concept the sense of the belonging will improve. By considering community demand in urban design and protecting cognitive, behavioral, and emotional connections within TOD areas it leads to creating sustainable urban living. This approach can benefit local society and urban planners. According to these explanations, TOD aims to facilitate efficient urban mobility and active movement but also tries to build a better sense of the environment and provide balance, equal, interconnected also resilient cities.

k) Economic attributes: Commercial Viability

The most specific and significant factor in Transit-Oriented Development (TOD) is an economic attribute that contributes to reshaping urban environments and improving their capacity for better development. this approach had direct influence on residential areas because people are willing to live in areas with better opportunities. With a focus on other studies, TOD neighborhoods change the commuter routine and provide essential economic requirements to obtain environmental and economic profits (harmain, hasibuan, & sodri, 2021). TOD connects transit hubs in terms of financial and economic factors, which receive and influence the urban environments and being influenced by them. When TOD structure is implemented in urban fabric there are some important

factors that influence the economic statute and the eras such as the real value of the property, the benefits of the business, the future of the investment, and economic activities that establish and grow in and around these transportation nodes. In TOD areas economic situations are vital aspects because they can identify the doability of long-term sustainability on transit-based projects, also increasing the advancement in the proximity of the stations and reinforcing the economic prospect in communities located in nearby of transport hubs (Cervero & Kockelman, 1997). Having access to businesses in close distance to transport stations is important in the TOD context because the community needs to take advantage of these services due to this convenient access for customers, livable economic situation, and convenient access on foot to this area are the significant factors. Designing urban areas through TOD is required to be connected well with other amenities to build proper accessibility also nurturing and flourishing local businesses in a divers-based approach ultimately can grow and expand the economic framework within the urban system.

3.8. Defining the Importance of Accessibility to Educational Centers

Access to educational facilities is a fundamental aspect of Transit-Oriented Development (TOD), particularly in fostering urban environments that significantly influence family life. According to the TOD structure, it is important to prioritize the accessibility availability of schools, traffic safety, and efficient transit systems to ensure that children can attend school regularly and without any difficulty. These elements in urban areas are crucial to establishing equitable, inclusive communities where families and children can thrive. There are many challenges that may arise for families and students when there are no poor or even not viable options to go to schools on foot as a primary mobility tool, this situation affects the daily routine and brings about increment in road traffic, car dependency, and also personal safety (Bierbaum, Vincent, & McKoy, 2010). By pointing to these challenges when the TOD areas are designed, physical accessibility should be considered, and the sense of safety and security must foster also community and their engagement to make vibrant and developed urban areas that can support the well-being of the residents.

-Identifying Educational Centers in TOD Areas

In this thesis, one of the focus areas is demonstrating educational centers within 166 stations by considering TOD buffer zones. The aim was to find out the location of the educational institution to provide a comprehensive analysis. By identifying schools in a GIS-based approach and using the OpenStreetMap platform this information was illustrated and mapped to assess the amount of accessibility in the transportation stations.

-Applying Open route service (ORS GIS plugin) and Service area analysis

To evaluate accessibility in case study stations, pedestrian isochrones which represent walking distances of 5 to 10 minutes were filled around each station. Also, service areas ranged from 400 to 800 meters were identified as practical thresholds for reaching schools on foot. These analyses were selected based on real and feasible expectations for pedestrians that guarantee families and students can comfortably access educational institutions within reachable walking distance.

-Filtering Stations Based on Poor School Access

Stations with limited access to schools within the 800-meter walking radius were collected as destinations with inadequate access to educational centers. By this method the total number of the stations which was 166 stations filtered,96 stations were removed and 70 stations for more detailed evaluation remained. This step was vital for focusing on stations that guaranteed a closer look at their connectivity to educational resources and overall accessibility.

-Applying TOD Criteria to Selected Stations

This part of the method involved assessing the remaining 70 stations based on 11 Transit-Oriented Development (TOD) characteristics. These criteria were collected and prioritized regarding improvement sustainability in urban areas also by using the Weighted Scoring Model (WSM) selected stations investigated for their significance. Rating stations were based on the assigning weight according to how well each station met the criteria, and by calculating the weighted scores

for each factor, a total score was derived for every station. This process provided a clear evaluation of each station's alignment with TOD principles.

-Categorizing Stations into Groups:

After calculating each station's total scores, they were categorized into three groups based on their performance. This categorization helps prioritize the areas requiring attention and resources, ensuring that stations are improved according to their performance and needs.

This table determined the final score range of the selected stations, which were divided into three categories.

Category	Score Range	Description
Bottom 25% (Lowest Score)	0 to 3.80	Stations requiring significant improvements in accessibility, design, and overall, TOD principles.
Middle 50% (Middle-Range Score)	3.80 to 4.80	Stations perform adequately but require updates in specific factors to enhance efficiency.
Top 25% (Highest Score)	4.80 to 6.00	High-performing stations that meet TOD objectives effectively, with minimal or no improvements needed.

Table 03, TOD characteristic final score category, Source: Elaborated by Author

3.9. Using Multi-Criteria Decision Making (MCDM) Method

The decision-making process known as Multi-Criteria Decision-Making (MCDM) is designed to perfectly investigate important criteria that are effective in successful TOD application in urban areas. This method is used to assess and rank essential criteria. It helps to choose the most suitable factor from a range of significant alternatives for sustainability. MCDM integrates both quantitative and qualitative information, ensuring a comprehensive and unbiased approach to decision-making.

3.9.1. Using Weighted Scoring Model (WSM) Method

This method within MCDM assigns weights to various characteristics based on their importance. Each factor is scored, and the final scores are multiplied by the corresponding weights to calculate a weighted score. The final criteria are ranked based on the total weighted scores to provide a clear and objective comparison.

By considering:

- **Define Criteria**: I identified 11 relevant factors for evaluating the stations based on Transit-Oriented Development (TOD) principles.
- **Assign Weights**: I assigned weights to each factor based on their importance. The total of all weights adds up to 1, reflecting the relative significance of each factor in the evaluation.
- **Rate Each Station**: I rated each station on a consistent scale (1–9) for each of the 11 factors, reflecting its performance about the criteria.
- **Calculate Weighted Scores**: I multiplied each station's rating by the corresponding weight for each factor. The formula is:

$$\text{Total Score} = \sum \left(\text{Rating}_i \times \text{Weight}_i \right)$$

Where:

- Rating i_i is the score for the i^{th} Factor (ranging from 1 to 9, for example).
- Weight $_i$ is the assigned weight for the i^{th} Factor.
- The sum $(\sum)$ is taken across all 11 factors.
- **Sum the Scores**: I summed the weighted scores for each station across all factors to get a total score.

1. For each station, calculate the total score by summing the weighted ratings across all 11 factors:

$$\text{Total Score}_{k} = \sum_{i=1}^{11} \left(\text{Rating}_{i,k} \times \text{Weight}_{i} \right)$$

2. Sum, these total scores across all n Stations:

$$\text{Sum of Total Scores for All Stations} = \sum_{k=1}^{n} \text{Total Score}_{k}$$

- **Rank Stations**: Based on the total scores, I ranked the stations from best to worst.

In the previously mentioned Categorizing Stations into Groups step, the final score of each station is categorized into three groups.

Criteria	Weight
1- Land Use: Educational Not Reachable	0.20
2-Land Use: Educational Reachable	0.15
3-Design: Transit Accessibility	0.13
4-Density: Mixed-Use Development	0.12
5-Distance: Walkability	0.10
6-Design: Good lighting	0.09
7-Diversity: Functional Diversity	0.07
8-Accessibility: Multimodal Connectivity	0.06
9-Safety and security: Dense vegetation	0.04
10-Public Spaces and Placemaking: Movement	0.03
11-Economic attributes: Commercial Viability	0.01

Table 04, Assess the weight of each characteristic, Source: Elaborated by Author

3.10. Analyzing the 800-Meter Buffer Zone: A GIS-Based Approach

By using the GIS-based method the selected stations were examined by an 800-meter radius surrounding public transportation nodes, in Transit-Oriented Development (TOD) this distance was mostly used in studies due to the comfortable doability. This buffer area, which reflects a walkable area around transit stations, is significant for understanding the connectivity and integration of urban spaces with transportation networks.

3.11. Categorizing Population Density and Urban Zones

This step includes categorizing the population density in the buffer zones around each station to better understand how many people reside in these areas. In Transit-Oriented Development areas proximity to rail stations has a positive effect on population density, also TOD provides infrastructure to analyze population dispersion patterns which is crucial for evaluating how the population engages with areas.

3.12. Accessibility to Grey and Green Urban Areas

In this study, there is a particular center on the urban ranges that are separated into two categories grey zones which speak about residential areas, and green zones which consider all sorts of vegetation. This classification is propelled by the (grey-green) system presented by (Corbane Pesaresi Panagiotis Kemper (2018). The concept of green zones emphasizes the part of green spaces in progressing the livability of Transit-Oriented Development TOD zones. These spaces offer profitable comes about since they contribute to natural social and mental prosperity progressing the security and community (Kuo Sullivan 2001). By examining the grey-green concept that's attempting to address the challenges of this investigation the proposal focuses on the significance of adjusting residential and green spaces in urban situations that are both comprehensive and economical with an accentuation on openness and quality of life. In TOD arranging participation with grey zones is critical since private ranges must be found in nearness to travel stations for forming urban designs. Guaranteeing residential zones are inside strolling or cycling removes travel alternatives boosts dynamic transportation diminishes car reliance and makes inspiration toward open travel utilization. This technique not as it were underpins maintainable versatility but moreover impacts private choices with people prioritizing comfort and network when choosing where to live.

3.12.1. Mapping Grey and Green Areas Using GIS

By utilizing GIS-based techniques, green spaces (encompassing all forms of vegetation) and grey areas (residential zones) around the selected transit stations were mapped and measured. This spatial analysis can cater insights into the interplay between urban environments and access to transit.

3.12.2. Evaluating Accessibility with 800-Meter Walking Distance

To evaluate the accessibility in grey and green areas from transit stations an 800-meter walking radius, or Pedestrian Isochrones, was used. This distance reflects a typical walking range. By applying this criterion, the thesis tries to determine the proportion of each space type that can be conveniently accessed on foot.

-Identifying Inaccessible Areas:

By applying an 800-meter walking distance, areas outside of this threshold were marked as inaccessible. This analysis illustrated the amount of both grey and green spaces that were not easily accessible from the transit stations on foot, underscoring accessibility gaps that could undermine the objectives of equitable Transit-Oriented Development (TOD) planning. The total area of each category was measured using GIS-based tools, and the percentage of each area's coverage was then calculated.

-Percentage of Residential Area Reachable:

Residential Area Reachable %= Reachable Residential Area/Total Residential Area × 100

-Not Reachable Residential Area:

Residential Area Not Reachable=Total Residential Area−Reachable Residential Area

-Percentage Accessible Green Area:

Accessible Green Area %=Accessible Green Area / Total Green Area×100

-Not Accessible Green Area:

Not Accessible Green Area=Total Green Area−Accessible Green Area

3.12.3. Analyzing the Difference in Accessibility Between Grey and Green Areas:

There is a significant difference between grey and green spaces. These differences are crucial to reflect on how the design of urban environments impacts residents' ability to interact with public transit, ultimately influencing their overall quality of life

3.12.4. Using Population Data in Both Areas

To gain a deeper understanding of the accessibility in grey and green spaces, population data was integrated into the analysis. Application of this data enables the assessment of the number of individuals residing within areas that are either accessible or inaccessible, this analysis provides information about the public transportation equity and urban sustainability.

-Population in Reachable Residential Areas:

Total Population × Reachable Residential Area Percentage/100

-Population in Not Reachable Residential Areas:

Total Population × Not Reachable Residential Area Percentage

-Population in Accessible Green Areas:

Total Population × Accessible Green Area Percentage/100

-Population in Not Accessible Green Areas:

Total Population × Not Accessible Green Area Percentage/100

3.13. Case Study

This thesis creates an overview of case studies which is 166 stations situated within the Copenhagen metropolitan area and Region of Zealand. The important steps of the thesis are identifying stations with inadequate access to educational institutions and then filtering out them, 70 stations remain for further examination. Through the application of 11 key Transit-Oriented Development (TOD) characteristics and analysis, this selection was refined to 18 stations. These stations were identified with the lowest scores according to a categorization system based on station weight, as outlined earlier in the study. The following table offers a comprehensive analysis of these 18 stations, presenting a thorough overview of the contextual background for each case study site.

Figure 07. The finger plan, Source: Byplanlaboratorium, 1993, front page

-*Case study filtering*

Figure 08, 70 Case study stations before filtering

Source: Elaborated by Author

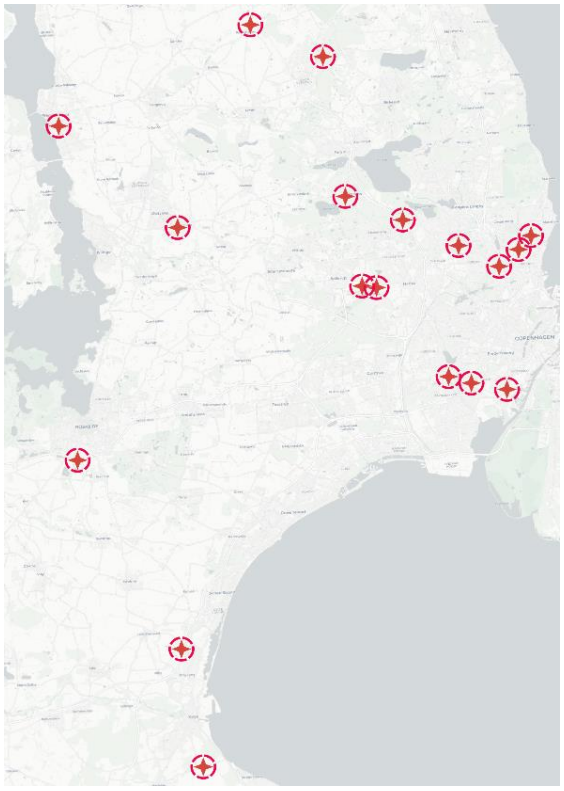


Figure 09, 18 Case study stations after filtering

Source: Elaborated by Author

-*Selected Stations*

This table consists of 18 station names, 18 selected station locations, the type of station and the year that station was constructed, and, finally, the urban fabric types in the case study.

Station Name	Location	Type of Station	Year of Construction	Type of urban area
1- Egøje	Køge Municipality, Region Zealand	Railway Station	1928	Suburban
2- Køge North	Northern part of Køge, Denmark	Intercity, Regional, S-train	2019	Urban
3- Roskilde Festivalplads	Roskilde Dyrskueplads, Denmark	Occasional boarding platform	1847	Suburban

4-Frederikssund	Frederikssund, North Zealand, Denmark	S-train Station	1879	Suburban
5- Stenløse	Stenløse,Ølstykke-Stenløse,Denmark	S-train Station	1882	Suburban
6- Allerød	Lillerød, Allerød Municipality, Denmark	S-train Station	1864	Suburban
7- Brodeskov	Hillerød Municipality, Denmark	Railway Station	1864	Suburban
8- Buddinge	Buddinge, northwest of Copenhagen	Suburban Railway Station	1906	Suburban
9- Dyssegård	Copenhagen, Denmark	Suburban Railway Station	1932	Suburban
10-Charlottenlund	Charlottenlund, north of Copenhagen	Suburban Railway Station	1863	Suburban
11- Bernstorffsvej	Copenhagen, Denmark	Northern Line Station	1936	Urban
12- Skovbrynet	Bagsværd, northwest of Copenhagen	Suburban Railway Station	1930	Suburban
13- Værløse	Værløse, Furesø Municipality, Denmark	Commuter Railway Station	1934	Suburban
14- Skovlunde	Skovlunde, west of Copenhagen	Commuter Railway Station	1882	Suburban
15- Malmparken	Ballerup, northwest of Copenhagen	S-train Station	1989	Suburban
16- Sydhavn	Kongens Enghave, Southern Copenhagen	S-train Station S-train Station	1972	Urban
17- Vigerslev Allé	Valby, Copenhagen	S-train Station	2005	Urban
18- Hvidovre	Hvidovre Municipality, Copenhagen	Railway Station	1935	Suburban

Tabel 05, 18 selected stations properties, Source: Elaborated by Author

3.13.1. Calculation of 11 TOD characteristics score

The table illustrates the assessment of 11 crucial transit-oriented development (TOD) characteristics for each station, with weighted scores that show their overall performance. The total score provides a straightforward measure of each station's alignment with sustainable development goals. How the scores are higher indicates the appropriate situation in contrast Stations with lower scores highlight areas that need attention and improvement. This analysis presents a valuable resource and information for comparing stations and pointing out further development and refinement opportunities.

*(**1**) Land Use: Educational Not Reachable (0.20), (**2**) Land Use: Educational Reachable (0.15), (**3**) Design: Transit Accessibility (0.13), (**4**) Density: Mixed-Use Development (0.12), (**5**) Distance: Walkability (0.10), (**6**) Design: Good lighting (0.09), (**7**) Diversity: Functional Diversity (0.07), (**8**) Accessibility: Multimodal Connectivity (0.06), (**9**) safety and security: Dense vegetation (0.04), (**10**) Node-place-design model: Movement (0.03), (**11**) Economic attributes: Commercial Viability (0.01).*

stations	1	2	3	4	5	6	7	8	9	10	11	total
1-Vestamager	0.6	1.15	0.65	0.6	0.5	0.36	0.21	0.18	0.28	0.06	0.02	4.61
2-Sundby	0.6	1.20	0.65	0.72	0.5	0.36	0.28	0.18	0.2	0.06	0.03	4.78
3-Dr byen	0.2	1.35	0.91	0.72	0.7	0.54	0.35	0.30	0.2	0.15	0.04	5.47
4-Lergravsparken	0.2	1.35	0.91	0.72	0.7	0.54	0.42	0.30	0.12	0.15	0.04	5.45
5-Christianshavn	0.2	1.35	0.91	0.84	0.6	0.54	0.35	0.36	0.08	0.15	0.05	5.43
6-Herfolge	1	0.45	0.52	0.60	0.4	0.27	0.21	0.18	0.28	0.09	0.03	4.09
7-Egoje	1.2	0.15	0.52	0.48	0.1	0.54	0.07	0.18	0.28	0.24	0.02	3.78
8-Koge Nord	0.6	0.15	0.52	0.36	0.5	0.27	0.49	0.42	0.16	0.21	0.07	3.75
9-Viby Sjaelland	0.6	1.15	0.52	0.6	0.6	0.36	0.21	0.24	0.16	0.06	0.04	4.68
10-Solrod Strand	0.2	1.35	0.91	0.84	0.4	0.36	0.35	0.18	0.32	0.06	0.04	5.07
11-Roskilde festivalplads	1	0.45	0.48	0.36	0.1	0.18	0.21	0.30	0.28	0.27	0.07	3.70
12-Roskilde	0.6	1.15	0.65	0.6	0.5	0.36	0.42	0.24	0.28	0.15	0.04	5.05
13-Trekroner	0.4	1.20	0.65	0.6	0.6	0.36	0.35	0.30	0.16	0.09	0.03	4.48
14-Hedehusene	0.2	1.20	0.52	0.6	0.4	0.36	0.42	0.30	0.08	0.09	0.04	4.71
15-Hoje Taastrup	0.2	1.35	0.91	0.72	0.1	0.36	0.42	0.24	0.12	0.09	0.05	4.72
16-Taastrup	0.2	1.20	0.78	0.72	0.5	0.54	0.35	0.24	0.08	0.09	0.04	4.74
17-Greve	0.4	1.15	0.65	0.48	0.4	0.45	0.35	0.30	0.04	0.09	0.04	4.85
18-Hundige	0.6	1.15	0.65	0.6	0.4	0.45	0.35	0.30	0.04	0.09	0.04	4.97
19-Ishoj	0.6	1.15	0.78	0.6	0.5	0.45	0.35	0.36	0.04	0.12	0.05	4.84
20-Vallensbaek	0.6	0.75	0.52	0.72	0.5	0.36	0.42	0.30	0.08	0.09	0.05	3.85
21-Brondby Strand	1.6	0.45	0.52	0.72	0.5	0.36	0.35	0.30	0.08	0.09	0.05	4.82
22-Avedore	1	1.15	0.52	0.72	0.4	0.36	0.35	0.30	0.08	0.09	0.04	4.81
23-Albertslund	1.2	1.15	0.65	0.72	0.5	0.36	0.35	0.36	0.04	0.12	0.05	4.74
24-Glostrup	1.2	0.45	0.65	0.48	0.2	0.45	0.42	0.30	0.04	0.12	0.05	4.82
25-Brondbyoster	1	0.45	0.52	0.48	0.3	0.45	0.42	0.18	0.16	0.12	0.05	4.55
26-Rodover	0.6	1.15	0.52	0.6	0.3	0.27	0.28	0.12	0.16	0.12	0.04	4.72
27-Hvidovre	0.6	0.9	0.52	0.48	0.3	0.27	0.28	0.12	0.08	0.15	0.04	3.74
28-Danshoj	0.6	1.15	0.26	0.48	0.6	0.36	0.28	0.12	0.08	0.15	0.04	3.96
29-Vigerslev Alle	0.4	0.9	0.48	0.36	0.5	0.27	0.35	0.18	0.08	0.12	0.03	3.67
30-Kobenhavn Syd	1	0.9	0.65	0.36	0.4	0.36	0.21	0.24	0.08	0.15	0.04	4.23
31-Sjaelor	0.4	1.20	0.78	0.36	0.3	0.36	0.21	0.12	0.04	0.09	0.03	3.81
32-Sydhavn	0.6	1.05	0.26	0.36	0.4	0.54	0.14	0.18	0.04	0.09	0.04	3.70
33-Amarken	0.6	0.9	0.52	0.48	0.4	0.27	0.28	0.0	0.08	0.09	0.03	4
34-Frederikssund	1	0.75	0.39	0.48	0.3	0.27	0.28	0.18	0.04	0.09	0.04	3.64
35-Stenlose	0.4	0.9	0.65	0.36	0.3	0.36	0.14	0.30	0.04	0.09	0.03	3.57
36-Ballerup	0.4	0.9	0.78	0.48	0.3	0.45	0.28	0.18	0.04	0.09	0.03	4.15
37-Malmparken	0.8	0.75	0.52	0.48	0.4	0.27	0.14	0.12	0.08	0.06	0.02	3.70
38-Skovlunde	1	0.45	0.48	0.48	0.3	0.36	0.21	0.30	0.08	0.06	0.02	3.74
39-Islev	1	0.6	0.52	0.48	0.3	0.36	0.21	0.18	0.12	0.12	0.03	4.12
40-Jyllingevej	0.4	1.20	0.52	0.48	0.4	0.27	0.21	0.24	0.12	0.12	0.03	3.83
41-Vanlose	0.8	1.15	0.78	0.48	0.5	0.36	0.28	0.24	0.08	0.09	0.04	4.80
42-Flintholm	1	0.9	0.78	0.48	0.5	0.36	0.28	0.24	0.08	0.15	0.04	4.81
43-Hillerod	0.8	1.15	0.65	0.6	0.4	0.36	0.28	0.24	0.04	0.12	0.04	4.88
44-Brodeskov	1.6	0.3	0.26	0.48	0.1	0.09	0.14	0.24	0.36	0.18	0.02	3.77
45-Allerod	1.8	0	0.39	0.48	0.3	0.18	0.21	0.18	0.12	0.06	0.02	3.78
46-Birkerod	1	0.75	0.65	0.36	0.3	0.18	0.21	0.24	0.08	0.06	0.02	3.85
47-Vaerlose	0.6	0.75	0.52	0.48	0.3	0.27	0.21	0.06	0.08	0.06	0.06	3.57
48-Skovbryent	1.6	0.15	0.26	0.36	0.1	0.18	0.14	0.36	0.32	0.06	0.03	3.64
49-Bagsvaerd	1	0.75	0.39	0.48	0.4	0.27	0.21	0.24	0.08	0.12	0.03	3.87
50-Stengarden	0.6	1.15	0.65	0.48	0.4	0.36	0.28	0.18	0.04	0.12	0.03	4.29
51-Buddinge	0.2	1.05	0.52	0.6	0.3	0.27	0.28	0.12	0.04	0.12	0.03	3.54
52-Kildebakke	0.6	0.9	0.52	0.36	0.4	0.36	0.28	0.18	0.08	0.12	0.03	3.83
53-Dyssegard	1.4	0.45	0.26	0.6	0.2	0.27	0.21	0.18	0.08	0.12	0.02	3.79
54-Emdrup	1	0.9	0.39	0.84	0.4	0.27	0.28	0.18	0.16	0.12	0.03	4.54
55-Ryparken	1.4	0.9	0.52	0.6	0.2	0.27	0.21	0.18	0.08	0.12	0.03	4.51

56-Svanemollen	1.2	0.9	0.52	0.6	0.3	0.27	0.28	0.24	0.08	0.12	0.03	4.54
57-Norrebors Runddel	1.2	1.15	0.78	0.36	0.6	0.45	0.35	0.30	0.04	0.15	0.04	5.42
59-Bispebjerg	1.6	0.9	0.78	0.48	0.6	0.45	0.35	0.30	0.08	0.18	0.05	5.77
60-Hellerup	1.4	0.9	0.91	0.48	0.6	0.45	0.28	0.30	0.08	0.09	0.03	5.76
61-Bernstorffsvej	1.6	0.3	0.39	0.48	0.2	0.18	0.21	0.24	0.16	0.09	0.03	3.66
62-Charlottenlud	1.6	0.15	0.39	0.36	0.4	0.27	0.14	0.06	0.12	0.06	0.02	3.47
63-Odrup	1.6	0.3	0.39	0.36	0.3	0.27	0.21	0.18	0.16	0.09	0.03	3.89
64-Gentofte	1.4	0.45	0.52	0.36	0.4	0.36	0.28	0.24	0.08	0.09	0.03	4.21
65-Lyngby	1.4	0.45	0.65	0.84	0.60	0.45	0.35	0.30	0.04	0.21	0.07	5.40
66-Lyngby Lokal	0.6	1.15	0.52	0.84	0.4	0.18	0.35	0.30	0.12	0.15	0.07	4.18
67-Fuglevad	1.6	0.15	0.39	0.48	0.2	0.18	0.21	0.18	0.32	0.09	0.03	3.83
68-Virum	1.4	0.60	0.65	0.48	0.4	0.36	0.21	0.24	0.16	0.09	0.03	4.62
69-Ravnholm	1.6	0.3	0.26	0.36	0.2	0.27	0.21	0.30	0.32	0.06	0.03	3.91
70-Naerum	1.4	0.45	0.39	0.6	0.2	0.27	0.35	0.18	0.2	0.06	0.05	4.15

Tabel 06, 70 Stations weigh calculation, Source: Elaborated by Author

3.13.2. Stations Categories

Regarding the final selection of stations, stations are grouped to reflect their performance and areas for growth:

Red: These stations need improvement to offer better station surroundings, but their performance is falling short. Prioritizing their development is essential to reinforce servicing to the community. Also, it is important to mention this shortcoming in performance may result differently from human observation and experience of the urban environment.

Yellow: As a result of the evaluation and assessment of these stations, it is clear that these transit stops are performing well overall. Specific criteria require attention and updates to ensure continued progress and offer better services to the community.

Green: These stations excel in their performance. The criteria evaluation results show that the station's performance and surrounding attributes can meet human demands, but whether all their needs and expectations are addressed depends on the community's thoughts.

-Calculation of the number of selected stations

In doing so, the total number of stations must be reduced to provide more accurate outcomes; in this selection, 70 stations are assessed and evaluated by 11 TOD factors, and the results are in 3 groups. As mentioned, above, Bottom identified a station with a low-performance score. It includes 25 percent of the whole selection, and the second group consists of 50 percent of all stations, which is yellow colored. The station function is proper, and station scores are in the middle category, indicating a balance between station workability and some inadequate factor efficiency. In Green Grope, regarding the performance appraisal of station results determined that these stations are working efficiently and include 25 percent of the whole stations.

Bottom = total station number × 25 percent of the whole stations

70 × 25/100 = 18

Middle = total station number × 50 percent of the whole stations

70 × 50/100 = 35

Top = total station number × 25 percent of the whole stations

70 × 25/100 = 18

The table displays the total scores of the selected stations based on 11 key characteristics of transit-oriented development (TOD), with a corresponding chart visually representing these results. These scores reflect each station's overall TOD potential, with Dyssegard achieving the highest score of 3.79 , and Buddinge scoring the lowest at 3.54 Despite the variation in scores, each station presents unique opportunities for improvement in specific areas, underscoring the potential for future development and enhancement.

Selected Stations	Score
1-1-Egoje	3.78
2- Koge Nord	3.75
3-Roskilde festivalplads	3.70
4- Hvidovre	3.76
5- Vigerslev Alle	3.67
6- Sydhavn	3.70
7- Frederikssund	3.64
8- Stenlose	3.57
9- Malmparken	3.70
10- Skovlunde	3.74
11- Brodeskov	3.77
12- Allerod	3.78
13- Vaerlose	3.57
14- Skovbryent	3.64
15- Buddinge	3.54
16- Dyssegard	3.79
17-Bernstorffsvej	3.66
18- Charlottenlud	3.74

Tabel 07, 18 selected stations final score

Source: Elaborated by Author

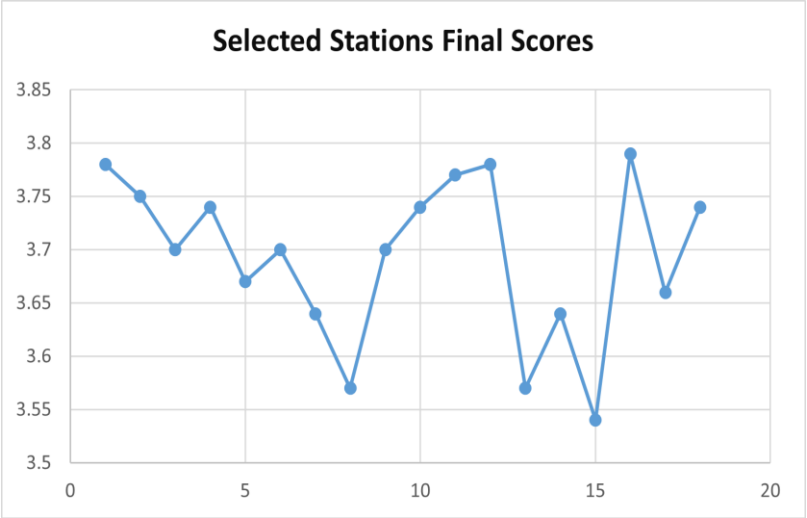
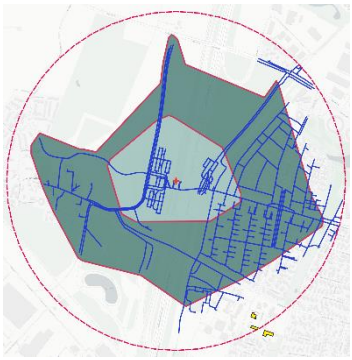
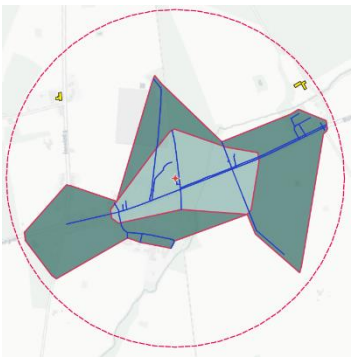
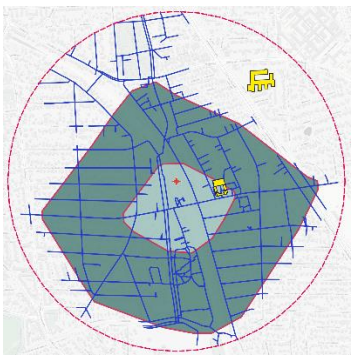
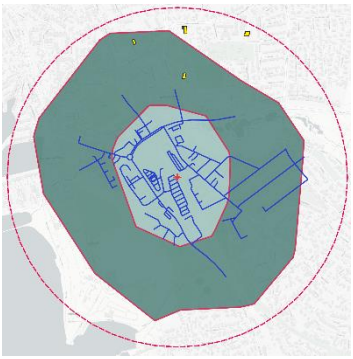
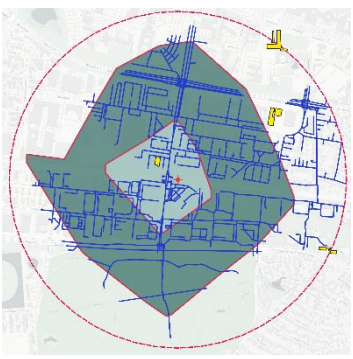
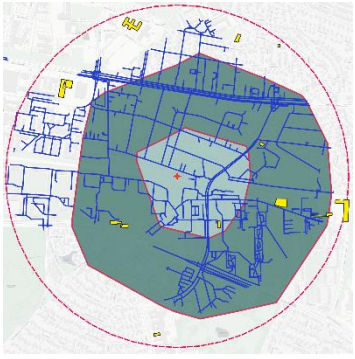
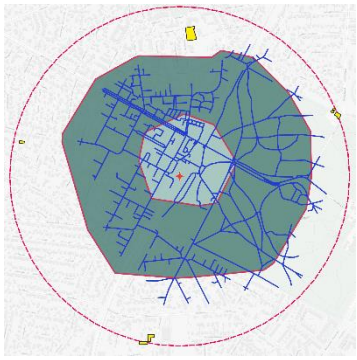
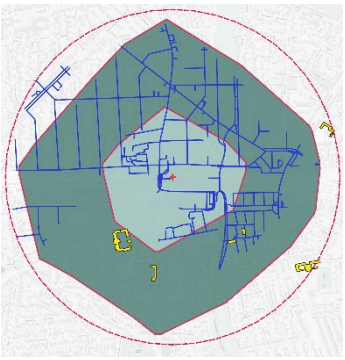
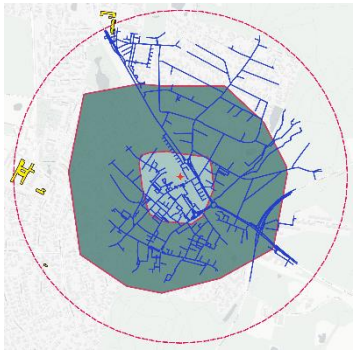
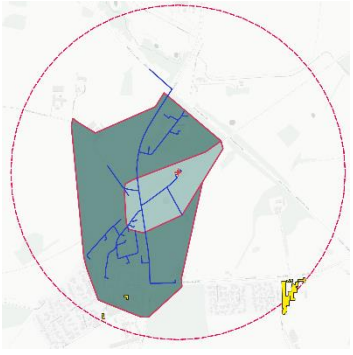
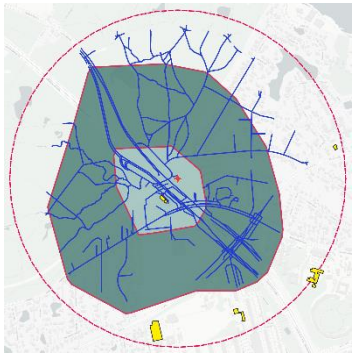
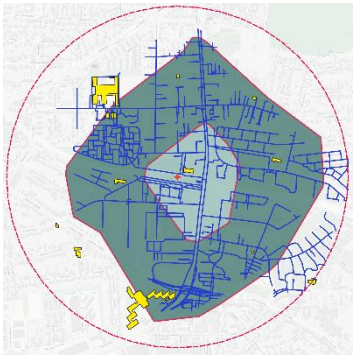
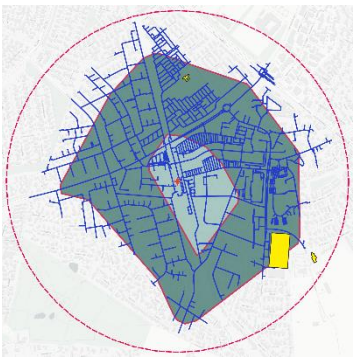
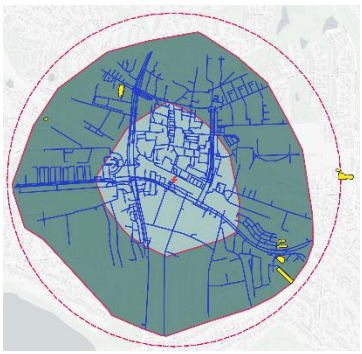
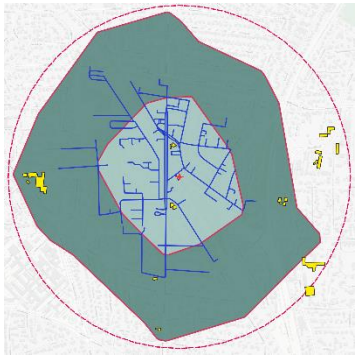
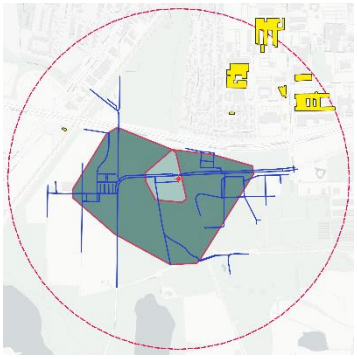
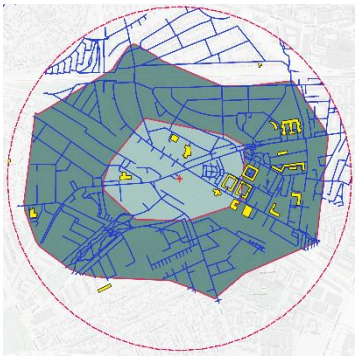


Figure 10,Stations final score chasrt Source: Elaborated by Author

3.14. Identifying Educational Centers in TOD Areas and Applying ORS GIS plugin and Service Areas Analysis:

These 18 maps offer an overview of the areas surrounding each selected station, with a particular emphasis on accessibility and connections within the framework of transit-oriented development (TOD). Each map illustrates the station's 800-meter radius, outlined by a red dotted line, which serves as the focal area of the analysis. Within this zone, the maps depict pedestrian walkability, using varying shades of green to show areas accessible within 400 to 800 meters on foot. A blue line traces the transportation network service area, highlighting how different transport modes connect people to the station and its nearby regions. Additionally, yellow polygons mark the locations of educational centers, shedding light on the availability of vital resources within the TOD zone. Together, these maps provide a comprehensive view of the relationship between transportation hubs, accessibility, and community services.

		
Koge Nord Station	**Egoje Station**	**Dyssegard Station**
		
Frederikssund Station	**Malmparken Station**	**Skovlunde Station**
		
Charlottenlund Station	**Hvidovre Station**	**Sydhavn Station**
		
Allerod Station	**Brodeskov Station**	**Skovbryent Station**

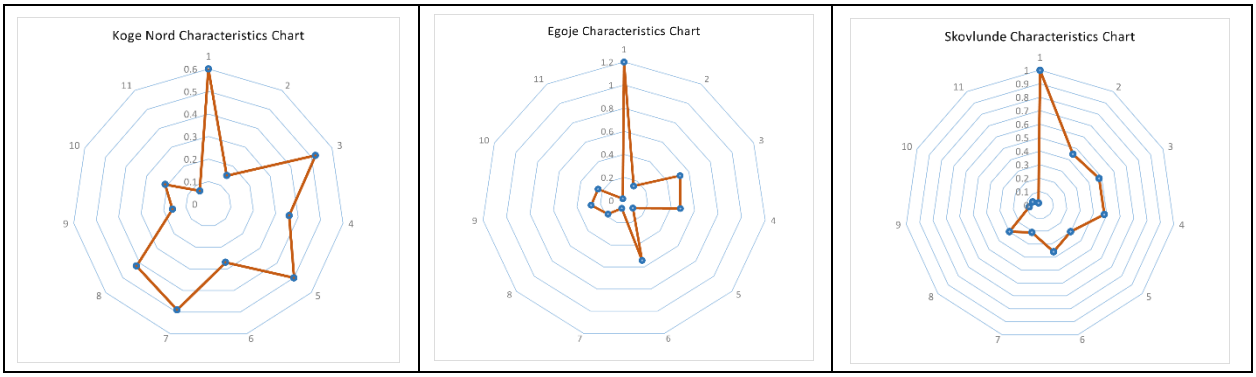
		
Buddinge Station	**Stenlose Station**	**Vaerlose Station**
		
Bernstorffsvej Station	**Roskilde Festival Station**	**Vigerslev Alle Station**

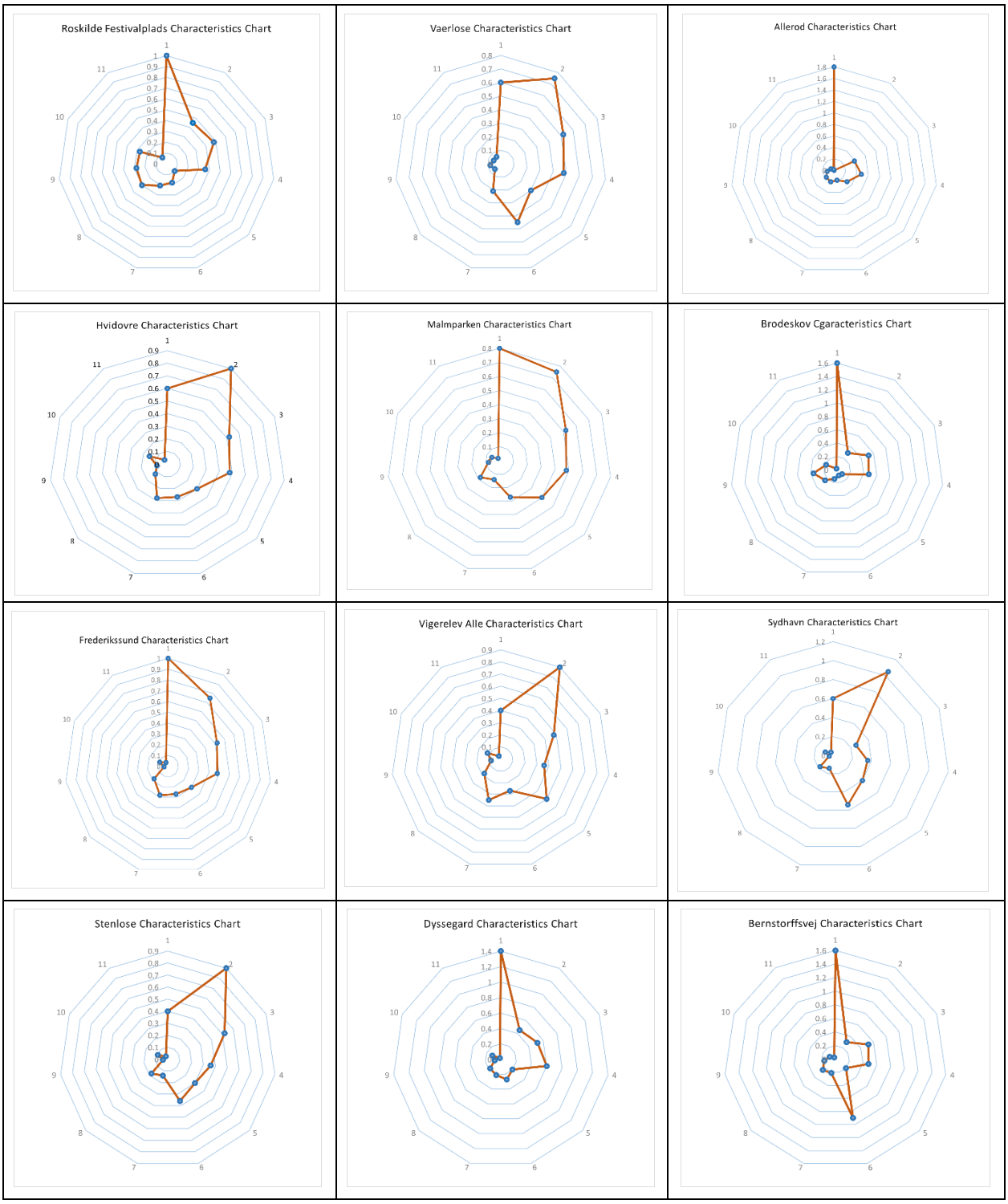
Toward the final interpretation of the assessment of Transit-Oriented Development characteristics in 18 stations with lower scores of performance, maps illustrated different outcomes; in many stations, access to educational centers is not feasible on foot, and it takes more than 10 minutes to walk, due to continuous streets and the location of the stations in fragmented and low-density urban form by 800-meter walking distance from stations reaching to schools and other destinations are not doable. However, other types of transportation are available to facilitate urban movement. In this case study, walking and cycling are primary tools for human activity. In stations like Egoje and Brodeskov, there are not enough transportation services because they are less populated, and walking in a semi-forest environment is not a practical approach for the community. It may cause some problems and improve car usage. In some states, reaching an educational institution is more convenient by walking as green mobility because schools are near the schools. Also, existing proper public transportation can simplify it. By considering all students, from children to university pupils, walking time and distance must be appropriate for all ages, genders, and different

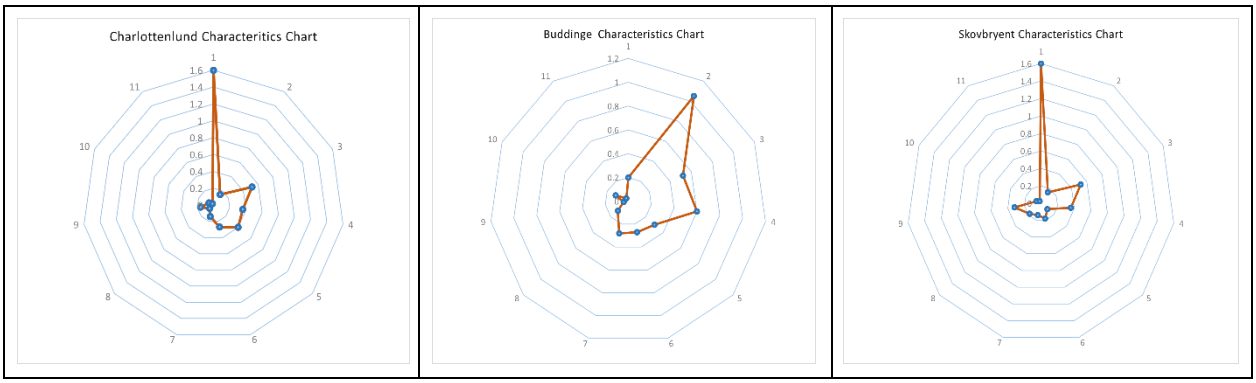
disabilities, which points to no more than 10 min and 800 meters of walking. Stations like Vigerslev Alle, Buddinge, and Sydhavn Educational Center are well integrated into the urban fabric and create suitable situations for the community to use this comfort. Being embedded in primary needs leads to sustainable development and an effect on human satisfaction.

3.15. Result of TOD Characteristics

The radar chart offers a visual framework of the weighted scores for 11 essential characteristics of Transit-Oriented Development (TOD) across 18 stations, with a special focus on their proximity to educational centers within an 800-meter walking radius. These characteristics include land use and urban design to population density and walkability analyzed to evaluate each station's TOD performance and potential, with particular attention to which residents can access nearby educational institutions.in this present, the score of each criterion determined in which station access to schools is convenient it should be mentioned that when the score is high it points to inappropriate conditions in stations and in contrast, a low score defines situations that stations are in popper level and TOD characteristics offer the best performance and in some cases, there is the capacity to empower the station surrounding.



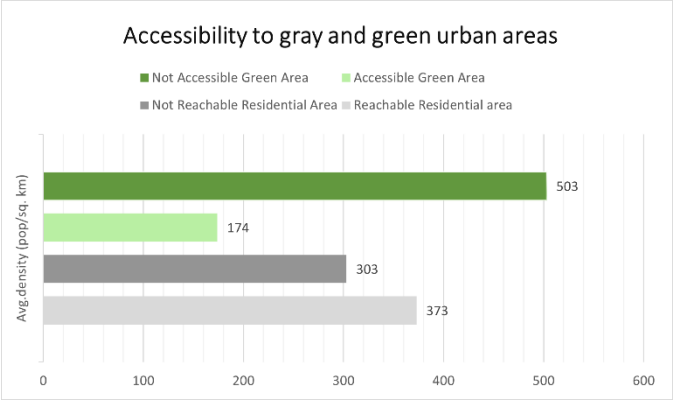

Roskilde Festivalplads Characteristics Chart
Vaerlose Characteristics Chart
Allerod Characteristics Chart
Hvidovre Characteristics Chart
Malmparken Characteristics Chart
Brodeskov Cgaracteristics Chart
Frederikssund Characteristics Chart
Vigerelev Alle Characteristics Chart
Sydhavn Characteristics Chart
Stenlose Characteristics Chart
Dyssegard Characteristics Chart
Bernstorffsvej Characteristics Chart



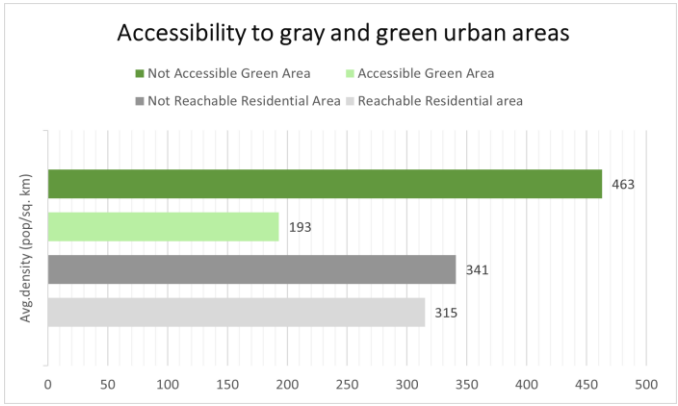
Regarding evaluating and assessing TOD characteristics in 18 stations, various results are illustrated in the radar charts.in many stations, access to educational institutions has the highest score, which means that due to the sprawl of urban form in Copenhagen, many schools are located far from stations, which brings many obstacles and persuades using private vehicles. Many schools are positioned in 800-meter station buffers, and reaching these destinations by walking and other public transportation is a doable action.in some stations, transit accessibility is tricky because station entrance is only from one side or it is possible by tunnel, dense vegetation as platform surrounding concept made open spaces close to stops unsafe, and inadequate lighting is another issue that can be seen in some stations, regarding mix use development some stations positioned in industrial neighborhood that bring about insufficient division between residential, commercial and industrial areas in land use, as result of this in specific station daily movement is low and fewer people ten to walk in semi-industrial areas because there is no attraction for them .by improving local business in stations economic development can be achieved and by designing some meeting point in vicinity of stations people are motivated to walk and the level of their social communication increase. Increasing the presence of green areas as accessible public spaces fosters better community engagement and encourages social inclusion, particularly in less populated stations. Walking as a green mode of mobility is not recommended in specific locations, as these stations are situated in deep green areas where people often prefer public transportation instead of walking. Overall, these factors point to specific criteria in unique locations that can be improved and updated to provide and offer better services and facilitate human lives and also try to obtain sustainability in terms of urban development, community demand, and social aspects like cohesion and inclusion.

3.16. Grey and Green Area Accessibility Analysis

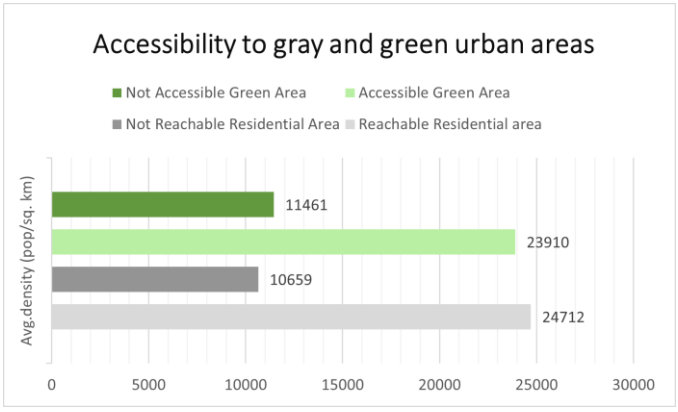
Conducting GIS-based techniques to search for the balance between residential (grey) and green (vegetative) areas surrounding chosen transit stations, these stations were mapped and measured to understand their distribution and accessibility. The analysis focused on an 800-meter walking radius, representing a doable 5 to 10-minute walk, to evaluate and investigate how conveniently residents could access these areas. Furthermore, the study considered the average population density within these zones to assess how effectively these spaces cater to the needs of the community.



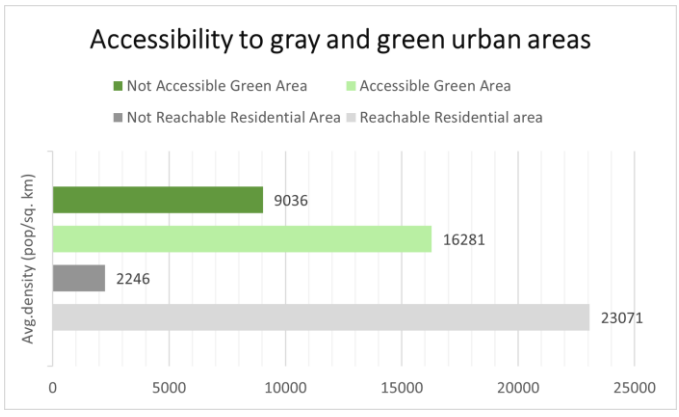
Egoje Station



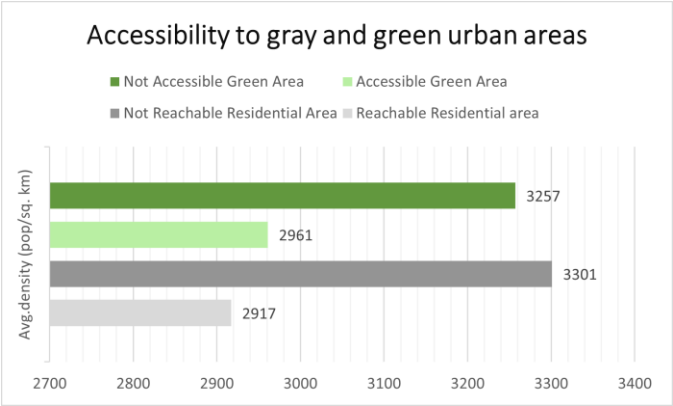
Koge Nord Station



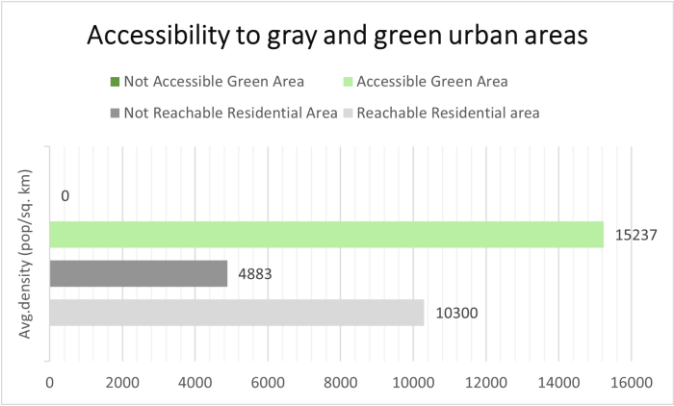
Vigerslev Alle Station



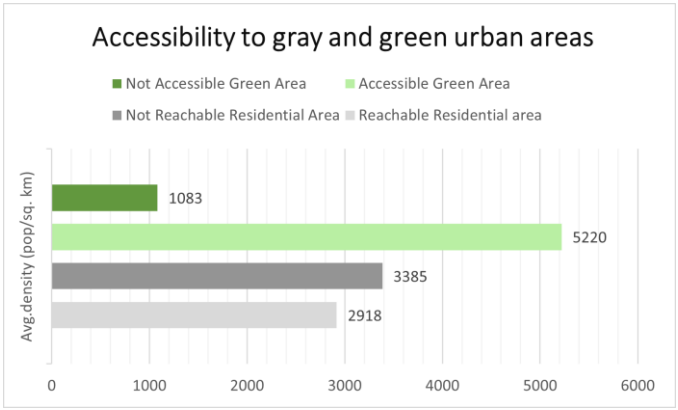
Sydhavn Station



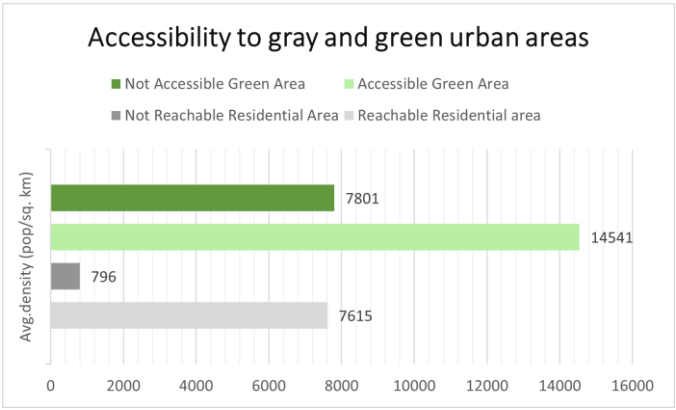
Frederikssund Station



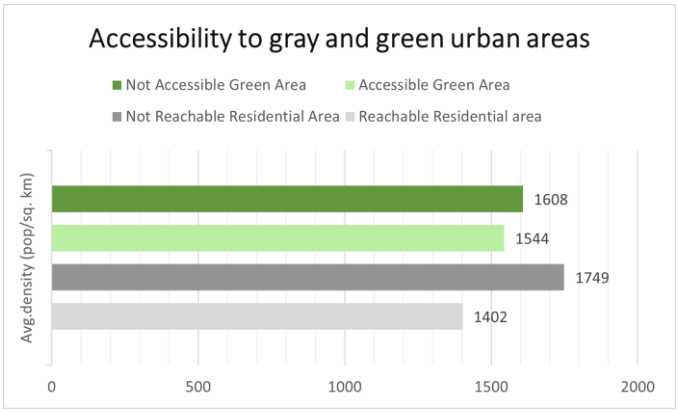
Bernstorffsvej Station



Stenlose Station



Dyssegard Station



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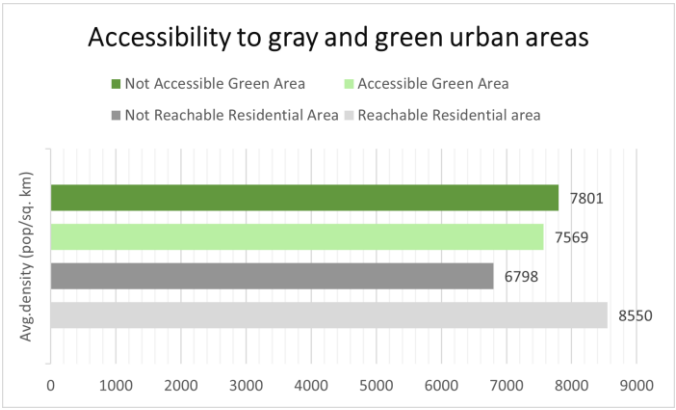
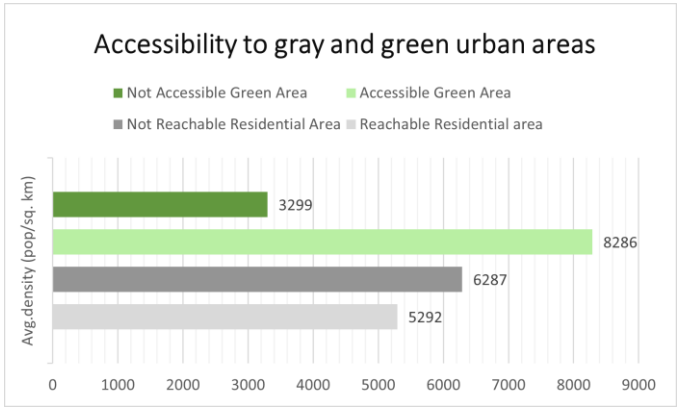
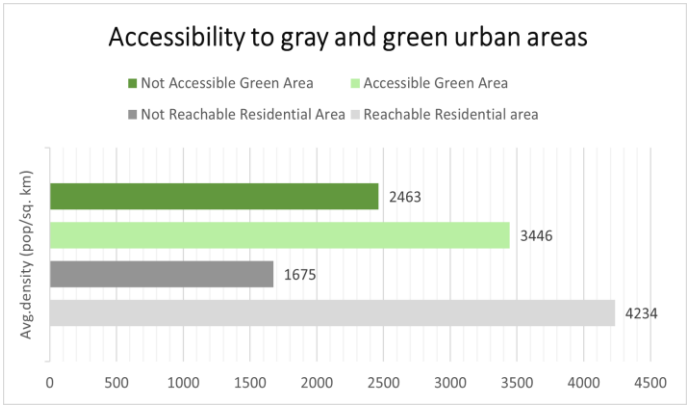


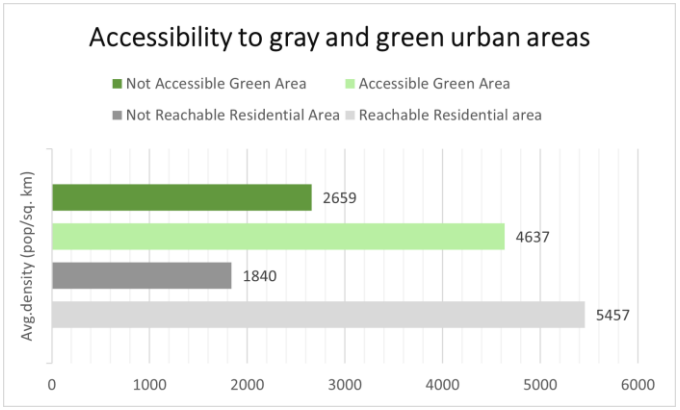
Buddinge Station



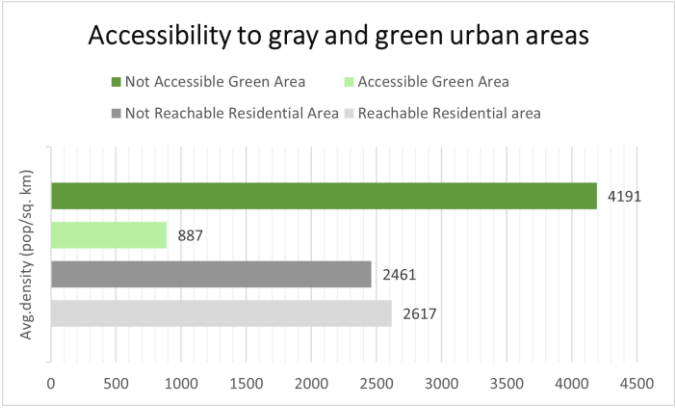
Charlottenlund Station



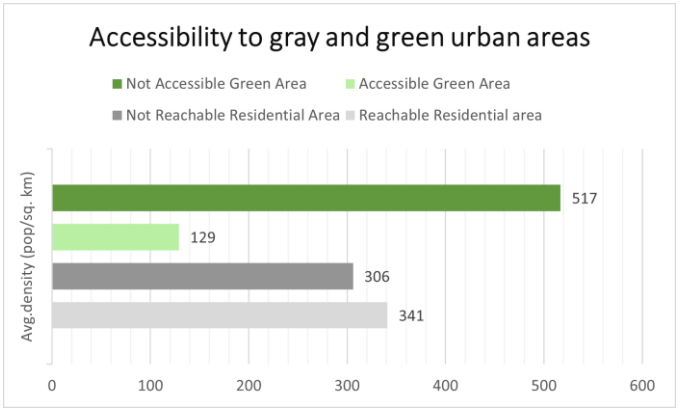
Hvidovre Station



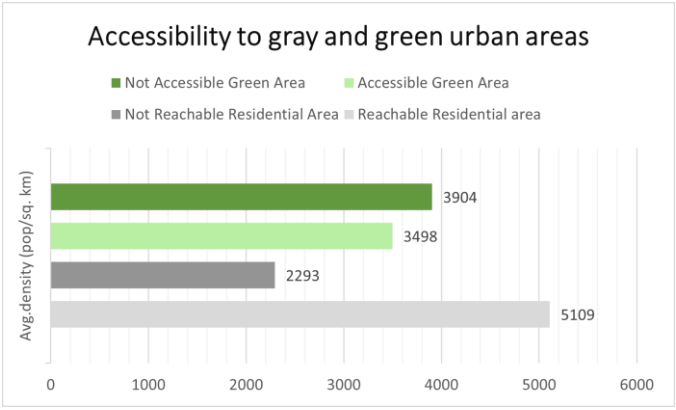
Vaerlose Station



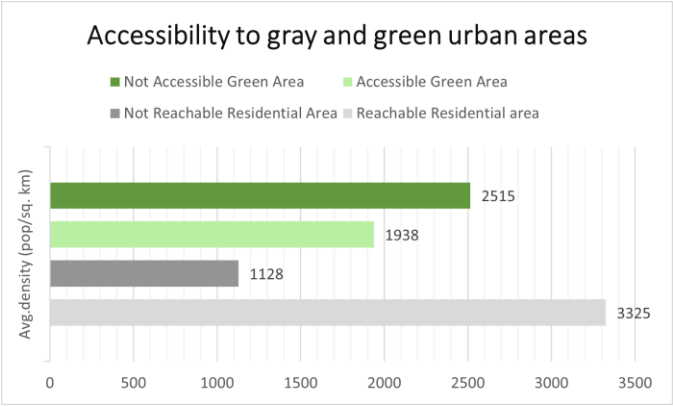
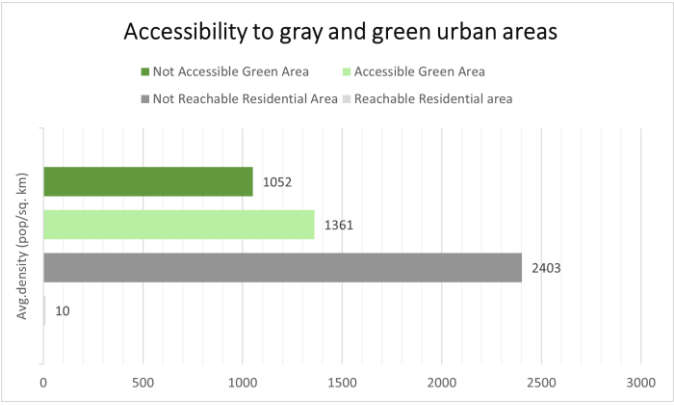
Allerod Station



Brodeskov Station



Skovlunde Station

	
Malmparken Station	Roskilde Festivalplads Station

These charts illustrate the number of grey areas introduced as residential spaces and green areas, which include all types of vegetation aligned with population density because of the importance of humans' access to these spaces. Human settlements are the primary framework of the tod areas. All facilities and services serve individuals' demands; emphasizing green areas' reachability and direct connection between green and grey areas is beneficial for people because open green areas not only can invite people to walk and experience the environment but can also reduce anxiety and improve mental and physical health. In many states, existing green spaces are required to balance areas and create connections between natural and human-made areas. These areas can influence people, and interaction between communities develops.in some stations, ample greenery not only makes the air quality better but also causes unsafe situations .accees to these areas is practical for all communities, and improving walking infrastructure and a friendly environment also boosts public transportation to meet residents' needs and makes equal society and people in far areas are included and not feel excluded because of disparities. Charts show that areas near center stations are more populated and crowded due to easy access to resources and services. Providing equal situations and integrating grey and green space in the urban framework also cater to transportation needs. People are more willing to live in any place.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

This chapter investigates the key findings of the thesis, by considering the evaluation of Transit-Oriented Development (TOD) potential at 18 chosen stations according to the methodology presented in chapter X. Throughout the research process, we have synthesized crucial outcomes and pointed out the essential factors needed to assess TOD opportunities. The results of this analysis are comprehending enough to understand how these locations can be improved to promote more sustainable, equitable, and vibrant urban development.

4.2. Educational Center Accessibility in 18 Selected Stations

Among the 18 stations of this thesis, a total of 96 educational centers have been identified. 46 of these numbers can be reached through active mobility, specifically walking within an 800-meter radius form the stations. The selection of the case study stations was based on a careful assessment of how easily educational centers can be approached on foot, evaluated through 11 fundamentals of Transit-Oriented Development (TOD). For more information about the selected stations, walking isochrones were created, to map out and illustrate distances from each station within 5 to 10 minutes of walking. Service areas extending 400 and 800 meters from each station were considered feasible walking distances to these centers. In well-planned urban areas, where buildings are compact and regularly arranged, walking to destinations is both possible and comfortable. These neighborhoods are designed to improve active mobility, with educational centers that are required to be accessible within a 5 to 10-minute walk. The framework of these areas defined an integrated urban environment that supports human movement. On the other hand, stations in suburban regions present a stark contrast. These areas are remarkably located in sprawl areas, disconnected neighborhoods, and a reliance on car travel. The fragmented design of these spaces, along with a lack of connectivity to the urban core, creates some limitations toward walkability. As a result, the distance to educational centers often went further than the expected 5 to 10-minute walk, making it harder and more impractical to reach these centers on foot.

This table demonstrated selected stations, which are 18 stations, the number of accessible and not accessible educational centers also the typology of urban areas in the case study.

Selected Stations	Number of Not Accessible Educational Centers	Number of Accessible Educational Centers	Type of Urban Area
1-Egoje	2	0	Suburban
2- Koge Nord	3	0	Urban

3-Roskilde festivalplads	5	0	Suburban
4- Hvidovre	2	4	Suburban
5- Vigerslev Alle	2	7	Urban
6- Sydhavn	3	6	Urban
7- Frederikssund	2	2	Suburban
8- Stenlose	1	1	Suburban
9- Malmparken	2	1	Suburban
10- Skovlunde	5	4	Suburban
11- Brodeskov	2	1	Suburban
12- Allerod	4	0	Suburban
13- Vaerlose	1	5	Suburban
14- Skovbryent	4	1	Suburban
15- Buddinge	2	7	Suburban
16- Dyssegard	1	1	Suburban
17-Bernstorffsvej	5	6	Urban
18- Charlottenlud	4	0	Suburban

Tabel 08, 18 Selected station Accessible and Not Accessible Educational Centers, Source: Elaborated by Author

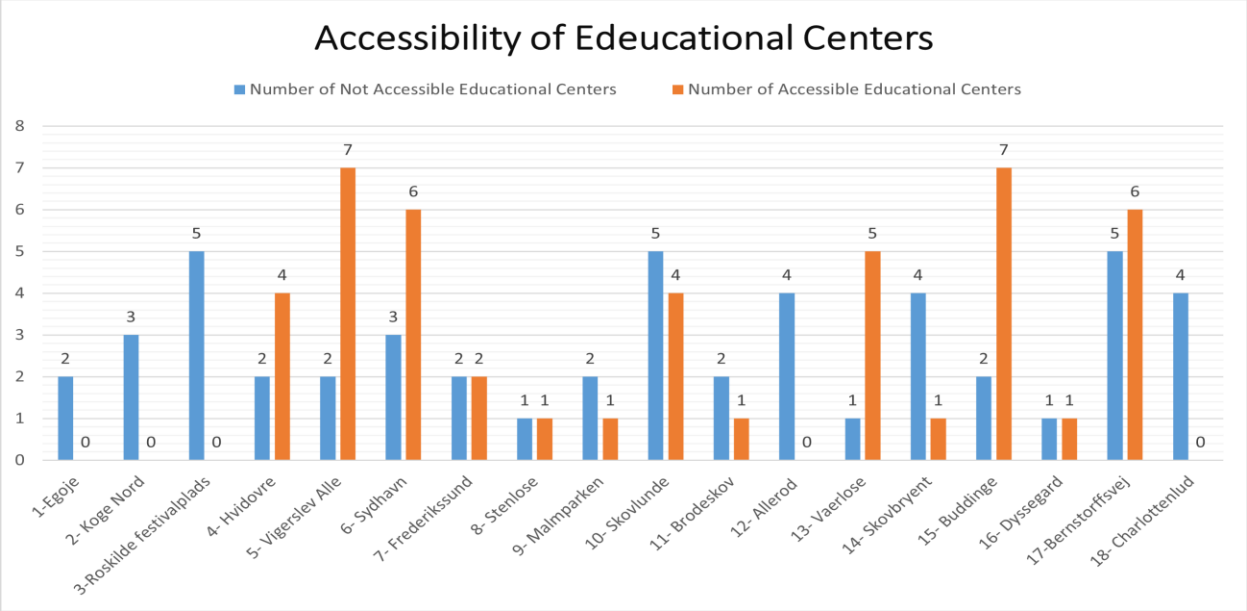


Figure11, Accessible and Not Accessible Educational Centers difference, Source: Elaborated by Author

This bar chart illustrates the disparity in access to educational facilities across 18 stations. It noted that those suburban areas, such as Roskilde Festivalplads, Skovlunde, and Allerod, face limited proximity to educational institutions. On the other hand, urban stations like Vigerslev Alle, Sydhavn, and Bernstorffsvej provide more convenient access to education.

4.3. Comparison of 18 stations with 11 TOD characteristics

In this present, 18 selected stations characterized by 11 TOD criteria were investigated; these factors include access to educational institutions, transportation options, diversity in land use, walkability, safety, placement, and economic attributes. These factors are very influential because people have essential needs when facing the urban environment. Individual satisfaction will increase if the environment around the stations provides and solves these. Also, a sense of belonging and familiarity may occur in the first impression of the environment. Previous studies have shown that these characteristics directly affect human experience and behavior in connection with open spaces surrounding the stations, and these criteria play an instrumental role in accessing the performance of the stations and spaces close to them. In this comparison, station factors are examined and evaluated to understand how urban design improves community life, enhances mobility, and promotes sustainability, all within the principles of transit-oriented development (TOD). The findings suggest that the highest scores of each TOD factor indicate areas that would benefit from further development, whereas the lowest scores reflect regions where accessibility is already relatively strong.

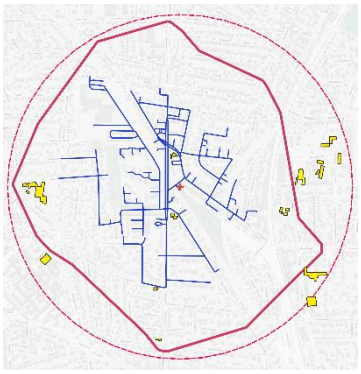
-Land Use: Educational Not Reachable

What it measures: This criterion assesses how easily educational centers, such as schools and universities, can be accessed from the station area. A higher score suggests that these facilities are not conveniently located, making it more difficult for residents to access educational opportunities.

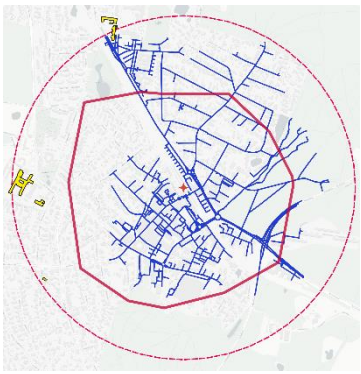
Higher Scores:

Stations such as Allerod (1.8), Brodeskov (1.6), Bernstorffsvej (1.6), Skovbryent (1.6), and Charlottenlund (1.6), Egoje (1.2), Frederikssund (1) got higher scores, showing that educational facilities are not easily accessible from these locations. This situation may prevent residents' ability to access education, especially for those who rely on public transportation or walking. Enhancing transit connections and reinforcing the design of these areas could improve access to education and better serve the community.

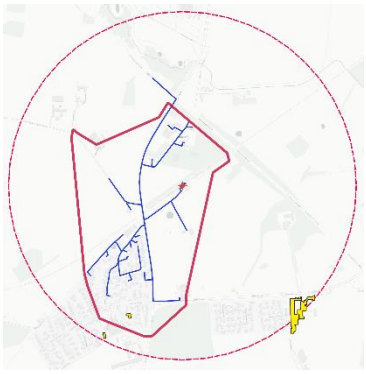
These maps illustrated the specific stations that have poor access to educational centers, in these maps red dotted line determines the 800-meter station buffer, the red line shows the walking isochrones from the station within 5 to 10 min walking distance, blue line determines the road network as a service area and yellow polygons are educational institutions.



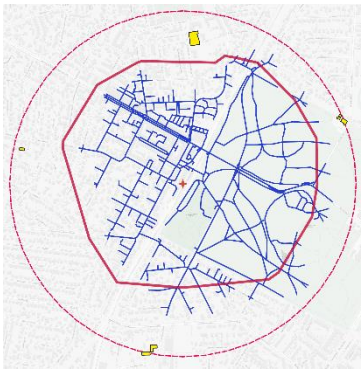
Bernstorffsvej Station



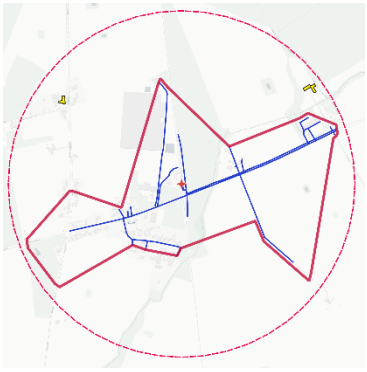
Allerod Station



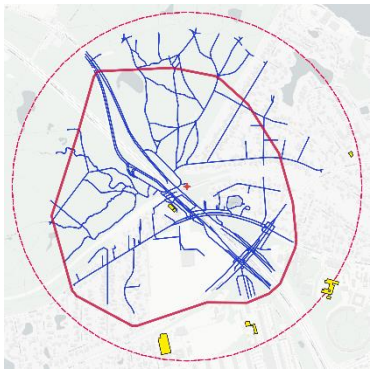
Brodeskov Station



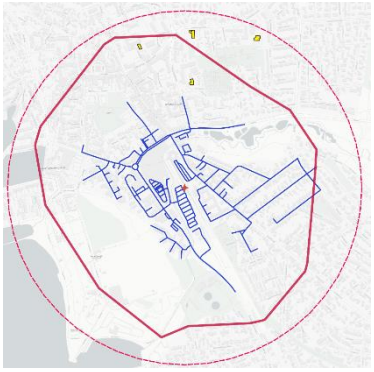
Charlottenlund Station



Egoje Station



Skovbryent Station

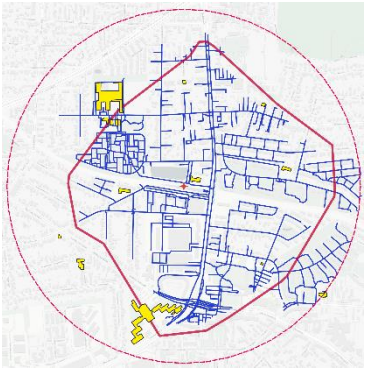


Frederikssund Station

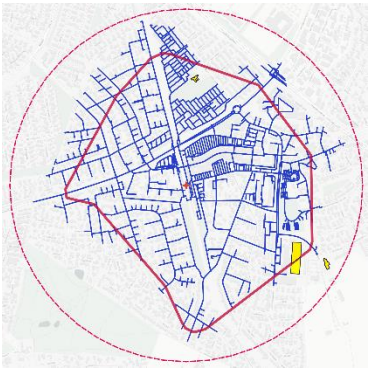
-Lower Scores:

On the other hand, stations like Buddinge (0.2), Sydhavn (0.6), Stenlose (0.4) receive lower scores, suggesting that educational facilities are conveniently located. This points to effective urban planning that prioritizes easy access to schools and universities, benefiting families and individuals in these areas by providing essential educational opportunities within reach.

These maps illustrate the specific stations that have lower scores, which means access to educational centers is appropriate. In these maps, the red dotted line determines the 800-meter station buffer. The red line shows the walking isochrones from the station within 5 to 10 minutes' walking distance. The blue line determines the road network as a service area, and the yellow polygons are educational institutions.



Buddinge Station



Stenlose Station

Sydhavn Station

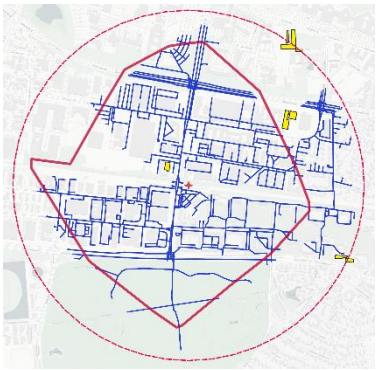
-Land Use: Educational Reachable

What it measures: This factor evaluates how easily educational institutions can be reached from the station area, focusing on whether they are accessible by walking or other modes of transport. A lower score in this area displays that educational facilities are well integrated into the urban setting and easily reachable.

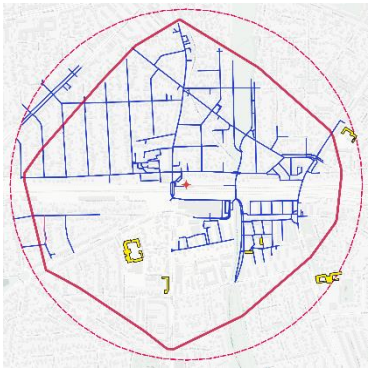
Higher Scores:

Hvidovre (0.9), Malmparken (0.75) , Vaerlose (0.75),Dyssegard (0.45), Roskilde festivalplads (0.45), show higher scores, suggesting that while educational institutions are accessible, there is room for improvement. Enhancing connectivity or creating more direct routes to these facilities would further strengthen the link between residents and their access to education.

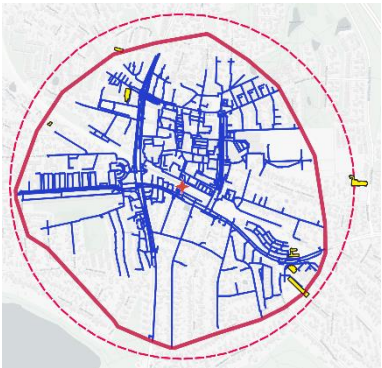
These maps illustrated the specific stations that have higher score that means access to educational centers is not proper these stations requires an improvement to offer better service , in these maps red dotted line determines the 800-meter station buffer, the red line shows the walking isochrones from the station within 5 to 10 min walking distance, blue line determines the road network as a service area and yellow polygons are educational institutions.



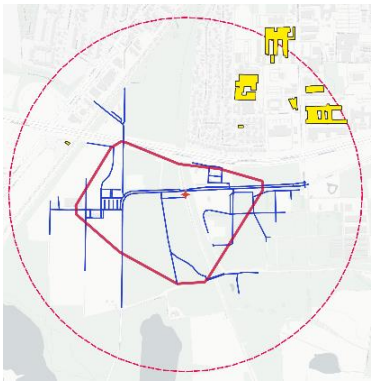
Malmparken Station



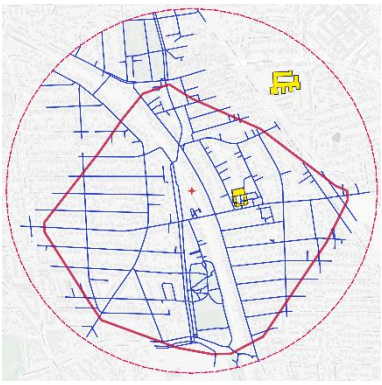
Hvidovre Station



Vaerlose Station



Roskilde festivalplads Station

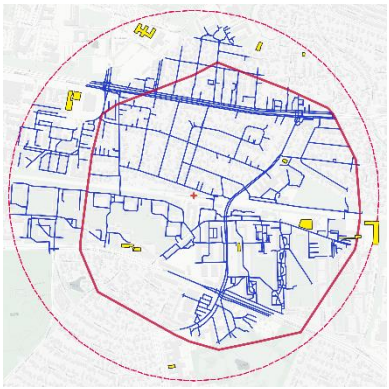


Dyssegard Station

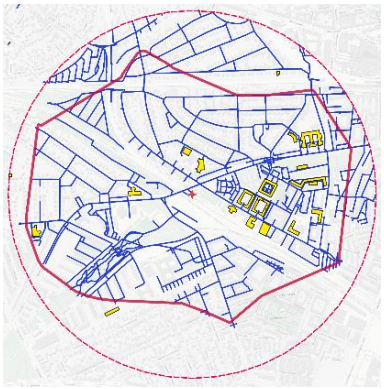
Lower Scores:

Skovlunde (0.45) and Vigerslev Alle (0.4) demonstrate very low scores, indicating that educational facilities are well-integrated and easily accessible by walking or even other types of public transportation from these stations. This reflects successful urban planning that prioritizes the proximity of educational institutions, creating a supportive environment for residents, particularly students.

These maps illustrate the specific stations with a lower score, meaning access to educational centers is appropriate, and stations are integrated with the area. In these maps, the red dotted line determines the 800-meter station buffer, and the red line shows the walking isochrones from the station within 5 to 10 minutes of walking distance. The blue line defines the road network as a service area, and the yellow polygons are educational institutions.



Vigerslev Alle Station



Skovlunde Station

- Design: Transit Accessibility

What it measures: This characteristic evaluates how easily transit services such as buses, trams, and trains can be accessed directly from the station area. It focuses on how effectively individuals can switch from one transportation mode to another, which plays a critical role in improving overall mobility and accessibility within urban areas.

Higher Scores:

Stenlose (0.65) and Egoje (0.52) show higher scores among all stations and apparently, most of the station are in a situation with medium scores which means almost all transportation is available and frequent in these areas but, significant challenges related to the accessibility of transit services have demonstrated. To improve these areas, enhancing the infrastructure to ensure a more seamless integration of transport options into the daily lives of residents would be essential.

Lower Scores:

Stations such as Sydhavn (0.26) and Frederikssund (0.39) exhibit lower scores, suggesting that these areas have successfully incorporated efficient transit systems. Their well-developed transit accessibility allows for smooth travel for residents, setting an example of the effective integration of public transport in urban planning.

-Density: Mixed-Use Development

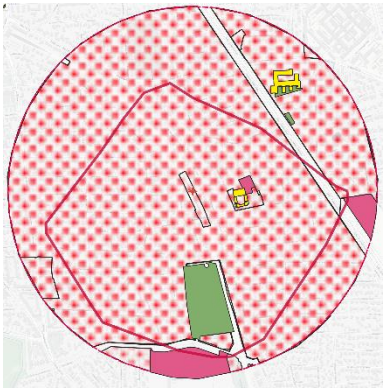
What it measures: This criterion examines how effectively the surrounding areas of the station integrate mixed-use developments, where residential, commercial, and recreational spaces exist side by side. Higher scores suggest that these areas lack sufficient or well-utilized mixed-use development.

Higher Scores:

Dyssegard (0.60) and Buddinge (0.60) exhibit higher scores, indicating that these areas lack diverse and well-integrated land uses. There is a need for more strategic urban planning to create spaces where residential, commercial, and recreational functions are combined, promoting more vibrant, self-sustaining communities.

Table 1these maps displayed 800-meter buffer of station that aligned with 5 to 10 min walk. These stations surrounding offer various services and use for different purpose from residential that identified by light pink, yellow polygon used for educational centers, dark pink for sport facilities, dark brown utilize for industrial areas, light brown for energy production and green areas like park and gardens

Buddinge Station



Dyssegard Station

Lower Scores:

By doing analysis and mapping the data and calculation, it is clear that most of the stations have lower scores and are located in suburban and fragmented areas, which means diversity in land use has been compiled, suggesting that these stations have successfully integrated mixed-use developments but is some specific stations mixed-use development aid more integration which provides variety of services for residents and contributing to lively and well-connected neighborhoods.

- Distance: Walkability

What it measures: This criterion assesses the distance from key amenities such as stores, public services, and green spaces to the station. Higher scores suggest that these amenities are not easily accessible on foot, which could negatively affect the overall quality of life for the community.

Higher Scores:

Koge Nord (0.5) and Malmparken (0.40) have relatively high scores for walkability, indicating that residents in these areas may face challenges when trying to reach essential services on foot. Improving pedestrian infrastructure and reducing the distance to important amenities would significantly enhance walkability, thereby improving the overall livability and convenience for the community.

Lower Scores:

it is generally proved that Copenhagen is a safe enough for walking due to the proper walking infrastructure , in this part calculation showed that majority of the stations holds lower scores, suggesting that these areas are relatively more walkable, allowing residents to easily access essential amenities. Walkability plays a critical role in creating pedestrian-friendly environments that minimize car dependency, fostering healthier and more sustainable lifestyles.

Figure 12, Malmparken Station pavement

Source: by Author

Figure 13, Charlottenlund Station walking area

Source: by Author

-Design: Good Lighting

What it measures: This factor evaluates the adequacy and distribution of lighting in the surrounding areas. Proper lighting is crucial for safety and creates a more inviting atmosphere, particularly during the evening or nighttime.

Higher Scores:

Sydhavn (0.63) and Egoje (0.56) show higher scores, suggesting that these areas may not provide enough lighting, which could impact safety. Enhancing the street lighting in these locations would improve security, reduce crime, and create a more welcoming and safer environment for residents and visitors.

Figure14,Sydhavn Station surrounding

Source: by Author

Figure14,Egoje Station surrounding

Source: by Author

Lower Scores:

On the other hand, Charlottenlund (0.15) scored lower, indicating that these areas offer sufficient lighting, ensuring safety and comfort for pedestrians throughout the day and night.

Figure15, Charlottenlund Station surrounding

Source: by Author

Figure 16, Charlottenlund Station entrance

Source: by Author

-Diversity: Functional Diversity

What it measures: This criterion examines the range of services and functions available in the vicinity of the station. Higher scores suggest a lack of variety in the functions offered, resulting in a less dynamic urban environment.

Higher Scores:

Vigerslev Alle (0.49), Koge Nord (0.49), and Dyssegard (0.27) have higher scores, pointing to the need for greater diversity in the services and functions available. By expanding offerings such as retail, leisure, and community spaces, these areas can become more vibrant and provide a fuller range of opportunities for residents.

Figure 18**,** Koge Nord Station surrounding

Source: by Author

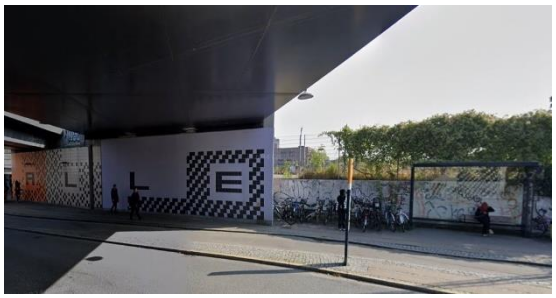


Figure 19, Vigerslev Alle Station surrounding

Source: by Author

Lower Scores:

In contrast, while most surrounding stations have proper access to different facilities, some specific stations require improvement and attention. This suggests a well-rounded mix of services. This diversity helps to create a more adaptable and resilient neighborhood where residents have access to a wide array of choices and amenities close to home.

-Accessibility: Multimodal Connectivity

What it measures: This criterion assesses how well various transportation options, such as buses, trains, and bike paths, are integrated within the station's vicinity. Effective multimodal connectivity facilitates smooth transitions between different transport modes, thus improving overall mobility and ease of travel.

Higher Scores:

Koge Nord (0.42), Skovbryent (0.36) and Bernstorffsvej (0.24) score higher in this aspect, indicating that these stations could benefit from stronger integration between different modes of transportation. By improving the connections among transport options, these areas can offer residents better access and a more efficient and convenient travel experience.

Figure 20, Koge Nord Station connectivity

Source: by Author

Figure 21, Bernstorffsvej Station connectivity

Source: by Author

Figure 22,Skovbryent Station connectivity and entrance

Source: by Author

Lower Scores:

On the other hand, Charlottenlund (0.06) performs relatively well in this regard, demonstrating effective integration of multiple transportation modes. This facilitates people's movement, allowing them to navigate between various transit options more efficiently.

-Safety and Security: Dense Vegetation

What it measures: This criterion evaluates how the presence of dense vegetation in urban spaces can enhance safety through natural surveillance. It also considers how greenery can decrease the likelihood of crime and elevate the overall visual appeal of the area, contributing to a more attractive and secure environment.

Higher Scores:

Areas such as Brodeskov (0.36) and Roskilde festivalplads (0.28) and exhibit higher scores, suggesting that these stations surrounding covered by dense vegetation. While these stations improve ecological connection, homes of various biodiversity and better air quality but it may increase a sense of unsafe areas for the community.

Figure 23,Roskilde festivalplads Station

Source: by Author

Figure 24, Brodeskov Station

Source: by Author

Lower Scores:

Conversely, Malmparken (0.14) and Vaerlose (0.21), and rest of the stations show lower scores, indicating that these areas already have a proper connection with green open spaces. This contributes positively to the safety of the environment and enhances the overall quality of life for residents.

Figure 25, Malmparken Station access to greenery

Source: by Author

Figure 26, Vaerlose Station access to greenery

Source: by Author

-Public Spaces and Placemaking: Movement

What it measures: This criterion assesses how effectively public spaces are designed to encourage mobility and foster social connections. It considers elements such as pedestrian flow, communal

gathering spaces, and the overall layout that invites people to stay, move around, and interact with their surroundings.

Higher Scores:

Roskilde festivalplads (0.27) and Egoje (0.24) show elevated scores, suggesting that public spaces in these locations may not be entirely conducive to movement and social interaction. These areas could benefit from enhanced placemaking approaches prioritizing pedestrian-friendly designs and developing welcoming, interactive spaces.

Lower Scores:

Many stations in Copenhagen's urban concept report lower scores, indicating that their public spaces serve the community and are perfumed. However, effective social interaction within these areas can be improved by promoting movement and engagement.

-Economic Attributes: Commercial Viability

What it measures: This attribute evaluates the economic vibrancy and the availability of commercial prospects around the station. Higher values often indicate a lack of commercial activity, potentially stifling the local economy and reducing access to necessary services.

Higher Score:

Due to the locations of most stations in suburban and scattered areas, there is a proper situation to empower economic investment and enhance it mostly at the local scale. Stations such as Roskilde festivalplads (0.07) and Koge Nord (0.07) exhibit higher scores, suggesting that these areas face limited commercial opportunities. Fostering more commercial activities in these locations could help stimulate economic growth and enhance service availability for the local population.

Lower Score:

On the other hand, almost more than half of stations located far from shopping and retail facilities and stations showcase lower scores, the level of commercial activity to meet primary needs is quite appropriate. These areas benefit from vibrant economic interactions, offering employment and essential services, which are valuable for the well-being of the residents.

4.4. Summarizing the stations that need improvement

The table demonstrates a detailed and organized framework of the stations that need improvement based on the 11 keys of TOD. Each factor addresses a crucial element of transit-oriented development (TOD), such as accessibility, safety, connectivity, and economic sustainability.to reach a better score and achieve to appropriate TOD framework there is a gape in some specific factor that creates a potential for better TOD characteristics performance and this action leads to improvement in services and enhanced accessibility for all communities. In terms of access to educational centers, calculation demonstrated that stations like Allerod, Charlottenlund, Bernstorffsvej, Skovbrynet, and Brodeskov have the potential to empower access to education and make the situation better for the community. While in stations like Hvidovre, Dyssegard, Vaerlose, Roskilde festivalplads, and Malmparken, many institutional areas exist. The connection between these stations and schools is not well organized. It can be improved by more services or relocating educational centers close to stations. In terms of transit accessibility, the design of the station surrounding Stenlose and Egoje required immediate enhancement because, due to the urban form, the area is low-density. The station platform and its vicinity are not adequately designed and are not welcoming, either. This can lead to less transportation usage and low movement in the areas. Regarding mixed-use development, Dyssegard and Buddinge have high density and, due to their location being close to the city center, are the perfect locations for individuals. These stations are very populated, and because of their urban form, most of the environment is used for settlements and residential areas. Access to schools is okay, but there is an opportunity to provide more recreational areas that invite people to social communication and also other services and resources like commercial areas to boost benefits if these stations surround. Making station surroundings safe and proper is essential, motivating people to use public transportation and walk more. However, in stations like Koge Nord local, which is situated in the proximity of the highway, and

Malmparken, which is situated in an industrial neighborhood, insufficient walking infrastructure and low-density character of the station surrounding results in less contribution to sustainable and developed areas and individual more likely use private vehicle than public. Also, because of the neighborhood type, there are fewer communities that prefer to walk because they feel the area is unsafe and has less movement, which may result in limited use of public transportation and the community feeling less connection and access to transit hubs. In stations like Vigerslev Alle, Koge Nord, and Dyssegard, there is enormous need for diversity in land use and to attract more community to live in these areas; the lack of access to different services encourages people to use their cars than public transport these stations are not human-centered hubs, and they use because of its function, less spaces like café can lead to low social interaction, and not suitable access and availability of the services may resulted that people feel unequal life condition. Due to the TOD aim of making land use and transportation connected and integrated in terms of multi-modal connectivity, stations like Skovbryent, Koge Nord, and Bernstorffsvej assign more types of transportation, specifically green mobility like walking and cycling equipment. These stations could benefit from stronger integration between different destinations. By improving the connections among transport options, these areas can offer residents better access and a more efficient and convenient travel experience. Proper integration between green areas and transportation is an important issue in TOD areas because when the greenery becomes dense, vegetation in the first impression may offer a desirable sense to commuters and travelers. However, dense vegetation may induce an unsafe environment, and this action is consequent to lower transportation use Stations like Brodeskov and Roskilde festival plans are far behind the city center, and rural concepts may be showcased by them, However, although green areas invite different biodiversity and improve health, dim and dense green areas can influence the human experience in close interaction with the station, this growth of greenery needs to be contrived to make urban environment sustainable and attract walking and use public transport more. In urban and suburban areas, which introduced themselves by a higher amount of movement, it is worth mentioning that the TOD buffer focuses on the importance of walking and the existence of friendly urban design on foot as proper urban design; walking infrastructure like pavement can encourage the community to be merge by the environment while in stations like Roskilde festival plans and Egoje lack of human mobility can be seen due to the less populated and also located in far areas, also people who reside in the proximity of these stations tend to use their car than public transport

maybe it is not frequent to attract humans to use it. This results from low population density and inappropriate urban design in Koge Nord and Roskilde festival plans; due to their locations in suburban and scattered areas, there is a proper situation to empower economic investment and enhancement mainly locally. Because it can provide more job opportunities, invite more social interaction, and improve urban development in these stations

The table displaced the assessment of each TOD characteristics and station that required improvement regarding the analysis and calculation of final score.

Criteria	Stations Requiring Improvement	Score Range
1. Land Use: Educational Not Reachable	Allerod,Charlottenlund, Bernstorffsvej, Skovbrynet, Brodeskov	1-1.8
2. Land Use: Educational Reachable	Hvidovre, Dyssegard ,Vaerlose, Roskilde festivalplads, Malmparken	0.45-0.9
3. Design: Transit Accessibility	Egoje, Stenlose	0.52-0.65
4. Density: Mixed-Use Development	Dyssegard, Buddinge	0.60
6. Design: Good Lighting	Koge Nord, Malmparken	0.45
7. Diversity: Functional Diversity	Vigerslev Alle, Koge Nord, Dyssegard	0.28
8. Accessibility: Multimodal Connectivity	Koge Nord, Skovbryent ,Bernstorffsvej	0.24-0.42
9. Safety and Security: Dense Vegetation	Brodeskov , Roskilde festivalplads	0.28-0.36
10. Public Spaces and Placemaking: Movement	Roskilde festivalplads ,Egoje	0.24-0.27
11. Economic Attributes: Commercial Viability	Roskilde festivalplads, Koge Nord	0.07

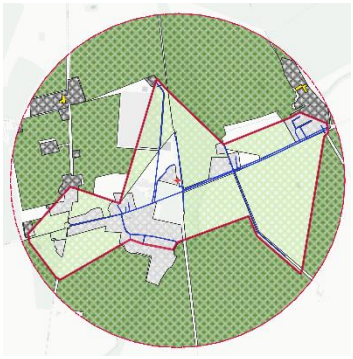
Table 09, Stations require improvement, Source: Elaborated by Author

4.5. Grey and Green Areas Accessibility in 18 Selected Stations

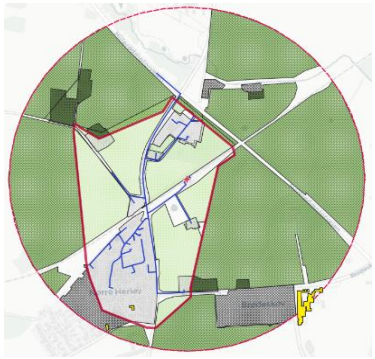
Examining the grey and green spaces around the 18 chosen stations determined a remarkable disparity in their interaction. These aspects are divided into three categories, each reflecting differentiation in accessibility, urban areas' design, and connectivity between frameworks like land use and transportation by green areas collaboration. Each category explained unique challenges that influence the overall sustainability and quality of life within the urban setting. In the Copenhagen urban concept, there is no balance between green (all types of vegetation) and grey (residential) areas due to prioritizing access to transportation. In this part of the analysis, maps clearly determined that there is a disparity in the relationship between green and grey areas; in this 3 category this difference explained and this categories are defined by the measurable areas of both greenery and residential neighborhood inside the 800 meters radius around each station, category 1 is about numerous amount of green areas which located outside of the walking threshold and it not reachable , most of these stations are in suburban areas and less populated. in category two these is semi equal ness among both green and grey areas, and these areas are apparently accessible on foot, but it should be mentioned that to reach to areas out of walking zones there is demand for more frequent transportation services and in some cases using personal vehicle cand be a practical instrument to assist humans, also this balance between green and grey areas especially in out of walking zones may motivated people to walk because being in touch with greenery and attract them for social gathering that leads to reduce social exclusion. In the third category, the number of grey areas is more significant, and there are no natural and open green spaces for the community to walk and improve their health; these stations are more populated, and some areas include industrial areas that make walking tricky. It is important that more transport options in areas outside of walking zones can create balance and create a sustainable environment overall.

Category 1: Abundant Green Areas with Limited Accessibility

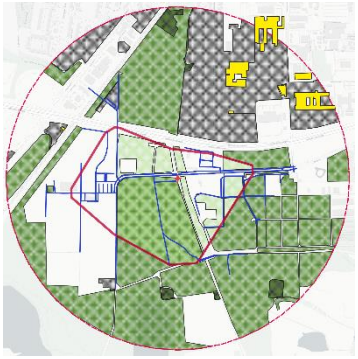
Stations: Egoje Station, Brodeskov Station, Roskilde Festival Station.



Egoje Station



Brodeskov Station



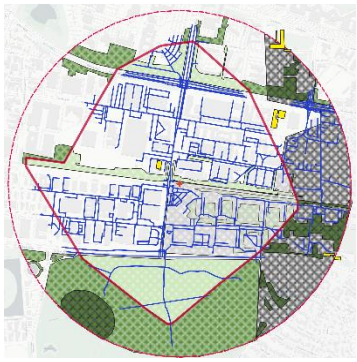
Roskilde Festival Station

Within the to begin with category the ranges around the TOD zones contain wide green spaces secured with different plant life. These stations are situated in rural ranges where buildings are divided, and the populace thickness tends to be lower. Although green space is copious, coming to these ranges is frequently a challenge. The need of persistent person on foot ways and the disconnected street systems make it troublesome for inhabitants to get to these green spaces inside sensible strolling remove. Strolling times habitually outperform the 10-minute check, making it unreasonable to reach these ranges without the utilization of cars. As a result, families who have to be get to instructive teach are more likely to depend on elective shapes of transportation.

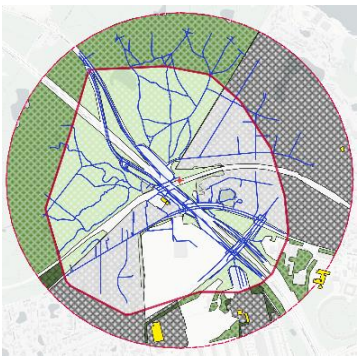
Category 2: Balanced Green and Gray Areas with Better Integration

Stations: Koge Nord Station, Malmparken Station, Skovbrynet Station, Allerod Station, Stenlose Station, Skovlunde Station.

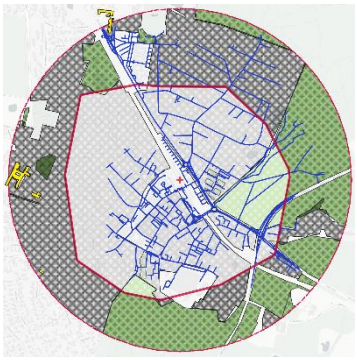
Koge Nord Station



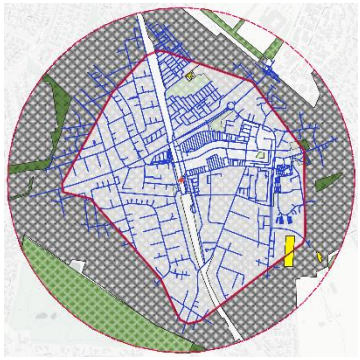
Malmparken Station



Skovbryent Station



Allerod Station



Stenlose Station

Skovlunde Station

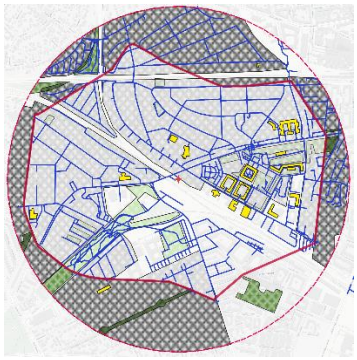
There is an equivalent division between the built environment, presented as grey space, and green areas. Illustrated maps displayed that access to these areas is feasible in specific stations because walking infrastructure is proper, and service areas cover almost the whole part of the buffer zone for the community. A station like Malmparken is located in semi-industrial areas, and these shortcomings are in the required residential areas and Skovlunde. In Koge Nord station, a good combination of both spaces can be seen. Unfortunately, because the highway is in the middle of the connection zone and access is only doable by the bridge, it brings some limitations for people. Although the appropriate separation between the zones appears in Allerod, poor access and interconnection at some points of the buffer are evident.

Category 3: Predominance of Gray Areas with Insufficient Green Spaces

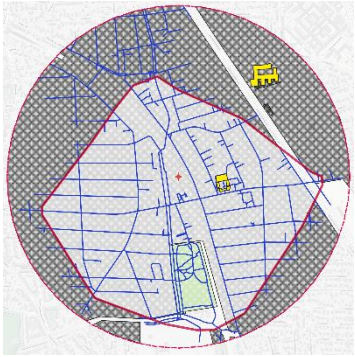
Stations: Vaerlose Station, Frederikssund Station, Vigerslev Alle Station, Dyssegard Station, Bernstorffsvej Station, Charlottenlund Station, Buddinge Station, Hvidovre Station, Sydhavn Station.

Vaerlose Station

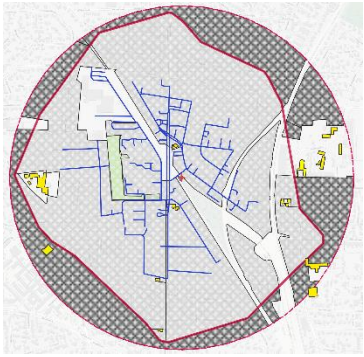
Frederikssund Station



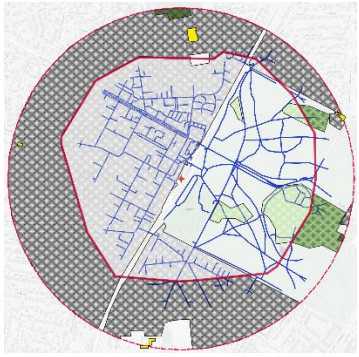
Vigerslev Alle Station



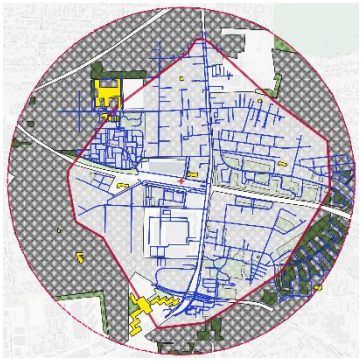
Dyssegard Station



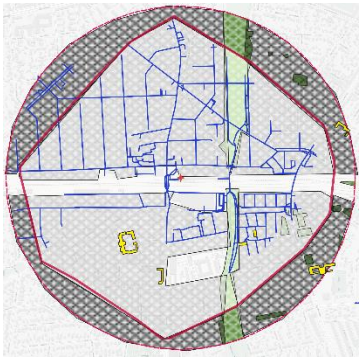
Bernstorffsvej Station



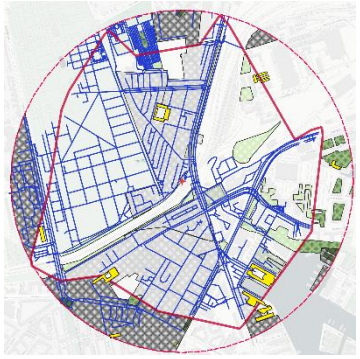
Charlottenlud Station



Buddinge Station



Hvidovre Station



Sydhavn Station

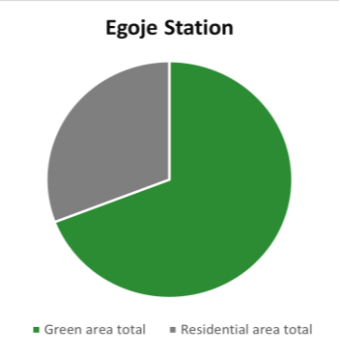
The third category emphasizes stations found in ranges ruled by private grey spaces where green spaces are rare or nonexistent. This shortage seriously limits inhabitants' get to parks or nature, causing a need for normal zones to bolster their prosperity. The difference between built-up spaces and green situations presents significant challenges influencing the general quality of life. Broad investigation has highlighted the significance of urban green spaces in advancing sound economic communities. There's a frequent deficiency in getting to green ranges due to the high number of citizens where lodging needs take priority over the arrangement of regular open spaces. Moreover, urban arranging hones have habitually ignored the significance of maintainability and long-term well-being in favor of improvement objectives.

4.6. Comparison of the total area of Grey and Green area:

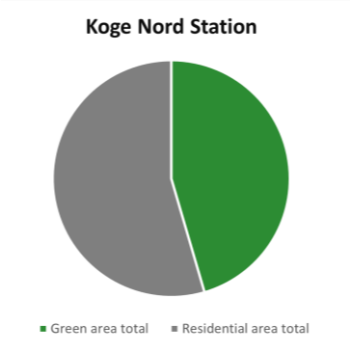
The analysis of the grey and green areas across the 18 stations highlighted some challenges and opportunities for developing urban spaces that prioritize human well-being. Each station shows its distribution of green (natural) and grey (residential) areas, which has significant implications for social unity, health, and the broader sustainability of the urban landscape. The accompanying pie charts provide a visual representation, where the green portion illustrates the overall extent of green spaces, while the grey portion represents the residential area.it is evident that grey areas such as residential areas are the leading and important areas, which are the homes for individuals and create human-centric hubs for various activities, they should be appropriately integrated into the urban environment while residential areas are beneficial, but if these areas are positioned far from community needs, and services people may face challenges for their daily life. Green areas mean accessible open spaces for human activity. The availability of green areas is the primary need of people because it can reduce stress and boost mental and physical health. People are more likely to feel healthy when they are connected to greenery. The best interaction and position between residential areas and green open spaces can satisfy human desires and improve sustainable community and resilience. Urban development must be aligned with green and grey environments because diversity in land use and residential areas is important, and easy access to green urban fabric is fundamental. Design cities, specifically TOD areas characterized by proper integration between green and grey areas, can enhance walking and movement because by providing pedestrian-friendly spaces, pavement, and reachable

distance to green parks and gardens in urban concept, the sense of inclusion will increase and people less likely to feel inequality, they can conveniently improve their social lives and connect with the community also by merging green and grey spaces in urban areas there is the appropriate connection among natural areas and manufactured areas will form that adapt situation for fostering ecological connectivity and sustainable urban development for current and future generation.

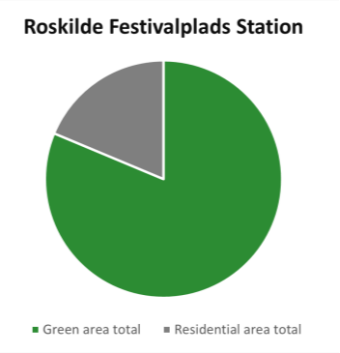
1-Egoje: This station has a green area of 1,561,344 square meters, with residential space amounting to 696,372 square meters. The number of green areas is more than the number of residential spaces, which leads to an imbalance; it should be mentioned that there is a need for residential development and accessibility.



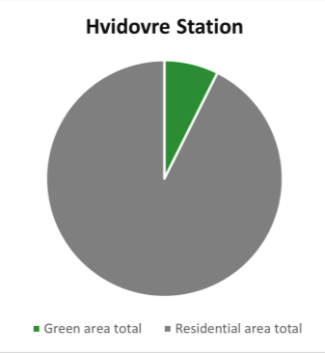
2- **Koge Nord**: This station features 557,429 square meters of green space compared to 668,307 square meters of residential area, which shows a balance between areas. Access to both green and grey spaces effectively provides community well-being.



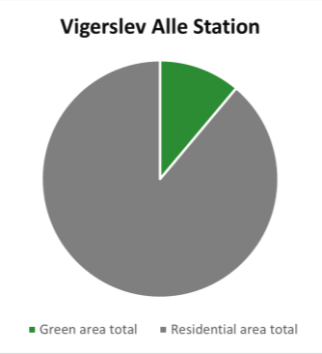
3- **Roskilde Festivalplads**: This station boasts 1,561,344 square meters of green space, far exceeding the 359,240 square meters of residential area. The vast area belonging to the greenery leads to an unequal situation, and residents need attention for more advancement.



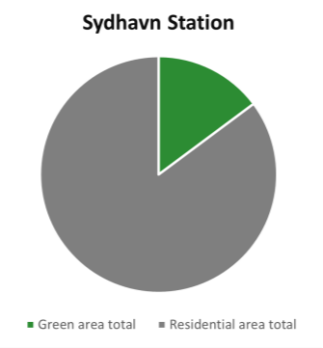
4-Hvidovre: The green space in Hvidovre measures 132,713 square meters, which is relatively small compared to its sprawling residential area of 1,660,969 square meters. This station needs immediate action to improve green space because individuals are more likely to feel unsatisfied due to poor access to green areas.



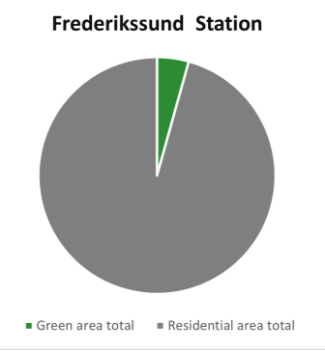
5- Vigerslev Alle: The station features 147,601 square meters of green space alongside 1,178,182 square meters of residential area. While this station is full of residential zones, some green areas must be established to make the urban areas equitable.



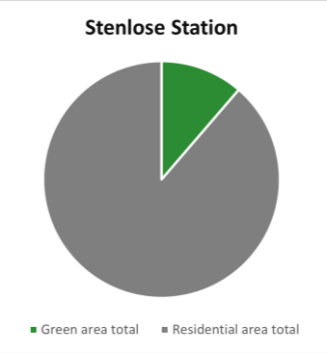
6- **Sydhavn**: It faces a significant imbalance with 117,949 square meters of green space and 678,829 square meters of residential area. Limited green spaces may raise health problems for residents, and there are many opportunities to build more friendly and comfortable areas for walking.



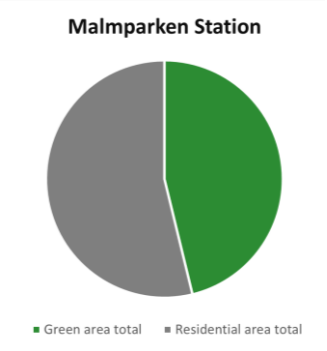
7-Frederikssund: The 222,437 square meters of green space stand in stark contrast to the expansive residential area of 4,917,855 square meters, revealing a significant imbalance. Humans require social interaction, and in this station, there are poor green areas, which brings about social inequality.



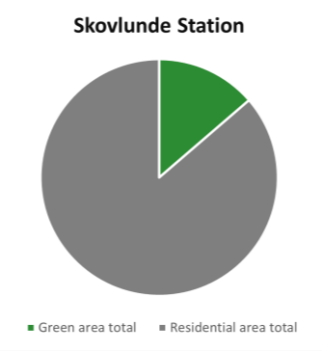
8-Stenlose: The green space of 208,274 square meters, compared to the residential area of 1,634,229 square meters, indicates a significant shortage of natural areas for the population's housing requirements. Poor green areas are harmful to all communities.



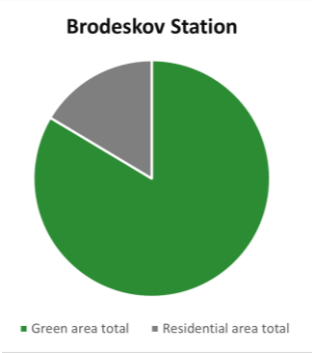
9-Malmparken: This station achieves a harmonious balance, with 726,705 square meters of green space compared to 846,519 square meters of residential area. The situation showed that access to grey and green areas is balanced. However, due to its position in an industrial area, the community demands access to vaster green areas. It should be more convenient near the station, not far away, and inaccessible on foot.



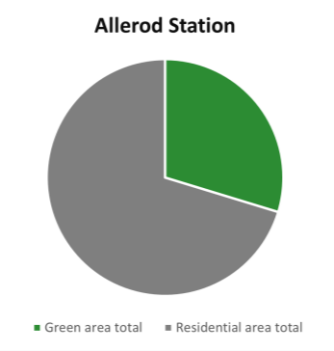
10-Skovlunde: This station features 314,257 square meters of green space and 1,985,773 square meters of residential area. Greenery in the station surroundings is desired to improve social wellness and attract community interaction. However, its position in semi-industrial areas prevents the community from accessing the green areas by walking due to the low movement in the neighborhood.



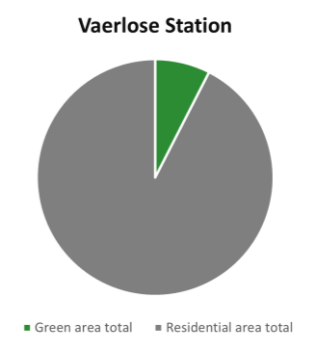
11-Brodeskov: It is distinguished by its significant emphasis on nature, with 1,471,565 square meters of green space and 288,975 square meters of residential area. Massive green areas may persuade residents to move from the neighborhood because they might feel unsafe and separated from other zones.



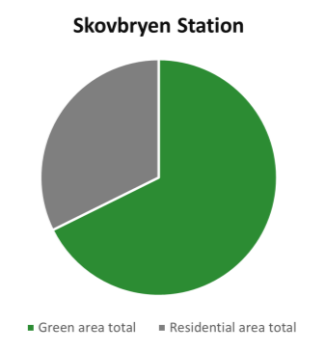
12-Allerod: The green space in this area spans 528,245 square meters, while the residential area covers 1,249,906 square meters. Although the current balance between the two is well-maintained, boosting the portion of the green areas can improve physical activity and social integration.



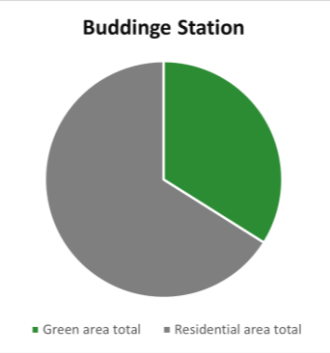
13- Vaerlose: The green space covers 182,034 square meters, while the residential area spans 2,235,388 square meters, highlighting a notable disparity between the two. People are in high demand to have comfortable access to green areas. This area is not a good location for walking because there is no attraction like a park or garden.



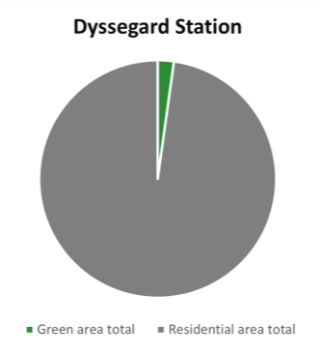
14-Skovbryent: It stands out with 870,733 square meters of green space, complemented by 415,768 square meters of residential area. The natural environment covers a significant area; this area is not a good detonation area for visitors during lousy weather.



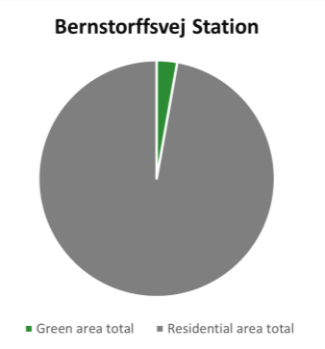
15-Buddinge: This station includes 708,869 square meters of green space alongside 1,379,126 square meters of residential area. While the amount of green space is reasonable, fostering green areas can increase social communication. Also, a balance between natural and human-made space can lead to better life quality due to proper access.



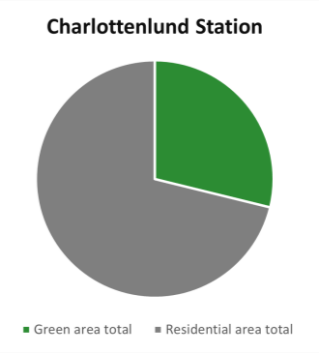
16-Dyssegard: This station faces a significant challenge, with only 62,620 square meters of green space in contrast to the expansive residential area of 2,782,330 square meters. Most people residing in these areas must walk or use a car to go to other places to use green open spaces. There is a high demand to create green areas to improve ecological connection, and access to green areas can improve mental and physical health.



17-Bernstorffsvej: This station features a relatively small green space of 54,105 square meters, contrasted with a much larger residential area of 1,874,127 square meters. The shortness of the green environment makes this area less attractive for families with children because all humans need to connect to green spaces.



18-Charlottenlund: The green space covers 644,042 square meters, whereas the residential area spans 1,589,016 square meters. Improving green areas can foster community engagement and motivate people to walk more. More greenery is required for better interaction, and direct access to green spaces can foster sustainable development in the station's surroundings.



4.7. Discussion

4.7.1. Successful TOD and Barriers to Implementation

In this thesis, the Transportation-Oriented Development (TOD) concept is used and investigated as a new urban strategy in contemporary urban spaces. By assessing the accessibility of educational centers and green and built environments, the findings illustrated important information regarding equity, social justice, and the real-life experiences of individuals in urban spaces. Successful TOD relies on three urban dimensions: dense and compact areas, various mixed-use neighborhoods, functional urban settlement plans, and transportation design, which are agreed upon by Yen et al. (2024). These characteristics can be seen in most of the stations; in Copenhagen, the urban form is sprawl and low density, and to create the best areas, there is room for government and local actors to identify areas' demands. Essential action needs to be set at the regional level to meet community needs, like fostering high-quality and frequent public transportation, followed by Hrelja et al. (2022) ideas. Also, collaboration between stakeholders and inviting the community to engage with this project is required because improving public transportation and providing pedestrian-friendly design depends on geographical location. Also, market demand and capacity

need to be analyzed to provide better services to residents. Walking as a primary means of human movement in urban areas must be prioritized, and by designing and planning urban fabric that is attractive enough and equipped with appropriate infrastructure to motivate residents to walk, this idea is similar to Jacobson and Forsyth's. (2008) point of view. Focusing on the success of the criteria for accessibility to transport hubs is very important in Copenhagen's concept because public transportation is expensive, and some communities cannot afford it. Also, walking distance is not feasible in some neighborhoods. There is no proper environment to walk in with good lighting and attractive mixed-use, which can bring about social inequality. This situation can be addressed by specific offers and plans for limited communities, such as students making transportation more user-friendly and cost-effective and increasing transit utilization. Urban planning policies are very effective for urban and suburban residents because economic opportunities and market demand should help people gain goals at the regional level and cover all communities. After all, implementing TOD can lead to gentrification, displacing low-income residents. Public-private partnerships offer better situations for the community in any position and life conditions by focusing on appropriate infrastructure investment, most notably on walking. This suggestion was mentioned by Carlton (2009) in other studies. It can motivate the community to be more active, healthy, and equal society.

4.7.2. Accessibility to Educational Centers

In the case study, a major problem was that many educational centers located outside the 800-meter buffer zone of Transit-Oriented Development (TOD) raised significant accessibility concerns. Regardless of the type of educational facility, the thesis pointed out that these centers are not well accessible by foot due to their location in scattered urban areas. This observation is consistent with the findings of El-Geneidy et al. (2010), who noted that actual walking routes to public transport often overreach the ideal walking length that is commonly used in planning. Limited access to educational facilities thus contributes to an unequal urban environment where walking becomes a fundamental means of transport, especially in areas with low population density and poor overall connectivity. These circumstances encourage people to move to denser areas with better educational services. These inequalities lead to uneven distribution of services

and strengthen, existing disparities in access to education, preventing progress toward more balanced and equitable urban development.

4.7.3. Accessibility in Grey and Green areas

Green regions in urban situations are basic components, particularly in Transit Oriented Advancements TODs where the zone is based on supportability and centricity. Green spaces are basic for progressing the sense of having a place and recognition, improving social interaction, and cultivating community wellness. Ponders that get to green regions like parks and gardens emphatically influence human well-being. Moreover, these spaces play an imperative part in diminishing stretch and moving forward mental well-being steady with Ekkel and de Vries's (2017) discoveries. The nearness of green spaces is additionally fundamental for progressing communication and social cohesion inside private zones. These spaces ought to be within a five-minute walk of the private center to permit visit use and aggregation into the way of life. This concept is bolstered by the seas of Wilbur et al. 2002, and Etzioni (1998). Be that as it may, in a few zones, the need for green space or the hardness of accessing it by street, which regularly requires longer commute times, maybe a major challenge. People periodically feel confined and detached without simply get-to-dim zones, as seen in a few of the case ponder stations. The need for green space limits openings for social interaction and breaks the natural quality and common prosperity that contributes to a cohesive community. The availability of dim spaces, particularly private zones, in a TOD environment is vital because it impacts the social structure altogether. The investigation appears that the destitute nearness to private ranges contrarily impacts commuters' transport choices at a few stations. When private ranges are not congenial on foot, individuals are constrained to utilize motorized transport, which comes about in longer and more tiring ventures. Physical and mental stretch caused by longer commutes highlights the importance of astute urban arranging. When private ranges are well associated with open transport frameworks, individuals are propelled to walk more effectively and comfortably, making it simpler to move between goals. This rule (Purwantiasning 2017) focuses on emphasizes the requirement for urban situations that prioritize the comfort network and prosperity of inhabitants. In addition, the achievability of green

and grey spaces is fundamental in choices around family areas and travel designs. The need for these spaces can result in urban situations that don't meet the demands of inhabitants, particularly in regions with a thick population and a lack of framework. As a result of long commutes or strolls, the efficiency level will diminish but cause physical weariness push and, indeed, sadness. Individuals living in regions with less reachability to other regions are regularly more seriously influenced by the insufficiencies of the urban situations in which they live. This highlights the requirement for evenhanded urban arranging to ensure that all communities have get to the spaces required for both physical wellbeing and social association.

4.7.4. Compare the Stations in terms of Accessibility to Green and Grey areas

When it comes to creating grey and green spaces, each station presents special challenges. A few regions take advantage of the enormity of green spaces, whereas others confront confinements that adversely impact both social cohesion and natural quality. Stations like Roskilde Festivalplads, Brodeskov, and Egoje illustrate the positive effect of prioritizing green spaces in urban planning. These stations are secured in terms of green ranges that advance natural maintainability and boost the great feeling of the community. However, these stations are located far from the center and are characterized by less population. The advantage of access to greenery is not a functional outcome; only local residents benefit from it. In contrast, in Dyssegard, Bernstorffsvej, and Hvidovre, a lack of existing green areas appeared it is proved that The nearness of parks, gardens, and open green spaces leads to cultivating a sense of having a place among inhabitants, energizes social intelligence, and contributes to making a cohesive community. To be the negative result of a deficiently green foundation. These spaces offer the wants of individuals from the built environment, supporting mental well-being and giving important openings for unwinding and association. In differentiation, Dyssegard, Bernstorffsvej, and Hvidovre appear to be the negative result of a deficiently green foundation. The need for available green spaces in these station buffer areas leads to social segregation, and neighborhood residence quality probably decreases. The deficiency of green spaces proved that it could diminish physical and mental prosperity. Lack of access to open spaces like parks may bring about a sense of loneliness due to shortcomings in social communication. People may feel detached from both their environment and each other, undermining the sense of community. This comparison decides the significance of urban arranging

that coordinates both green and grey spaces. Getting an adjustment between common regions and frameworks is fundamental for making lively interconnected communities where all inhabitants have access to spaces that increment their great feelings and sustain social associations.

4.8. Policy Recommendations for Improving Accessibility and Equity in TOD Areas:

At this point, there is a set of policy recommendations that aims to enhance accessibility, promote equity, and support the sustainable development of Transit-Oriented Development areas (TOD). These policies are designed to address issues such as unequal access to educational facilities, a lack of sufficient green spaces, poor connectivity between residential neighborhoods, and gaps in transit infrastructure. Urban planners and policymakers can create TOD environments that promote social equity, enhance community well-being, and ensure long-term urban sustainability by focusing on these areas.

4.8.1. Alignment with case study:

The proposed policies directly address the challenges identified in the case study:

Educational Accessibility: Stations such as Charlottenlund and Bernstorffsvej require improvements in walkability and more efficient transit options to enhance connectivity between schools and nearby residential areas.

Green Space Deficiency: Areas like Hvidovre and Dyssegard emphasize the need for better access to public parks and recreational spaces that are easily accessible to all residents.

Transit Gaps: Stations like Brodeskov and Roskilde Festivalplads need expanded transit services to improve connectivity and overall accessibility for surrounding neighborhoods.

By prioritizing these specific actions, urban planners can ensure that TOD areas become more equitable, accessible, and capable of fostering vibrant, inclusive communities.

-Improving Accessibility to Key Amenities:

Equality of access for all residents is essential to guaranteeing effortless access to educational facilities, green spaces, and residential areas in TOD areas.

Improve walking and cycling: Special attention should be paid to the development of safe and well-maintained pedestrian and cycling routes that integrate residential areas with schools, parks, and public transportation stations. These routes should be designed to be appealing, effective, and accessible to people of all ages and abilities. An attractive means of daily transportation.

Expand public transport connectivity: Many areas outside the 800-metre TOD buffer zone currently lack adequate public transport options, limiting access to essential services and amenities. To fill this gap, existing transit routes will need to be modified, and new shuttle services will need to be deployed to improve connectivity. Strengthening these transit networks can ensure that underserved neighborhoods are integrated into the broader urban mobility framework, promoting better inclusion for all residents.

-Promoting Mixed-Use Development and Affordable Housing:

A more thoughtful and combined approach to urban design is needed to create dynamic, compact urban environments that minimize travel distances and meet communities' distinct needs.

Land use integration: A more integrated approach to land use should be encouraged, where residential, commercial, and recreational spaces are developed close to public transport stations. This model reduces car dependency, stimulates local economic growth, and promotes social interaction. The project encourages creating dynamic, cohesive communities where residents can live, work, and enjoy recreational activities, all in a compact, walkable environment.

Support affordable housing: It is essential to prioritize the evolution of affordable housing close to public transport hubs. By ensuring that low and moderate-income families have access to affordable housing in TOD areas, we are taking an important step toward easing the burden of long-distance travel and improving mobility. This policy also recommends that all residents,

regardless of income level, can equally benefit from the opportunities and amenities that TOD projects provide**.**

-Enhancing Public and Green Spaces:

Creating a healthy and interconnected urban atmosphere is essential to promoting vibrant and inclusive public spaces, improving community well-being, and encouraging social connection.

Improve green spaces: Green spaces should be located within a five-minute walk (approximately 400 meters) from residential areas to ensure they are reachable to all. These spaces should be well-conserved, clearly signposted, and well-lit, creating a welcoming environment for all people, including those with limited mobility. Accessible and attractive green spaces promote physical activity and proper areas for exercising and recreation while fostering a sense of community and connectedness among residents.

Support community-led placemaking: It is essential to actively engage residents in designing, maintaining, and activating public spaces. By encouraging initiatives such as urban gardening, tree planting, and public art installations, residents can help create spaces that reflect their shared identity and meet their common needs. This co-creation process strengthens social bonds and improves the overall quality of life in TOD areas.

-Addressing Social Inequities:

Addressing differences in access to critical urban infrastructure, especially in deprived communities, requires ensuring that all residents have equal opportunities to thrive.

Focus on underserved areas: Priority should be given to less aggregated areas and underserved neighborhoods that often face significant challenges in accessing essential amenities such as proper residential zones, constitute of education, green space, accessible transportation, and healthcare.

By investing in these areas and improving connectivity to transit hubs and other essential services, urban planners can help break inequality and promote more significant equity in TOD areas.

Using data to create equity: Data-driven planning tools, such as geographic information systems (GIS), are essential to identifying areas with the most significant access gaps. This analytical approach allows policymakers to focus on areas that need the most support, ensuring that initiatives to enhance access and equity are targeted and effective.

CHAPTER FIVE: CONCLUSION

5.1. Comprehensive Reflection on Transit-Oriented Development (TOD)

As urbanization persistently transforms metropolitan landscapes in the 21st century, the necessity for sustainable and inclusive urban environments has become increasingly critical. Transit-Oriented Development (TOD) represents a viable strategy to confront these complexities. By advocating for the establishment of densely populated districts that incorporate a variety of functions in proximity to transit nodes, TOD seeks to foster urban settings that emphasize accessibility, connectivity, and sustainability. By prioritizing walkability and diminishing dependency on private transportation, TOD envisions urban spaces that are not only efficient but also equitable and sustainable for all residents. About the outcomes of this thesis, I have determined that the analysis is both practical and enlightening. It underscores the significant potential of TOD to enhance urban areas with accessibility, equity, and sustainability. Nevertheless, the thesis also identifies domains where TOD could be further developed, such as improving access to education, green spaces, and residential neighborhoods. This observation resonates with me, as it reinforces the principle that urban design must be responsive to the multifaceted needs and experiences of the individuals who inhabit these environments.

5.2. The Importance of Accessibility to Education and Grey and Green areas

One of the essential issues highlighted in this examination relates to the confined openness of instructive education inside. Transit-Oriented Development (TOD) locales Instructive offices are habitually arranged at impressive separations from open transportation hubs, constituting a considerable deterrent to evenhanded instructive. Instruction is not, as it were, an instrument for strengthening a person but, moreover, a crucial human right and a foundation of social value. The difference between the standards of TOD and the reality of instructive availability requires reevaluating urban arranging techniques because the matter is not education. The challenge is how they can reach it. The functional method is that all pupils and families have a reasonable approach to education, guaranteeing that instructive openings are accessible to all people independent of their private circumstances. Besides, the lack of available green spaces in specific TOD neighborhoods contributes to aberrations in urban living conditions. Green spaces are commonly respected as fundamental conveniences. They play a pivotal part in cultivating mental well-being and upgrading community prosperity. Such regions are imperative for encouraging social, intuitive

unwinding, and physical movement. Within the nonappearance of helpful get-to-parks and recreational offices, urban presence may end up disassociated from the familiar environment, resulting in segregation and reduced quality of life. In this respect, green spaces rise above unimportant tasteful capacities. They fundamentally advance a sympathetic and interconnected urban scene. Tending to the insufficiency of green spaces in TOD zones is essential for developing neighborhoods where community individuals encounter network engagement and bolster their day-by-day lives. This inquiry also emphasizes neighborhoods with impressive potential to impact urban involvement inside the TOD system. Well-integrated regions' nearness to travel hubs presents an opportunity to set up wonderful walkable communities. Such situations diminish dependence on private vehicles and energize more feasible transportation alternatives, counting cycling and electric transport shapes and upgrading inhabitants' versatility. As this demonstrates, when neighborhoods need a satisfactory network of travel stations, the preferences related to TOD are notably lessened. Drawn-out commutes and increased reliance on automobiles are not as if they were a waste of time and vitality but are too hurtful to both physical and mental well-being. This difference implies a more significant social hardship. Inhabitants possessing immature neighborhoods are the people most unfavorably influenced by the results of insufficient urban planning.

5.3. The Path Toward Inclusive and Walking-Friendly Community

To comprehensively correct openness insufficiencies, Transit-Oriented Development TOD) must expand past only upgrading the physical framework. It must prioritize the development of cohesive, interconnected, and comprehensive communities. A crucial viewpoint of this technique is the amalgamation of instructive educational green spaces and private ranges, which are crucial for the viability of TOD. The observational investigation underscores the need to arrange these components inside a pedestrian-friendly separate from travel hubs. When instructive offices, parks, and lodging choices are open, interconnected, and helpfully reachable on foot, inhabitants encounter improved versatility, decreased commuting lengths, and an increased sense of having a place inside their community, which emphatically impacts human behavior. This integration encourages development and contributes to the foundation of social systems and the support of community personality. When people can walk to their working environments instructively and

directly approach parks or other green spaces, their dependence on amplified commutes through physical mobility (as green activity) is leveled up, and automobile reliance is reduced, subsequently advancing expanded essential requirement intuition inside the neighborhoods. Such an environment incites a significant sense of association to the districts where people live, work, and reproduce, eventually coming about in urban settings where the quality of life is not managed by the distance required to reach fundamental administrations but by the ease with which one can participate in daily activities.

5.4. Case Studies and Potential at the Regional level

The investigation highlights the surprising victory stories of particular travel center points such as Dyssegard and Allerod. These areas exhibit the successful integration of Transit-Oriented Development. TOD standards can lead to well-connected, productive, and economical urban situations. By combining open transportation frameworks with pedestrian-friendly plans, mixed-use spaces, and available civilities, these centers illustrate the transformative potential of TOD in upgrading versatility and cultivating dynamic urban communities. These cases serve as profitable models for other cities endeavoring to optimize their travel systems and urban formats. In any case, the ponder too sheds light on the confinements confronted by ranges like Dyssegard, Bernstorffsvej, and Hvidovre, where the need for green spaces and lacking network to private zones (residential spaces) have prevented the total usage of TOD standards. These challenges underline the significance of tending to systemic boundaries and prioritizing incorporating green spaces and consistent associations between private neighborhoods and travel centers. Without these essential components, the genuine benefits of TOD remain undiscovered in these locales, creating missed openings for urban advancement. Despite these deterrents, the think emphasizes the endless potential for growing TOD activities on a territorial scale. By recognizing and tending to the holes in less fruitful zones and applying lessons learned from flourishing center points, city organizers and policymakers can make a more coordinated and cohesive urban system. This approach includes bridging the partitions between travel centers and private zones, making strides in framework, and guaranteeing that all inhabitants have evenhanded get to open transportation green spaces and fundamental administrations. The proposition contends that receiving TOD standards can improve urban life by advancing availability, supportability, and social value.

Through collaborative endeavors and focused ventures, cities can change into energetic, flexible, and comprehensive spaces that prioritize the prosperity of their inhabitants. By learning from the victories of well-performing travel center points and handling the challenges confronted by others, urban ranges can move closer to a future where network natural well-being and decency are at the center of advancement.

5.5. The Wider Impact of TOD and Its Practical Implications:

This part sheds light on how Transit-Oriented Development TOD can be a transformative approach to urban arranging. By moving forward with walkability, fortifying open travel frameworks, and joining more green spaces, TOD makes urban zones that are not as it were interconnected but too ecologically inviting and decent. This transformative modification in urban fabric can improve the quality of life for inhabitants, cultivating dynamic, steady communities where individuals feel associated and esteemed. TOD goes past the foundation to advance inclusivity. It envisions cities where everybody, regardless of wage foundation or capacity, has risen to fundamental administration openings and open spaces. This comprehensive approach can address numerous disparities that continue in today's urban situations, making cities more inviting and impartial. The point is to form neighborhoods where all inhabitants feel a sense of having a place and have the assets, they need to flourish in expansion to advance social balance. TOD has broader suggestions for maintainability. By empowering the utilization of public transportation and decreasing dependence on cars, TOD contributes to reducing carbon outflows and securing the environment. At the same time, the consolidation of green spaces has made strides toward discussing the quality of recreational openings. It reinforces communities by giving ranges where individuals can accumulate and interface with nature. However, it is essential to mention that all these integrations and updating TOD standards depend on the regional capacity and policymaker capability. It is critical to offer appropriate services to many individuals. As a result, in this case study, many stations were shaped by low density and less populated. Embracing TOD standards at the regional level can address financial differences, rural corruption, and urban sprawl. This approach highlights how keen urban planning can back supportability, decency, and human prosperity. At a time when cities are hooking with developing imbalances and natural challenges, TOD offers a guide for making urban spaces that are energetic, flexible, and comprehensive. Eventually, TOD

speaks to a vision of urban life that equalizes financial opportunity, natural duty, and social equity. By centering on people groups' needs and making evenhanded get to resources, TOD gives a down-to-earth and confident way forward for building cities that serve everybody. We will shape a future where urban ranges are flourishing centers of opportunity, maintainability, and decency through cautious arranging and collaborative endeavors.

5.6. Final Reflection

I emphatically bolster the thoughts and suggestions in moving forward with Transit-Oriented Development (TOD). The inquiry highlights the significance of keen urban arranging that makes it simpler for individuals to get to fundamental places like educational centers, green spaces, and human settlement (as grey areas), and imperative administrations by centering on openness and reasonableness city planners can make communities that serve the requirements of all inhabitants. The accentuation of making these zones more associated and open for everybody is significant in forming urban zones that are utilitarian and inviting. TOD offers a capable vision for changing cities into dynamic, well-connected situations that provide more development interaction and versatility opportunities. It can provide more opportunities for improvement in job location and advancing economic capacity by investigating market conidiation at the local level, which leads to less commuting and reasonable access to essential demands. It is not a fair planning concept, but it could be a call to activity for those included in forming long-standing times of urban life. This thought inclinations us to rethink how we construct our cities to guarantee they are not only helpful and practical but also profoundly established in human needs and encounters. The long run of urban living should strike an adjustment between essential viewpoints of lifestyle such as get-to-instruction nature and transportation. A well-rounded approach to city arranging would guarantee that all individuals, in any case of their foundation or circumstances, have the potential to obtain better circumstances, even with or without the assets and openings that empower them to flourish. Applying TOD standards can construct more feasible, comprehensive, and evenhanded urban spaces that reflect the requirements of all citizens. The thoughts in this consideration can aid cities that bolster human prosperity, cultivate community, and advance a high quality of life for everybody.

Abadi, A. A., & Nugraha, M. R. (2020). Dealing with private and public space interface problem in TOD area: Case study of Batuceper Station, Tangerang. *IOP Conference Series: Earth and Environmental Science, 532*(1), 012003. https://doi.org/10.1088/1755-1315/532/1/012003

Andi, I., Widayati, N., Priyomarsono, P., & Siwi, S. H. (2022). Analysis of the accessibility of pedestrian paths in Thamrin City area based on the Transit-Oriented Development (TOD) concept. https://doi.org/10.2991/assehr.k.220404.038

Arliani, V., Sjafruddin, A., Santoso, I., & Winarso, H. (2024). Accessibility and land use effect of residential area with different TOD typology to value creation. https://doi.org/10.1088/1755-1315/1294/1/012006

Bajracharya, B., Khan, S., & Longland, M. (2005, November 30). Regulatory and incentive mechanisms to implement transit-oriented development (TOD) in South-East Queensland. *The State of Australian Cities (SOAC) National Conferences* (pp. 1–16). Brisbane: Urban Research Program at the South Bank Campus, Queensland Conservatorium, Griffith University.

Bejleri, I., Steiner, R. L., Fischman, A., & Schmucker, J. (2011). Using GIS to analyze the role of barriers and facilitators to walking in children's travel to school. *Urban Design International, 16*(1), 51–62. https://doi.org/10.1057/UDI.2010.18

Bencekri, M., Lee, D., Ku, D., & Lee, S. (2024). A planning support system for boosting walkability**.** *Proceedings of the Institution of Civil Engineers*, 1–14. https://doi.org/10.1680/jmuen.23.00040

Berawi, M. A., Saroji, G., Iskandar, F. A., Ibrahim, B. E., Miraj, P., & Sari, M. (2020). Optimizing land use allocation of transit-oriented development (TOD) to generate maximum ridership. *Sustainability, 12*(9), 1–20. https://doi.org/10.3390/su12093574

Bierbaum, A. H., Vincent, J. M., & McKoy, D. L. (2010). Putting schools on the map: Linking transit-oriented development, families, and schools in the San Francisco Bay Area. University of California, Berkeley. Retrieved from https://escholarship.org/uc/item/0t52k01p

Borgers, A. W., Snellen, D., Poelman, J., & Timmermans, H. J. (2008). Preferences for car-restrained residential areas. *Journal of Urban Design, 13*(2), 257–267. https://doi.org/10.1080/13574800801965719

Calthorpe, P. (1993). The next American metropolis: Ecology, community, and the American dream**.** Princeton, NJ: Princeton Architectural Press.

Carlton, I. (2009). Histories of transit-oriented development: Perspectives on the development of the TOD concept. University of California, Berkeley, Institute of Urban and Regional Development. Retrieved from https://escholarship.org/uc/item/7wm9t8r6

Cervero, R., & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment, 2*(3), 199–219. https://doi.org/10.1016/S1361-9209(97)00009-6

Cervero, R., Ferrell, C., & Murphy, S. (2004). Transit-oriented development in the United States: Experiences, challenges, and prospects. Washington, DC: National Academies Press. https://doi.org/10.17226/23360

Chachondia, H., & Shukla, S. (2022). Transit-oriented development: Elixir to urban challenges. *International Journal of Progressive Research in Engineering Management and Science (IJPREMS), 2*(11), 8–18. https://doi.org/10.58257/IJPREMS30467

Chatman, D. G. (2013). Does TOD need the T? Auto use, residential sorting, and access to rail. Retrieved from https://trid.trb.org/view/1243004

Chica-Olmo, J., Rodríguez-López, C., & Chillón, P. (2018). Effect of distance from home to school and spatial dependence between homes on mode of commuting to school. *Journal of Transport Geography, 72*(2), 1–12. https://doi.org/10.1016/j.jtrangeo.2018.07.013

Corbane, C., Pesaresi, M., Panagiotis, P., & Kemper, T. (2018). The grey-green divide: Multi-temporal analysis of greenness across 10,000 urban centres derived from the Global Human Settlement Layer (GHSL). *International Journal of Digital Earth, 13*(1). https://doi.org/10.1080/17538947.2018.1530311

Dhini, D. R. F., & Wonorahardjo, S. (2020). A review of urban visual environment in transit-oriented development (TOD): Visual comfort and disturbance. *IOP Conference Series: Earth and Environmental Science, 532*(1), 012008. https://doi.org/10.1088/1755-1315/532/1/012008

Dittmar, H., & Ohland, G. (Eds.). (2003). The new transit town: Best practices in transit-oriented development. Washington, DC: Island Press.

El-Geneidy, A., Tétreault, P., & Surprenant-Legault, J. (2010). Pedestrian access to transit: Identifying redundancies and gaps using a variable service area analysis.

El-Geneidy, A., Tétreault, P., & Surprenant-Legault, J. (2014). New evidence on walking distances to transit stops: Identifying redundancies and gaps using variable service areas. *Transportation, 41*(2), 289–301. https://doi.org/10.1007/s11116-013-9508-z

Ekkel, E. D., & de Vries, S. (2017). Nearby green space and human health: Evaluating accessibility metrics. *Landscape and Urban Planning, 157*, 214–220. https://doi.org/10.1016/j.landurbplan.2016.05.007

Gilat, M., & Sussman, J. M. (2003). Coordinated transportation and land use planning in the developing world: Case of Mexico City. *Transportation Research Record: Journal of the Transportation Research Board, 1859*(1), 13–20. https://doi.org/10.3141/1859-13

Green, T. L. (2017). Enriching educational leadership through community equity literacy: A conceptual foundation. *Leadership and Policy in Schools*. https://doi.org/10.1080/15700763.2017.1326148

Hardi, A. Z., & Maatouk, M. M. H**.** (2023). The criteria and indicators for applying transit-oriented development (TOD) in metropolitan cities based on lessons learned from international experiences. *European Journal of Architecture and Urban Planning, 2*(2), 1–14. https://doi.org/10.24018/ejarch.2023.2.2.25

Harmain, R., Hasibuan, H. S., & Sodri, A. (2021). Carrying capacity of transit-oriented development (TOD) area in Jakarta. *IOP Conference Series: Earth and Environmental Science, 716*(1), 012131. https://doi.org/10.1088/1755-1315/716/1/012131

Hasan, P., Harimardika, M. R., Sugangga, M., Soelaiman, M. A., Ilhami, H., & Yasin, M. (2022). Space syntax analysis for assessment of TOD area. *IOP Conference Series: Earth and Environmental Science, 1058*(1), 012027. https://doi.org/10.1088/1755-1315/1058/1/012027

Hess, D. B., & Lombardi, P. A. (2004). Policy support for and barriers to transit-oriented development in the inner city: Literature review. *Transportation Research Record: Journal of the Transportation Research Board, 1887*(1), 26–33. https://doi.org/10.3141/1887-04

Higgins, C. D., & Kanaroglou, P. S. (2016). A latent class method for classifying and evaluating the performance of station area transit-oriented development in the Toronto region. *Journal of Transport Geography, 52*, 61–72. https://doi.org/10.1016/j.jtrangeo.2016.02.012

Hrelja, R., Olsson, L., Pettersson-Löfstedt, F., & Rye, T. (2022). Challenges of delivering TOD in low-density contexts: The Swedish experience of barriers and enablers. *European Transport Research Review, 14*(20). https://doi.org/10.1186/s12544-022-00546-1

Ibraeva, A., Correia, G. H. d. A., Silva, C., & Antunes, A. P. (2020). Transit-oriented development: A review of research achievements and challenges. *Transportation Research Part A: Policy and Practice, 132*, 110–130. https://doi.org/10.1016/j.tra.2019.10.018

Ilir, B., Steiner, R. L., Fischman, A., & Schmucker, J. (2011). Using GIS to analyze the role of barriers and facilitators to walking in children's travel to school. *Urban Design International, 16*(1), 51–62. https://doi.org/10.1057/UDI.2010.18

Jacobson, J., & Forsyth, A. (2008). Seven American TODs: Good practices for urban design in Transit-Oriented Development projects. *Journal of Transport and Land Use, 1*(2), 51–88. https://www.jstor.org/stable/26201614

Jun, C. (2023). The impacts of TOD on sustainability based on the livability prism model. *Applied and Computational Engineering, 6*(1), 127–133. https://doi.org/10.54254/2755-2721/6/20230746

Kemec, S., & Abdalkarim, S. H. (2023). Accessibility analysis of urban green space: The case of Erbil city. *ICONARP International Journal of Architecture and Planning, 11*(1), 27–42. https://doi.org/10.15320/ICONARP.2023.231

Knowles, R. D. (2012). Transit-oriented development in Copenhagen, Denmark: From the Finger Plan to Ørestad. *Journal of Transport Geography, 22*, 251–261. https://doi.org/10.1016/j.jtrangeo.2012.01.009

Kuo, F. E., & Sullivan, W. C. (2001). Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior, 33*(3), 343–367. https://doi.org/10.1177/0013916501333002

Li, J. (2018). Residential and transit decisions: Insights from focus groups of neighborhoods around transit stations. *Transport Policy, 63*, 1–9. https://doi.org/10.1016/j.tranpol.2017.10.012

Li, X., Xiao, Q., Zhu, Y., & Yang, Y. (2022). Influence of TOD modes on passenger travel behavior in urban rail transit systems. *Urban Rail Transit, 8*(3-4), 175–183. https://doi.org/10.1007/s40864-022-00179-6

Loo, B. P. Y., Cheng, A. H. T., & Nichols, S. L. (2017). Transit-oriented development on greenfield versus infill sites: Some lessons from Hong Kong. *Land Use Policy, 66*, 507–518. https://doi.org/10.1016/j.landurbplan.2017.05.013

Azhari Lukman. (2014). *Development and implementation of a transit-oriented development (TOD) index around the current transit nodes*. University of Twente.

Martha, K. D., & Handayeni, E. (2014). TOD best practice: Lesson learned for GHG mitigation on transportation sector in Surabaya City, Indonesia. *Procedia - Social and Behavioral Sciences, 135*, 152–158. https://doi.org/10.1016/j.sbspro.2014.07.340

Medved, P. (2016). A contribution to the structural model of autonomous sustainable neighbourhoods: New socio-economical basis for sustainable urban planning. *Journal of Cleaner Production, 120*, 1–11. https://doi.org/10.1016/j.jclepro.2016.01.091

Paydar, M., Kamani-Fard, A., & Etminani-Ghasrodashti, R. (2017). Perceived security of women in relation to their path choice toward sustainable neighborhood in Santiago, Chile. *Cities, 60*, 289–300. https://doi.org/10.1016/j.cities.2016.10.002

Singh, Y. J., Lukman, A., Flacke, J., Zuidgeest, M., & Van Maarseveen, M. F. A. M. (2017). Measuring TOD around transit nodes – Towards TOD policy. *Transport Policy, 56*, 96–111. https://doi.org/10.1016/j.tranpol.2017.03.013

Victoria Transport Policy Institute. (2010). Online TDM encyclopedia. Retrieved August 10, 2019, from https://www.vtpi.org/tdm/

World Commission on Environment and Development. (1987). *Our common future*. Oxford University Press.

Yen, B. T. H., Mulley, C., Chen, M. Y. J., & Chiou, Y. C. (2024). How transit-oriented development concepts and strategies influenced green transport systems: A meta-analysis approach. *Asian Transport Studies, 10*, 100136. https://doi.org/10.1016/j.eastsj.2024.100136