INTERVENTION AREAS FOR SUSTAINABLE TRANSPORTATION ON METU CAMPUS THROUGH TRANSITION DESIGN APPROACH

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ABSTRACT

INTERVENTION AREAS FOR SUSTAINABLE TRANSPORTATION ON METU CAMPUS THROUGH TRANSITION DESIGN APPROACH

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The development of sustainable transportation systems within university campuses presents a complex and multifaceted challenge, often characterized as a "wicked problem." This study aims to address this challenge by developing sustainable transportation intervention areas for Middle East Technical University (METU) campus through the *Transition Design* approach. Transition Design emphasizes systemic thinking, stakeholder engagement, and envisioning desirable futures, making it particularly suited for tackling complex problems.

This doctoral study aims to identify the current commuting behaviors of METU campus stakeholders, as well as their experiences, needs, and desires regarding the existing transportation system. Additionally, it seeks to pinpoint the advantageous and disadvantageous aspects of the current system through in-depth questioning of stakeholders. These insights form the basis for multiple solution suggestions generated through collaborative brainstorming sessions.

By involving users affected by these transportation issues, the study develops propositions at both micro (individual behavior) and macro (systemic infrastructure) levels. These propositions are created in a participatory manner, ensuring solutions are grounded in real-world experiences and needs. Finally, variables and factors

derived from previous insights are evaluated by experts with strategic roles in METU transportation planning. Their assessments are further analyzed using cross-impact analysis to uncover interdependencies and leverage points, which are then used to develop final sustainable transportation intervention areas for METU campus.

The study concludes with the proposal of short, mid, and long-term interventions. Addressing this comprehensive problem through stakeholder engagement and utilizing Transition Design approach demonstrates a significant model for holistically tackling issues in densely populated communities like university campuses.

Keywords: Sustainable Campus Transportation, Transition Design Approach, Wicked Problem, METU Campus Transportation Intervention Areas, Stakeholder Engagement

ÖZ

GEÇİŞ TASARIMI YAKLAŞIMI İLE ODTÜ KAMPÜSÜNDE SÜRDÜRÜLEBİLİR ULAŞIM İÇİN MÜDAHALE ALANLARI

Özgürlük, Mehmet Erdi
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Üniversite kampüslerinde sürdürülebilir ulaşım sistemlerinin geliştirilmesi, genellikle "zorlu bir problem" olarak adlandırılan karmaşık ve çok yönlü bir uğraş gerektirir. Bu çalışma, Orta Doğu Teknik Üniversitesi (ODTÜ) kampüsü için sürdürülebilir ulaşım müdahale alanları geliştirmeyi amaçlamakta ve bunu Geçiş Tasarımı (Transition Design) yaklaşımı ile ele almaktadır. Geçiş Tasarımı, sistemik düşünme, paydaş katılımı ve arzu edilen gelecekleri öngörme üzerine yoğunlaşır, bu da onu karmaşık problemlerle başa çıkmak için özellikle uygun hale getirir.

Bu doktora çalışması, ODTÜ kampüsündeki paydaşların mevcut ulaşım alışkanlıklarını, mevcut ulaşım sistemine ilişkin deneyimlerini, ihtiyaçlarını ve isteklerini belirlemeyi hedefler. Ayrıca, bu sistemle ilgili avantajlı ve dezavantajlı noktalar, paydaşların derinlemesine sorgulanması yoluyla tespit edilir ve ele alınır. Bu noktalar, iş birliğine dayalı beyin fırtınası oturumları aracılığıyla birçok çözüm önerisi oluşturmak için kullanılır.

Bu ulaşım sorunlarından etkilenen kullanıcıların katılımıyla, hem mikro (bireysel davranış) hem de makro (sistemik altyapı) seviyelerde öneriler katılımcı bir şekilde oluşturulur. Son olarak, önceki bilgilerden oluşturulan değişkenler ve faktörler, ODTÜ Kampüsü içinde strateji geliştirici rolünde uzmanlar tarafından

değerlendirilir. Uzmanların bu değişkenler ve faktörler üzerindeki değerlendirmeleri, birbirine bağımlılıkları ve kullanılacak kaldıraç noktalarını ortaya çıkarmak için çapraz etki analizi ile daha da incelenir ve bu bilgiler, ODTÜ kampüsü için nihai sürdürülebilir ulaşım müdahale alanları geliştirmekte kullanılır.

Son olarak, bu çalışmanın nihai adımı olarak kısa, orta ve uzun vadeli müdahaleler önerilir. Paydaş katılımı ile böylesine kapsamlı bir problemi ele almak ve geçiş tasarımı yaklaşımını kullanarak böyle zorlu bir probleme yanıt aramak, üniversite kampüsleri gibi yoğun nüfuslu toplulukların sorunlarını bütüncül bir şekilde ele almak için önemli bir model teşkil eder.

Anahtar Kelimeler: Sürdürülebilir Kampüs Ulaşımı, Geçiş Tasarımı Yaklaşımı, Zorlu Bir Problem, ODTÜ Kampüs Ulaşımı Müdahale Alanları, Paydaş Katılımı

To Philomelos…

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CHAPTER 1

INTRODUCTION

1.1 Problem Background

Universities, as dynamic and multifaceted institutions, play an important role in shaping sustainable futures not only through education but also through their operational practices. With the growing focus on sustainability and the corresponding policies in contemporary urban environments, examining the commuting habits of university populations has become a topic of increasing interest for both researchers and policymakers (Logan et al., 2020; Rybarczyk and Gallagher, 2014). As large, self-contained neighborhoods within cities, campuses are substantial contributors to urban traffic and associated environmental impacts, necessitating targeted mobility management policies (Papantoniou et al., 2020; Batur and Koç, 2017; Kaplan, 2015).

A university campus is a unique environment that can be viewed as a community in its own right. Checkoway (1997) defines a community as a process where people act collectively with others who share common concerns, whether based on their place of residence, shared interests, or cohesive relationships. This definition is particularly applicable to university campuses, which operate as similar of larger urban settings, reflecting same transportation and sustainability challenges (Balsas, 2003).

The urgency of addressing sustainable mobility on campuses is highlighted by the global challenges posed by transport-related carbon emissions. Transportation is a major contributor to global greenhouse gas emissions, and university campuses, as significant trip generators, play a notable role in exacerbating this problem (Foot

Print Network, 2014; Buehler and Pucher, 2011). Universities, therefore, are increasingly focusing on sustainability plans to transition towards greener campuses, aiming to mitigate congestion and reduce environmental impacts (Hancock and Nuttman, 2014).

A sustainable mobility system on campus involves implementing actions, processes, and strategies that encourage the use of environmentally friendly transportation modes, assist commuters in making informed and efficient travel choices, and enhance public awareness of the environmental impact of transportation (Kepaptsoglou et al., 2012). Campuses with large populations of students, faculty, and staff can be compared to small cities, necessitating enhanced transportation systems and improved accessibility to address the increasing demands of their users (Asadi-Shekari et al., 2014). The daily commutes of campus community have significant environmental and societal impacts, necessitating comprehensive planning to address issues such as air quality deterioration, insufficient parking, increasing congestion, high costs associated with parking infrastructure, and so on.

Sustainable campuses aim to reduce the negative environmental, economic, social, and health impacts resulting from their resource consumption. This commitment typically includes efforts to decrease energy use, greenhouse gas emissions, waste generation, and water consumption (Velazquez et al., 2006; Too and Bajracharya, 2015). The concept of a sustainable or green campus emphasizes the need for universities to act as role models in environmental control and to foster a culture of sustainability within their communities (Miller et al., 2011; Günerhan, 2016).

Universities are crucial in societal development, producing and applying knowledge to improve urban life quality. However, their role as major trip generators requires careful analysis of the commute behaviors, infrastructure, and information, considering planning and transport strategy development. Addressing the need for sustainable and efficient mobility alternatives for the campus community is essential (Tolley, 1996; Keyton et al., 2002; Schonfelder and Axhausen, 2003; Cebollada-Frontera and Miralles-Guasch, 2004).

The dependency on private automobiles for campus commuting is a significant challenge, directly linked to inadequate infrastructure and strategies for alternative transportation modes (Limanond, Butsingkorn and Chermkhunthod, 2011). As the number of university commuters increases, sustainable transportation options become imperative to reduce environmental impacts and improve accessibility (Buehler and Pucher, 2011).

The development of sustainable campus transportation systems is a complex and multifaceted challenge, often described as a *wicked problem*. Coined by Rittel and Webber (1973), wicked problems are characterized by their complexity, interdependencies, and resistance to straightforward solutions. They involve multiple stakeholders, each with their own perspectives and interests, and are often embedded within broader social, economic, and environmental systems. Traditional problem-solving approaches, which typically focus on isolated components, are insufficient for addressing the multifaceted nature of wicked problems.

At that point, transition design approach offers a framework to address this complexity by integrating diverse stakeholder perspectives, fostering collaborative efforts, and emphasizing systemic thinking. This introduction outlines the significance of sustainable mobility in campus settings, the challenges posed by current transportation patterns, and the necessity for comprehensive strategies to foster greener, more efficient, and socially inclusive transportation systems on university campuses.

Sustainable campus transportation involves numerous stakeholders, including students, faculty, staff, and external communities, each with unique transportation needs and preferences. These needs must be balanced against environmental impacts, economic constraints, and social equity. The challenge is not merely technical but involves behavioral, cultural, and systemic changes.

In this study, METU (Middle East Technical University) campus, with its highly dense population, is addressed to develop sustainable transportation solution intervention areas by actively involving the campus community in the process.

1.2 Significance of the Topic

Addressing sustainable campus transportation through the transition design approach offers a pathway to systemic change that can serve as a model for other institutions. By engaging stakeholders and considering long-term impacts, this study aims to create transportation solutions that are not only environmentally sustainable but also economically viable and socially equitable.

The outcomes of this study will contribute to the broader discourse on sustainable urban mobility and the role of educational institutions in leading by example. By implementing the proposed recommendations and interventions, METU can position itself as a leader in sustainable campus transportation, inspiring other universities to implement a similar approach. Other issues related to the significance of the topic are presented as follows:

Contribution to Sustainability in Higher Education

Incorporating sustainability into higher education is essential for tackling broader environmental and social challenges. Universities have significant potential to promote sustainable practices, not only through their operational practices but also by influencing students and surrounding communities.

The effective implementation of Transportation Demand Management (TDM) strategies underlines the importance of engaging diverse stakeholder groups to encourage sustainable transport options on campus. This approach reduces dependence on single-occupant vehicles and promotes alternative modes of transport (Fachrudin, 2020).

Community engagement initiatives, such as participatory design processes for sustainable transportation systems, allow students to apply theoretical concepts to real-world scenarios, fostering practical experience and deeper understanding. This enhances their learning experiences and fosters a sense of agency (Irwin, 2019). Transition design frameworks stress the importance of understanding local dynamics

and empowering stakeholders to co-create solutions that address community needs (Irwin, 2019; Irwin et al., 2015).

Achieving sustainability in higher education requires a collective effort involving students, faculty, administration, and external stakeholders. By promoting a shared vision and involving all parties in developing sustainable transportation scenarios, universities can ensure that today's actions contribute to long-term ecological resilience. Strategic planning and effective communication amplify sustainability initiatives, attracting environmentally conscious students and contributing to local and global sustainability goals (Tolley, 1996; Irwin, 2019).

To sum up, higher education institutions play a significant role in advancing sustainable practices, fostering resilience, and preparing future leaders to tackle climate change and social equity challenges (Irwin et al., 2015; Filho, 2019).

Role of Transportation in Campus Community Engagement

Transportation systems play a crucial role in promoting engagement within campus communities, significantly influencing social interactions and the overall campus experience. As university populations grow, the demands on transportation infrastructure can either worsen isolation or promote community cohesion. According to dela Cruz et al. (2016), investing in integrated pedestrian pathways and efficient bus systems can reduce environmental impacts while improving overall mobility, thereby creating more opportunities for engagement. Effective Transportation Demand Management (TDM) strategies can help decrease reliance on private vehicles and encourage active participation in campus events, contributing to a more interconnected community. Recognizing transportation's role in facilitating engagement allows institutions to reimagine campus environments as platforms for collaborative learning and meaningful social exchanges (Fachrudin, 2020).

Moreover, involving students in the decision-making process regarding transportation initiatives can enhance their sense of ownership and responsibility towards fostering a sustainable campus culture. Given the significant implications of

transportation choices on social dynamics and community engagement, empowering students to actively participate in developing these strategies is essential for driving meaningful change within campus ecosystems (Syal, 2022).

Potential for Influencing Broader Urban Transportation Policies

The complex relationship between sustainable campus transportation and broader urban policies requires higher education institutions to shift how they engage with local transportation authorities. By implementing sustainable transportation practices on campus, universities can act as living laboratories for innovative mobility solutions. Initiatives that reduce car dependency, such as improved biking infrastructure and extensive public transit partnerships, reflect the findings from the U-MOB project, which advocated for a 5% reduction in CO2 emissions through sustainable practices (Fernandes et al., 2019). By effectively demonstrating the growth of these approaches, universities can significantly influence municipal transportation policies. Engaging with city planners and local communities enables campuses to advocate for integrated solutions that address common transportation challenges, further amplifying their impact on urban mobility and environmental sustainability.

Addressing urban transportation policies through the lens of campus sustainability is particularly critical in today's context of climate change and urban congestion. By prioritizing non-motorized transport options, universities can contribute to systemic shifts in urban transport dynamics. Transition design emphasizes the importance of collaborative frameworks that mobilize stakeholders from various sectors, as noted by Irwin (2019). Such collaboration can lead to innovative outcomes, resulting in practical policy recommendations and strategies that extend beyond campus boundaries. Actively including students, faculty, and community members in the decision-making process promotes a sense of agency and ownership among stakeholders, potentially leading to transformative changes in how urban transportation is conceived and implemented (Dimitriou and Gakenheimer, 2011).

1.3 Aim, Goal Statement and Research Questions

The primary objective of this study is to develop sustainable transportation intervention areas for METU campus using the *Transition Design* approach. To achieve this aim, the study will involve some certain stages including:

1. **Identifying Current Transportation Patterns:** Understanding the existing transportation behaviors, challenges, and preferences of campus stakeholders. This step is crucial for identifying the root causes of unsustainable transportation practices and for designing interventions that address these causes effectively.
2. **Engaging Stakeholders:** Involving students, faculty, staff, and administration in the design process to ensure that proposed solutions are inclusive and address the needs of all community.
3. **Design Interventions:** Proposing specific design interventions at both the micro (individual behavior) and macro (systemic infrastructure) levels to support these intervention areas. These interventions may include policies, infrastructure improvements, and behavioral change initiatives.
4. **Developing Recommendations:** Creating short, medium, and long-term sustainable transportation intervention areas that can be progressively implemented. These interventions serve as roadmaps for transitioning to more sustainable transportation systems.

To guide the study, the following research questions will be addressed, with the main question being:

- How can sustainable transportation for the METU campus be supported through the development of short, medium, and long-term intervention areas with the participation of campus stakeholders?

To address this main question, the study also explores a series of sub-questions:

1. What are the current transportation patterns of METU campus stakeholders, and what challenges, experiences, and desires shape these patterns?
2. What are the stakeholders' perceptions of the existing transportation infrastructure, and what design interventions can promote more sustainable transportation behaviors?
3. How should the feasibility, potential, and sustainability value of the design interventions proposed by stakeholders for improving the transportation system be assessed and evaluated?
4. What are the inclusive variables and factors that affect each node of the campus transportation network, and how can the relationships between these factors be defined?
5. How can research findings and insights be translated into comprehensive strategies that improve transportation experiences and influence behavior towards sustainability?

1.4 Research Framework

In line with the objectives of the research, this doctoral study comprises a literature review, a four-stage methodology, and a conclusion that addresses the research questions and highlights opportunities for further studies (Figure 1.1). The methodology includes:

1. **Context Mapping:** Initial exploratory phase to understand stakeholders' current transportation behaviors and challenges. Context mapping involves tools such as interviews and generative sessions to gather detailed insights into stakeholders' experiences and perceptions.

2. **Generative Brainstorming Workshop:** Co-design sessions with stakeholders to develop and refine sustainable transportation interventions. This workshop use participatory design techniques to facilitate creative thinking and collaboration.
3. **Expert Reviews:** Evaluations by transportation and sustainability experts to assess the feasibility and potential impact of proposed interventions. Expert reviews provide critical feedback and ensure that the interventions are grounded in best practices.
4. **Cross-Impact Analysis:** Identifying and analyzing the interdependencies between various factors affecting campus transportation. This analysis helps in understanding the systemic nature of the problem and in identifying leverage points for effective interventions.

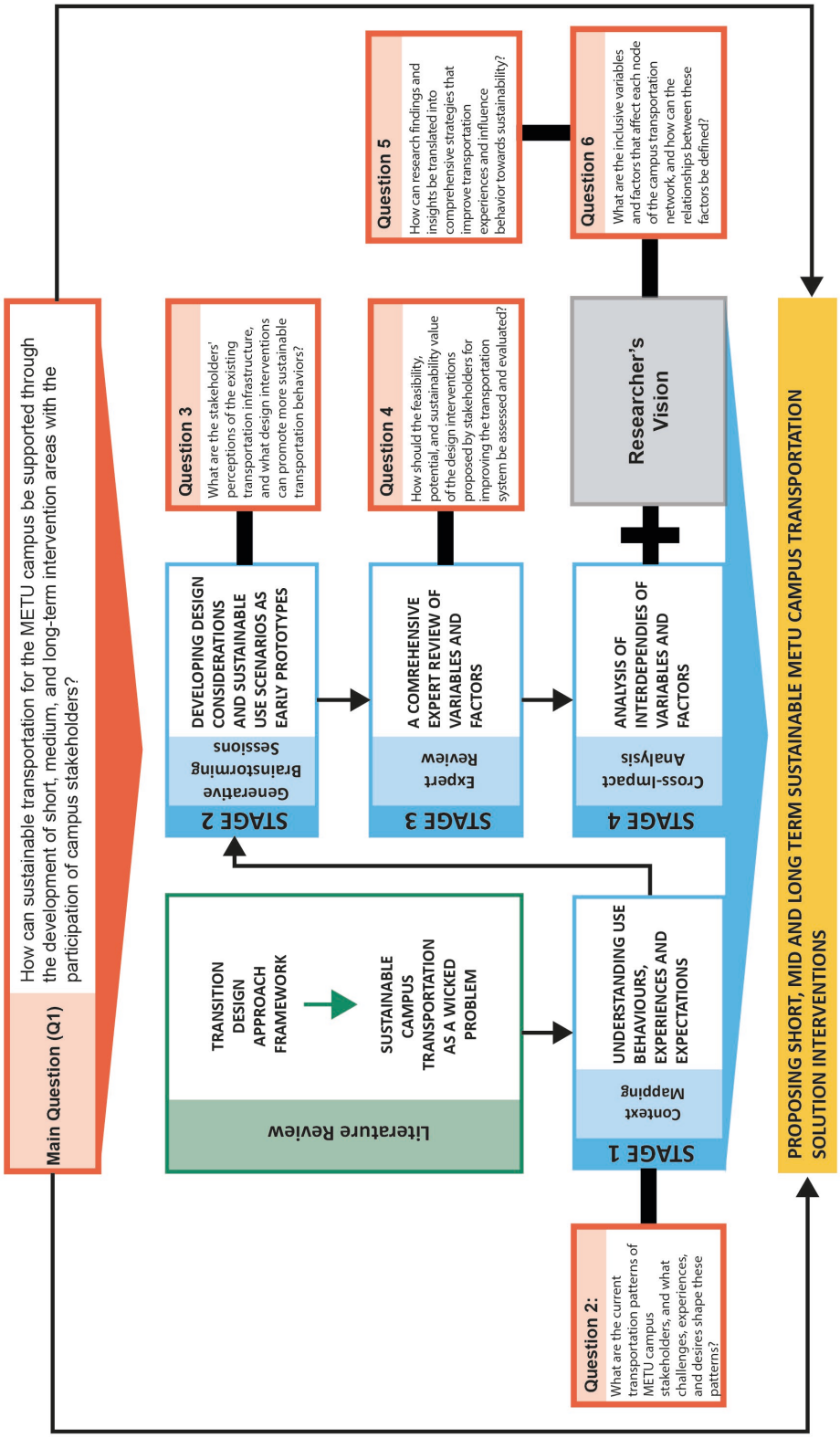


Figure 1.1. Research Framework of this Doctoral Study

1.5 Structure of the Dissertation

This dissertation is composed of eight chapters. Chapter 1 introduces the problem background and highlights the significance of this study. It defines the scope of the dissertation by explaining the aim and objectives of the research and the research questions. Additionally, it presents the research framework designed to address these questions.

Chapter 2 provides an overview of the research topic's background, focusing on sustainable transportation within campus settings. It delves into the characteristics of campus transportation, including mode choices and Transportation Demand Management (TDM) strategies, and examines the relationship between campuses and their surrounding cities. The chapter concludes with a detailed explanation of the current transportation infrastructure and network of METU campus.

Chapter 3 and 4 is dedicated to the research framework, beginning with *social innovation* and extending to the *transition design approach*. This framework forms the basis for addressing wicked problems at macro levels, such as the development of sustainable campus transportation, and illustrates how these complex issues can be managed effectively through this approach.

As part of the methodological plan, Chapter 5 presents Stage-I of the study, which involves *context mapping*. This stage explores the use behaviors, experiences, and expectations of campus stakeholders. Participants are sensitized and engaged through *generative workshops* to uncover insights, which are then analyzed and discussed.

Chapter 6, as a continuation of the methodological plan, involves Stage-II of the study, consisting of *generative brainstorming sessions* for developing design considerations and sustainable use scenarios as early prototypes. This chapter details the session structure, conduct, and analysis derived from these sessions, followed by a discussion of the findings.

As the last part of the methodological plan, Chapter 7 consists of Stage-III and Stage-IV of the study. In Stage-III, a comprehensive *expert review* is presented, including interviews and discussions of the experts' analyses. Additionally, Stage-IV involves the analysis of the interdependencies of variables and factors related to the METU campus transportation network using *cross-impact analysis*, which serve as a basis for developing further solution intervention areas.

As a conclusion, Chapter 8 answers the research questions, presents interventions, discusses the main contributions of this doctoral study for design research and practice, its limitations, and the opportunities it provides for further research.

CHAPTER 2

SUSTAINABLE CAMPUS TRANSPORTATION

University campuses serve as focal points of intensive human activity with a multitude of daily commutes. Universities have been making great efforts with the responsibility to implement and sustain measures aimed at addressing the mobility requirements of their communities, together with the need to conserve resources, optimize land use and maintain the unique characteristics inherent to their campuses. The growing number of university campus populations and the tendency of increase in using private automobiles during campus commuting forces university authorities to take actions about sustainable campus transportation issue worldwide. The purpose of this literature review is to understand existing approaches on dealing with this issue and reveal the examples of current practices implemented to have better transportation management within a campus environment. After a brief discussion on sustainability concept, this chapter continues to present possible alternative mediums of commuting and their importance for a better system solution in campus environment, TDM (Transportation Demand Management) strategies, university campuses and city relationship. It concludes with a detailed information on METU campus and its transportation related infrastructure and its vision for a sustainable community.

2.1 A Brief Discussion on Sustainability Concept

The most widely used definition of sustainable development which provides a basis to all others is from the Brundtland Commission: Sustainable development “meets the needs of present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Litman and Burwell (2006) also clarify that

sustainable development in broader terms strives to seek a balance between economic, social and environmental objectives.

There are found other well-known definitions to sustainability and sustainable development in the literature as follows:
"Sustainability is equity and harmony extended into the future, a careful journey without an endpoint, a continuous striving for the harmonious co-evolution of environmental, economic and socio-cultural goals." (Mega and Pedersen 1998) This definition emphazises sustainability concept being a holistic approach that considers the interconnectedness of environmental, economic, and social systems.

"The common aim [of sustainable development] must be to expand resources and improve the quality of life for as many people as heedless population growth forces upon the Earth, and do it with minimal prosthetic dependence" (Wilson, 1999). In essence, this definition highlights the importance of making life better for everyone while acting consciously about limited resources of the world and finding smart, long-lasting solutions to our problems.

Recently, sustainability has emerged as a critical research area in transportation due to the interdependencies between transportation and social, economic, and environmental systems. A great many of research is being carried out with respect to diversified aspects in order to figure out these interdependencies (Maheshwari et al., 2016).

2.1.1 Definition of Sustainable Transportation

Richardson (1999) states that sustainability of transportation systems need to be addressed as the world's population increases while its resources remain constant. *"A sustainable transportation system is defined as one in which fuel consumption, vehicle missions, safety, congestion, and social and economic access are such levels that they can be sustained into the indefinite future without causing great or irreparable harm to future generations of people throughout the world" (p.27).*

Although there is no common definition of sustainable transportation, it is generally accepted that sustainable transportation indicates finding a balance between current and future economic, social and environmental qualities (Steg and Gifford, 2005). Other well-known definitions to sustainable transportation are given as follows:

- A sustainable transport system is also should ensure the ability of future generations to meet their own needs (Balsas, 2003). It emphasizes the importance of considering the long-term impacts of transportation infrastructure, policies, and practices on both present and future generations.
- A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable (ECMT 2004). Therefore, a sustainable transport system strives to balance accessibility, safety, environmental friendliness, and affordability.
- Environmentally Sustainable Transportation (EST) is: Transportation that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes (OECD 1998). Overall, sustainable transportation effectively integrates the need for mobility with the imperative of resource conservation, ensuring that transportation systems support human well-being while minimizing negative impacts on public health, ecosystems, and natural resources.

In 2005, CST (Centre for Sustainable Transportation) developed a more complete definition of sustainable transportation. According to this definition, a sustainable transportation system is one that:

- Ensures that individuals' fundamental access needs are met in a safe manner that aligns with both human and ecosystem health, while promoting equity both within and across generations.

- Is affordable, operates efficiently, provides diverse transportation options, and contributes to a thriving economy.
- Limits emissions and waste to levels that the planet can absorb, minimizes the consumption of nonrenewable resources, restricts the use of renewable resources to their sustainable yield, promotes the reuse and recycling of materials, and reduces land use and noise production (CST, 2005).

From all above mentioned definitions, it can be inferred that under the concept of sustainability, transportation sustainability also seeks for a balance between now and future in regard to social, economic and environmental issues. Litman and Burwell (2006) extend these issues with related topics in Table 2.1.

Table 2.1 Transportation Impacts on Sustainability (Litman and Burwell, 2006)

ECONOMIC	SOCIAL	ENVIRONMENT
Mobilty barriers	Inequity of impacts	Air and water pollution
Traffic congestion	Mobility disadvantaged	Habitat loss
Accident damages	Human health impacts	Hydrologic impacts
Facility costs	Community interaction	DNRR (Depletion of non-renewable resources)
Consumer costs	Community livability	
DNRR (Depletion of non-renewable resources)	Aesthetics	

2.1.2 Performance Indicators of Sustainable Transportation

Sustainable transportation has become a critical concern for policymakers and urban planners as they strive to address the environmental, social, and economic challenges posed by traditional transportation systems (Miller et al., 2014; Jeon et al., 2013). At that point, Steg and Gifford (2005) state that the extent to which diversified sustainable strategies affect significant sustainable transport performance indicators

should be systematically determined with regard to the economic, social, and environmental effects of these transport systems.

Economic indicators should assess potential impacts on economic welfare, including macroeconomic shifts, GDP, economic efficiency, income distribution, and unemployment rates. Social indicators should capture effects on societal and individual well-being, such as health and safety (OECD, 1982). Environmental indicators should evaluate impacts on environmental quality, including resource consumption, emissions, waste, and the condition of soil, water, and air, which may influence both human and non-human life (OECD, 2005; Steg et al., 2003).

Litman and Burwell, prominent researchers in the field of sustainable transportation, have emphasized the need for a holistic approach that considers a wide range of performance indicators (Hipogrosso and Nesmachnow, 2020). The research of Litman and Burwell highlights the multifaceted nature of sustainable transportation and the importance of considering a wide range of performance indicators to evaluate the sustainability of transportation systems. By adopting a holistic approach that addresses environmental, economic, and social considerations, policymakers and urban planners can work towards the development of more sustainable transportation solutions that meet the needs of communities while minimizing the negative impacts on the environment.

According to Litman and Burwell (2006) these performance indicators of sustainable transportation under economic, social, and environmental issues with direct evaluation of these indicators through specified objectives can be summarized as in Table 2.2.

Table 2.2 Sustainable Transportation Indicators (Litman and Burwell, 2006)

ECONOMIC		
Objectives	**Indicator**	**Direction**
Accessibility – commuting	Average commute travel time	Less is better
Accessibility – land use mix	Number of job opportunities and commercial services within 30-minute travel distance of residents	More is better
Accessibility – smart growth	Implementation of policy and planning practices that lead to more accessible, clustered, mixed, multimodal development	More is better
Transport diversity	Mode split: portion of travel made by walking, cycling, rideshare, public transit and telework	More is better
Affordability	Portion of household expenditures devoted to transport by 20% lowest-income households	Less is better
Facility costs	Per capita expenditures on roads, traffic services and parking facilities	Less is better
Freight efficiency	Speed and affordability of freight and commercial transport	More is better
Planning	Degree to which transport institutions reflect least-cost planning and investment practices	More is better

SOCIAL		
Objectives	**Indicator**	**Direction**
Safety	Per capita crash disabilities and fatalities	Less is better
Health and fitness	Percentage of population that regularly walks and cycles	More is better
Community livability	Degree to which transport activities increase community livability (local environmental quality)	More is better
Equity – fairness	Degree to which prices reflect full costs unless a subsidy is specifically justified	More is better
Equity – non-drivers.	Quality of accessibility and transport services for non-drivers	More is better
Equity – disabilities	Quality of transport facilities and services for people with disabilities (e.g., wheelchair users, people with visual impairments)	More is better
Non-motorized transport planning	Degree to which impacts on non-motorized transport are considered in transportation modelling and planning	More is better
Citizen involvement	Public involvement in transport planning process	More is better

Table 2.3 (continued) Sustainable Transportation Indicators (Litman and Burwell, 2006)

ENVIRONMENT		
Objectives	**Indicator**	**Direction**
Climate change emissions	Per capita fossil fuel consumption, and emissions of CO2 and other climate change emissions	Less is better
Other air pollution	Per capita emissions of 'conventional' air pollutants (CO, VOC, NOx, particulates, etc.)	Less is better
Noise pollution	Portion of population exposed to high levels of traffic noise	Less is better
Water pollution	Per capita vehicle fluid losses	Less is better
Land use impacts	Per capita land devoted to transportation facilities	Less is better
Habitat protection	Preservation of wildlife habitat (wetlands, forests, etc.)	More is better
Resource efficiency	Non-renewable resource consumption in the production and use of vehicles and transport facilities	Less is better

2.1.3 Objectives of Sustainable Transportation

Sustainable transportation objectives are generally categorized into four major themes: economic, social, environmental, and good governance and policy. Each of these themes encompasses several dimensions that can be measured through specific performance indicators. According to Litman (2011), the goals, objectives, and performance indicators for sustainable transportation are outlined in Table 2.3 as follows:

Table 2.4 Key Sustainable Transport Goals, Objectives and Indicators

(Litman, 2011)

ECONOMIC		
Sustainability Goals	**Objectives**	**Performance Indicators**
Economic productivity	Transport system efficiency Transport system integration Maximize accessibility Efficient pricing and incentives	o Per capita GDP o Portion of budgets devoted to transport o Per capita congestion delay o Efficient pricing (road, parking, insurance, fuel, etc.) o Efficient prioritization of facilities
Energy efficiency	Minimize energy costs, particularly petroleum imports	o Per capita transport energy consumption o Per capita use of imported fuels
Affordability	All residents can afford access to basic (essential) services and activities	o Availability and quality of affordable modes (walking, cycling, ridesharing and public transport) o Portion of low-income households that spend more than 20% of budgets on transport
Efficient transport operations	Efficient operations and asset management maximizes cost efficiency.	o Performance audit results. o Service delivery unit costs compared with peers. o Service quality.

SOCIAL		
Sustainability Goals	**Objectives**	**Performance Indicators**
Equity / fairness	Transport system accommodates all users, including those with disabilities, low incomes, and other constraints.	o Transport system diversity. o Portion of destinations accessible by people with disabilities and low incomes.
Safety, security and health	Minimize risk of crashes and assaults, and support physical fitness.	o Per capita traffic casualty (injury and death) rates. o Traveler assault (crime) rates. o Human exposure to harmful pollutants. o Portion of travel by walking and cycling.
Community development	Helps create inclusive and attractive communities.	o Land use mix. o Walkability and bikability o Quality of road and street environments.
Cultural heritage preservation	Respect and protect cultural heritage. Support cultural activities.	o Preservation of cultural resources and traditions. o Responsiveness to traditional communities.

Table 2.5 (continued) Key Sustainable Transport Goals, Objectives and Indicators

ENVIRONMENT		
Sustainability Goals	**Objectives**	**Performance Indicators**
Climate stability	Reduce global warming emissions Mitigate climate change impacts	o Per capita emissions of greenhouse gases (CO2, CFCs, CH4, etc.).
Prevent air pollution	Reduce air pollution emissions Reduce harmful pollutant exposure	o Per capita emissions (PM, VOCs, NOx, CO, etc.). o Air quality standards and management plans.
Minimize noise	Minimize traffic noise exposure	o Traffic noise levels
Protect water quality & hydrologic functions	Minimize water pollution. Minimize impervious surface area.	o Per capita fuel consumption. o Management of used oil, leaks and storm water. o Per capita impervious surface area.
Open space and biodiversity protection	Minimize transport facility land use. Encourage compact development. Preserve high quality habitat.	o Per capita land devoted to transport facilities. o Support for smart growth development. o Policies to protect high value farmlands and habitat.
Good Governance and Planning		
Integrated, comprehensive and inclusive planning	Clearly defined planning process. Integrated and comprehensive analysis. Strong citizen engagement. Lease-cost planning.	o Clearly defined goals, objectives and indicators. o Availability of planning information and documents. o Portion of population engaged in planning decisions. o Range of objectives, impacts and options considered. o Efficient and equitable funding allocation

When selecting indicators for sustainable transportation, it is crucial to differentiate between goals and objectives to avoid confusion. Goals represent the ultimate outcomes that society desires, while objectives are specific actions or milestones that help achieve these goals. Decision-makers sometimes prioritize impacts that are easier to measure, potentially neglecting more complex but essential impacts and goals (Litman and Burwell, 2006).

In Table 2.4, Litman (2011) compares the relationships between sustainability goals and transport planning objectives, highlighting the need for comprehensive assessment in sustainable transport planning.

Table 2.6 Sustainable Transport Goals and Objectives (Litman, 2011)

Sustainability Goals	Transport Planning Objectives							
	Transport Diversity	System Integration	Affordability	Resource (energy and land) Efficiency	Demand Management (efficient pricing & prioritization)	Land Use Accessibility (smart growth)	Cost Effective Operations	Comprehensive and Inclusive Planning
Economic productivity		✓		✓	✓	✓	✓	
Economic development	✓	✓	✓	✓	✓	✓	✓	
Energy efficiency	✓	✓		✓	✓	✓		
Affordability	✓	✓	✓	✓	✓	✓		
Operational efficiency					✓		✓	✓
Equity / Fairness	✓	✓	✓		✓	✓		
Safety, security and health	✓	✓	✓	✓	✓	✓		✓
Community development	✓	✓	✓	✓	✓	✓		✓
Heritage protection	✓			✓	✓	✓		✓
Climate stability	✓	✓	✓	✓	✓	✓		
Air pollution prevention	✓	✓	✓	✓	✓	✓		
Noise prevention	✓			✓				
Water pollution	✓	✓	✓	✓	✓	✓		✓
Open space preservation	✓	✓	✓		✓	✓		✓
Good planning								✓
Efficient Pricing				✓	✓		✓	

2.2 Campus Transportation Characteristics

University campuses show similarities to small cities in both of which people from diverse backgrounds work and study (Balsas, 2003). Abdul-Azeez broaden this definition as university campuses are unique communities where a variety of activities occur in close proximity. They serve as environments where individuals from different backgrounds, income levels, cultures, lifestyles, and attitudes gather to live, learn, work, and engage in recreational activities (2018). However, they also face many of the same problems as large cities, including increased transportation demand, traffic congestion, noise pollution, and environmental issues. The trend toward motorization on campuses reflects that of society, with a dominant dependency on cars. Therefore, sustainable transportation planning is essential through the development of transportation systems encouraging non-motorized modes and public transportation (Norzalwi and Ismail, 2011). Azzali and Sabour state that on a daily basis, students, teachers, staff, and visitors commute to and from the campus, significantly affect both the environment and society (2018).

Campus mobility has various consequences that campus planners must take into account, including deteriorating air quality, inadequate parking availability, increased congestion, high costs associated with parking construction, and limited financial resources (Hoşkara, 2018). Furthermore Tolley (1996) highlights additional important consequences derive from university transportation systems, including adverse externalities such as noise, air pollution, depletion of green spaces, visual disruption, and health effects on both staff and students. Safety is another concern with mobility, and university administrators should seek solutions to enhance traffic safety on campus (Balsas, 2003). In addition to addressing environmental considerations, ensuring accessibility and equity is also crucial for sustainable universities. Therefore, efforts should be directed towards facilitating access and mobility without compromising the distinctive qualities of campus environments and minimizing broader environmental and social impacts as much as possible (Miralles and Domene, 2010).

Unlike in cities, mobility on university campuses is more flexible and variable in terms of timing. Universities typically experience a consistent flow of commuters throughout the day due to classes starting at various times, whereas cities anticipate peaks in transportation demand during rush hours (Bond and Steiner, 2006). Moreover, universities have a unique opportunity to test and adopt transportation policy adjustments. They have complete control over their road infrastructure, parking facilities, and land use within their campuses. By implementing policy changes in these areas, they can enhance the sustainability of not only their transportation systems but also the surrounding community (Miller, 2001). This privilege of controlling over transportation policies provides universities with a great power on shaping individuals transportation behaviors throughout of their lives.

University campuses host a significant youth population, who can carry the concept of sustainable transportation with them to future and broader communities (Altıntaşı and Yaman, 2012). Therefore, campus administrators and planners should establish a well-structured plan to encourage responsible transportation behavior which would turn to habits based on the campus commuting. Additionally, universities should strive to cultivate environmental awareness among students, who will eventually assume influential roles in government, corporations, and other organizations (Tolley, 1996). If students are properly motivated, they can overcome some of their undesired commuting behaviors they are reluctant to change and improve better and more sustainable transportation habits during their education period which will soon affect the rest of the society they get involved. Indeed, innovative transportation methods are expected to spread from higher education institutions to other regions of society (Bond and Steiner, 2006).

2.2.1 Mode Choices

Scholars have connected transportation to overall physical, mental, social, and economic welfare (Lee and Sener, 2016; Singleton, 2019). The mode choice decisions of daily campus commuters are influenced by many diverse factors,

resulting in distinctive transportation patterns within the campus community. In the existing literature, various studies have explored a multitude of influential factors on sustainability in different urban settings under normal conditions. These factors include gender (Akar et al., 2013), accessibility (Collins and Chambers, 2005), activity schedules (Tomlinson, 2014), cost of travel (Collins and Chambers, 2005; Shannon et al., 2006), transit passes (Boyd et al., 2003), and more. Exceptionally, such diverse and intricate circumstances like the challenges caused by the Coronavirus disease pandemic had been effective on travelers' behaviors for a certain period of time (Naaman et al., 2024).

In order to have a basic understanding of transportation motives of campus commuters, it is significant to search for what affects the behaviors of general population regarding transportation in a broader aspect. Zhou (2012) have identified six groups of factors influencing travel behaviors of the population by looking through the existing literature:

1. Including elements related to physical environment and urban layout as well as population density, land use mixture, topography, infrastructure availability, and the connectivity of multimodal networks.
2. Factors specific to transportation modes, such as availability, accessibility, convenience, comfort, privacy, safety, travel time, and costs.
3. Personal attributes of travelers, such as occupation, marital status, gender, age, income, childcare responsibilities, car ownership, and the possession of a driver's license.
4. Trip-related characteristics such as the time, purpose, distance, origin, and destination of travel.
5. The presence of Travel Demand Management (TDM) measures, such as parking costs, restrictions, information campaigns discouraging car use, and subsidies for transit passes.
6. Phycological factors like habits, attitudes, concerns about health and environment, familiarity with alternative modes of transportation, and unconscious attachment of car use (Zhou, 2012).

Having similar characteristics in line with allied demographics, university students are part of a homogeneous community apart from the general population. They share the same concerns for learning at universities in a close age gap and income level but from diverse backgrounds. Their similar yet distinct characteristics regarding their transportation behaviors other than the rest of society could be summarized as follows within the existing literature:

- University students have a control over avoiding peak hours thanks to flexible course hours while campus commuting and they do not have a strict schedule leading all weekdays to travel respectively (Kattach et al., 2011; Santos et al., 2011).
- Many university students are unmarried and thus have no childcare responsibilities which constraints their transportation choices (Zhou, 2012).
- University students have lower car ownership and access when compared workers in respect to financial issues (Kattach et al., 2011; Santos et al., 2011).
- Because of factors such as limited or even no income, and being younger, university students are more likely to use public transport, walk, and bike compared to the general population (London Bus Partnership Forum, 2003).
- University students generally exhibit greater enthusiasm for TDM measures than the rest of the society (Toor and Havlick, 2004).

According to Naaman et al., it is essential to make a thorough research on travel behaviors and influencing factors of campus commuters in order to promote the use of sustainable transport modes and to decrease the dependence of car usage among them (2024). In that sense, universities hold a unique power to influence travel behavior (Milard-Ball et al., 2004). They are responsible for generating most of the traffic in and around campuses while they shape both the campus and surrounding community regarding transportation behaviors (Delmelle, 2012; Larkham, 2000). Encouraging the use of alternative, active transportation modes like walking,

cycling, carpooling, and public transit can greatly enhance sustainability both on and off campus (Fu et al., 2016).

In the following part, alternative transportation modes which are public transport, walking, cycling, car and ride sharing, bike sharing and also the issue of car dependency will be discussed regarding the significance of promoting those alternatives and constraints and barriers related to those modes as well as the importance of decreasing car dependency around campus environment.

2.2.1.1 Public Transport

Public transport which may also be called as public transportation, public transit, mass transportation or mass transit is a system allowing group of passengers to travel on a fixed route and timely schedule on daily basis with a charge a posted fee for each trip. Buses are the main forms of public transport while metro as rapid transit, trams, and ferries are also included in this system. However, minibuses which are used frequently specifically in Turkey are accepted as intermediary means of transportation and categorized of being paratransit supporting public transport in the literature.

Buses play a crucial role in public transport systems. They are often the most accessible and sustainable means of transportation for all members of society in many countries. Therefore, buses are fundamental to the social structure of any nation (Charbatzadeh et al., 2016). For instance, buses typically carry the highest volume of passengers within urban areas (White, 2010). Specifically, students are the main representatives of bus transport customers compared with many other social groups (Limanond et al., 2011). Therefore, many higher education administrators address the promotion of using buses as a sustainable means of transportation. When utilized effectively, buses have the potential to improve the overall student experience (Balsas, 2006). In this regard, Naaman et al. highlight a set of criteria on promoting use of public transport in university campuses as follows:

- Improving access to public transport services at the university,
- Increasing the quality of public transport services at the university,
- And increasing the number and reducing the headway of public transportation services at the university (2024).

2.2.1.2 Walking

The highest priority in campus planning should be given to pedestrians (Nurwati et al., 2006). Walking as a means of transportation is considered as active transportation with cycling. Active transportation is human-powered mobility directly replacing motor vehicle miles traveled, that's why, reducing vehicle emissions, bridging the first-mile and last-mile gap, conserving resources, and improving both individual and public health in general.

The seamless connection of roads and pathways facilitates easier travel (Litman, 2008). In order to promote walking, Krizek et al. highlight the importance of adequate facilities including pavements, public spaces and road crossings (2007). Convenience of infrastructure and security are the main considerations which establish comfort with walking in campuses. The academic community should have access that is both convenient and secure, ensuring connectivity between all facilities and users (Shuhana et al., 2007). On campus commuting, safety concerns primarily are gathered at intersections when pedestrians must cross roadways, walk through improperly built walk lanes or in the lack of walkways within the campus environment. Proper lighting is another concern that directly affects safety in regard to measuring walkability of campuses. Lighting plays a significant role in creating a secure environment. Particularly at night times, higher levels of lighting increase in potential for security. Proper and good lighting not only enhances visibility but also discourages crime thanks to easier monitoring techniques (Utaberta and Handryant, 2012). Moreover, other than good illumination, some comfort issues like protection from weather conditions, visual appearance, and amenities such as litter containers, benches, etc. also encourage walking (Balsas, 2003). Lastly, packing of stray dogs

in campuses must be listed as one of the most critical subjects directly affects the walkability with the fear of being attacked specially in secluded corridors within the campuses.

2.2.1.3 Cycling

Cycling is another active transportation means with walking. As being an active form of transportation, cycling offers numerous social, economic, environmental, transportation, and health advantages (Pucher and Buehler, 2012; Rabl and De Nazelle, 2012). Moreover, the bicycle serves as an excellent alternative to cars for short trips because it generates no pollution, requires no energy, operates quietly, occupies minimal space, and is both fast and cost-effective (Tolley, 1990).

In terms of cycling, many university campuses have insufficient and inadequate bicycle infrastructure, such as bike paths, lanes, intersection treatments, signage, and parking (Balsas, 2003). Cycling on campus can often pose risks, with accidents resulting from speeding, the intervening in traffic, inadequate right-of-way design, and younger individuals' tendency to deviate from designated bike routes and disregard traffic regulations (Dober, 2000). Developing proper cycling infrastructure within the campus environment is essential for both ensuring the safety of cyclists and encouraging sustainable transportation throughout campuses. It is widely acknowledged that encouraging cycling on university campuses makes universities more attractive and desirable for students and staff, while also contributing to sustainable transportation goals (Aliari et al., 2020). McClintock suggests that special infrastructural improvements for cyclists can significantly enhance their safety, while providing distinct advantages in terms of convenience, comfort, directness, and overall attractiveness (1992). Onac et al. extended those features which would be utilized in the design of the cycling routes and providing a proper bike infrastructure as directness and shortness of the lanes (directness); comprehensible and connected lanes (consistency); infrastructure with legible signage, adequate lighting, and limited waiting times at intersections (attractiveness);

fluent and comfortable traffic flow, flat and drift-resistant pavement, apart from walls and main roads, and reduced slopes (convenience); and divided lanes, even pavement surface, decent lighting and minimizing the hazardous crossings (safety) (2021). However, ensuring those infrastructural features within the campus environment cannot solely resolve all the barriers against cycling in campuses. Apart from safety, long distances, and topography, which requires much effort, and not having a bicycle are other main obstacles to cycling on campuses. Lastly, cycling has a strong connection with the culture of society. Cycling as a mean of transportation can be seen as evolved in a cycling culture in some parts of the world, however, some societies still associate cycling with sport and leisure activities and its role of as a transportation means has been marginal in urban areas (Nelson and Allen, 1997).

2.2.1.4 Ride Sharing

Ride sharing, which is also called carpooling, has gained importance in line with the developments with shared economy as well as the technology. Ride sharing helps to connect people in need of commuting to similar destinations in close time slots. There are several economic, environmental, and social benefits of ride sharing. While investments in infrastructure for supporting the increasing individual car use is becoming a significant financial burden for governments, expenses related to car ownership get more financially straining for individuals as well. Moreover, vehicle emissions are a major contributor to greenhouse gases, directly leading to global climate change. (European Commission, 2010). Furthermore, traffic congestion greatly impacts the reduction of people's quality of life worldwide (OECD, 1999). Considering all of these, in reality, cars on average carry 1.6 passengers, only 25% of the expected emissions are due to people travelling, while the remaining emissions resulting from empty seats (Jeanes, 2010). Therefore, many researchers from diverse disciplines such as transportation (Morency, 2007); economics (Brownstone and Golob, 1992); and behavioral, social, and environmental psychology (Nordlund and

Garvill, 2003) have identified ride sharing as an effective solution to the inefficiency of current transportation systems. Furthermore, Agatz et al. note that on an individual level, ride sharing enables car owners to share travel costs and provides increased mobility for those without cars (2012). Overall, ride sharing, or the joint travel of two or more people in a single car, has initiated a common practice of sharing both the costs and benefits of a privately owned vehicle (Furuhata et al., 2013).

The availability of mobile internet technology has created new possibilities for individuals with similar travel plans and schedules to share rides at short notice (Agatz et al., 2011). This has led to a noticeable increase in the demand for ride-sharing services aimed at people sharing common routes and schedules (Saranow, 2006). The widespread use of internet-enabled smartphones allows users to both offer and request trips conveniently, facilitating dynamic, on-demand ride sharing (Agatz et al., 2010). According to Casey et al., dynamic ride sharing differs from traditional car sharing, carpooling, and vanpooling in two main ways. Unlike traditional methods where routes are predetermined, dynamic ride sharing allows for spontaneous matching of random points and times based on the trip's purpose. Additionally, arrangements for dynamic ride sharing are typically made shortly before the trip, meeting immediate travel needs rather than planning weeks in advance (2000).

Common practices about sustainable ride sharing systems with high capacity consist of university shuttles serving academic travelers apart from public transportation. These systems differ from public transport in several ways. Firstly, their services are only for academic travelers. Secondly, these systems are made to take passengers directly to the university campus, so eliminating the use of other modes of transportation. Even though they might be more expensive than regular public transit, their schedules are set to match the university’s hours, excluding mid-day commuting (Naaman et al., 2024). Another form of ride sharing, where individuals share their cars with others, is commonly preferred especially by students who communicate through online platforms to fulfill their commuting needs to nearby destinations. This type of sharing can either follow a fixed route on a daily basis or

be arranged on-demand with short notice. It can offer financial benefits for car owners through a systematic reservation system, or it can be more spontaneous, similar to hitchhiking, without any financial expectation from additional passengers, relying instead on a voluntary basis as part of a culture of solidarity.

Implementing ride sharing in university campuses could not be the first but at least an alternative for reaching green campus transport objectives which would decrease vehicle circulation thanks to shared trips overall. In *Sustainable Commuting*, Molina et al. state that ride sharing as also being one of green transport modes besides public transport, walking, and cycling (2020). Bruck et al. found that sustainable, carbon-minimizing transportation can be achieved without optimizing vehicles or promoting electric vehicles. Their study indicates that ride sharing in private vehicles rather than driving alone will reduce traffic density and contribute to more sustainable and environmentally friendly transportation (2017). Additionally, it is noted that widespread ride sharing can lead to time and cost savings. Shaheen et al. explore the benefits of ride sharing, confirming that it is both sustainable and economically viable, as supported by other studies (2018).

There are several factors affecting ride sharing decisions like comfort, privacy, culture, flexibility, and some demographic criteria such as age, gender, income level, and occupation. Although ride sharing is frequently preferred as a favorable option, in some circumstances people hesitate to participate. Molina et al. investigated the circumstances under which ride sharing is not preferred. Their research found that people are unwilling to share their cars during epidemic outbreaks, such as COVID-19 (2020).

2.2.1.5 Car Sharing

Car sharing or carsharing which is also called car clubs in UK is a model of car rental where people rent cars for a short period of time. Promoting car sharing systems in urban areas has long been seen as a crucial strategy for reducing private car traffic

and mitigating pollution. Decreasing the impact of air pollution on residents and buildings is essential for creating sustainable cities (Ampudia-Renuncio et al., 2018). Successful car-sharing programs are often linked to densely populated areas, such as city centers, and have increasingly been adopted by universities and other campuses.

Station-based car sharing, a traditional concept that has been around for over six decades, involves a fleet of cars shared by multiple users. These users have access to a car whenever needed, without the necessity of individual ownership (Ciari, Bock and Balmer, 2014). Although, there is not a clear definition of car sharing, Millard-Ball et al. have collected all definitions in the literature and agreed on defining car sharing as a practice involving multiple individuals within a for-profit or non-profit organization sharing the use of multiple vehicles in return for a fee. This fee might include a fixed rate, a membership charge, and a variable rate, typically based on usage time (2005).

Station-based car sharing offers an economic and ecological alternative to private car ownership. However, in recent years, a broader range of customers has been drawn to the newer free-floating carsharing (FFCS) systems (Heilig et al., 2017; Kopp, Gerike, and Axhausen, 2015). FFCS systems is a type of car sharing which is one-way and non-station-based model offering greater flexibility to users. In this system, users pick up a car from one station and can return it to any other station, not necessarily the one where they originally picked it up. FFCS represents an advancement of the one-way carsharing model allowing users to return the car to any public parking space within a designated operational zone (Schaefers, 2013).

The literature acknowledges several positive impacts associated with car sharing systems within restricted environments. These include:

- Environmental benefits, such as a decrease in total CO2 emissions (Shaheen and Cohen, 2007; Haefeli et al., 2006)
- Individual reduction in vehicle-kilometers travelled (Shaheen et al., 2009)
- Decrease in average numbers of vehicles per household (Martin and Shaheen, 2016).

Although it is a controversial issue of whether car sharing systems increase automotive commuting by allowing easier one-way travel and negatively affect traditional public transportation (Ampudia-Renuncio et al., 2018), it is evident that integrating electric vehicles into these shared systems within densely populated and congested zones would have a significant effect on reducing air pollution. Furthermore, car sharing systems would positively influence social equity for those without individual car ownership, addressing mobility needs and accessibility issues in highly populated areas.

2.2.1.6 Bike and Scooter Sharing

Bike or scooter sharing system is a shared micromobility service offering bikes and scooters to be rented for a short period of time in exchange for a fee. These systems are provided by either governments (i.e. city wide) or private organizations. Similar to car sharing, there are two types of bike and scooter sharing systems, which are docking and dockless systems. While in docking system one can rent a bike from a dock and return at another dock within the system, dockless systems offers flexibility of leaving the rented bikes or scooters to anywhere within the designated zone of the service by relying on smart technology.

Bike share programs were introduced several years ago to promote biking as a sustainable and convenient mode of transportation for daily use. These programs, especially in small and medium-sized communities like university campuses, offer numerous benefits to both individuals and the community. Individuals gain from increased physical activity, lower transportation costs, reduced car dependency, and less time spent in traffic. Communities benefit through fuel and energy savings, reduced parking demand and congestion, and lower environmental emissions (Kelarestaghi et al., 2019).

With the technological improvements, traditional bikes have evolved into e-bikes and e-scooters which requires less effort to ride and thus, such sharing systems offer

e-bikes and e-scooters to meet the transportation needs of users' first and last-mile travels. According to Weinert, Ma, and Yang, e-bikes are considered "semi"-motorized vehicles as they can function using both human power and electricity, with an average energy consumption of 1.2-1.5 kWh per 100 km. However, a major environmental concern associated with electric bikes and scooters is the use of lead-acid batteries, which exhibit high lead loss rates during production, manufacturing, and recycling (2006).

Introducing bicycle and scooter sharing programs is another way to offer sustainable transportation on university campuses. Promoting the use of bicycles and scooters, along with making them easily accessible, will encourage more frequent use of these transportation modes (Deveci et al., 2022). However, there are some certain considerations which can affect the use of these systems on university campuses. Aliari et al. highlight those factors that, like city-wide bike sharing systems, the demand for campus bikeshare is largely influenced by factors such as weather, time of day, day of the week, month of the year, and proximity to transit and other key destinations. However, unlike city-wide systems, campus bikeshare trips are more evenly distributed throughout the day rather than concentrated during peak hours (2020).

2.2.1.7 Problems with Automobile Dependency

Individual car use has many advantages like better on-time performance, door-to-door travel, comfort, safety, etc. However, using car as a transportation mode has many hidden costs (Balsas, 2003). Researchers have explored ways to promote active transportation. A study commissioned by the American Public Health Association found that heavy reliance on automobile travel leads to additional costs for road construction and maintenance, continued urban sprawl, decreased walkability, car accidents, and substantial long-term direct and indirect expenses (2010). Other than those economical costs, the extensive use of automobiles directly and indirectly affects the environment on university campuses and their surrounding

neighborhoods and causes spatial, environmental and social impacts as well. Spatial impacts include congestion, poor accessibility, large areas occupied for parking, air and noise pollution, energy consumption, and the deterioration of visual and natural conditions. Alongside these environmental impacts, there are numerous social impacts, both tangible and intangible. These include declining health among staff, students, and neighbors; disruption of work, study, living, and teaching environments; reduced personal safety and an increase in accidents; wasted time during traffic congestion; and a rise in mental health problems (Limanond et al., 2011; Emanuel and Adams, 2011).

Most campuses have been initially designed for pedestrian use but are then influenced by a culture that promotes driving whenever possible. This tendency forces campus officials to create more parking spaces, expand roadways, and overlook the development of infrastructure that supports non-motorized transportation (Toor and Havlick, 2004). Transitioning from car use to active commuting can be achieved either by making driving less convenient or by making biking and walking more accessible and easier (Kaplan, 2015).

University campus administrators should take some certain measures in order to decrease individual car use while encouraging active transportation with the aim of developing sustainable transportation within the campuses and improving the quality of their residents' lives. Sheepers et al. examine different incentives aimed at promoting active transportation to encourage physical activity and mitigate the negative effects of individual car use. In their analysis of published research, nearly all studies report positive outcomes in facilitating the shift from car use to active transportation. Intervention tools are categorized into legal, economic, communicative (media, behavioral), and physical (e.g., bike rentals, infrastructure improvements) measures. To successfully transition from individual car use to active transportation, multiple intervention tools are typically employed, such as social marketing campaigns, personalized transportation plans, facility upgrades, or financial incentives (2014).

However, targeting all individuals within campuses and taking generalized actions by implementing negative TDM (Transportation Demand Management) measures which means making use of individual car use more difficult on campuses may not be the rightest decision by university administrators to take. Such a strategy would inevitably exclude some special user groups which neglect social equity and sustainability. The seductive nature of car ownership leads many individuals to continue commuting by car, despite challenges related to congestion and parking problems. Furthermore, individuals often feel bound by family commitments and the need for multi-stage trips, such as dropping children off at school before going to work, which are seen as more convenient by car. In such situations, targeting individuals specifically may be more economically effective than implementing general strategies (Tolley, 1996).

2.2.2 TDM (Transportation Demand Management) Strategies

There are various methods to support a multimodal and efficient transportation system, known as Transportation Demand Management (TDM). TDM was first proposed in 1990 by Erik Ferguson. It focuses on altering transport behavior and offers numerous benefits, including reduced energy consumption, conservation of natural and environmental resources, efficient land use, fewer road traffic accidents and congestion, lower emissions, increased transportation options, and overall enhancements in livability and social equity. (E. Ferguson, 1998; Berman and Radow, 1997). Ferguson describes TDM as the practice of changing transportation behavior. TDM promotes strategies to improve management and foster more effective and environmentally conscious transportation attitudes (1990). According to Meyer, TDM is defined as a set of planning strategies and actions designed to influence people's travel behavior by presenting alternative transport options and/or reducing congestion (1997). Similarly to Meyer, Bond and Steiner highlight the aim of TDM strategies as that they should aim to achieve a balance between expanding travel options and motivating a reduction in individual car use (2006).

In general, the main aim of Transportation Demand Management (TDM) is to change and maintain individuals' travel-related behaviors. Travel behavior is influenced by structural factors like distance, time, cost, urban density, road characteristics, and transportation services, as well as individual factors such as travel purpose, education, time constraints, and demographic conditions such as age, income, gender, occupation, attitudes, and lifestyle (Steg et al., 2005; Steg et al., 2014; Stren, 2000; Ünal et al., 2019; van der Werff and Steg, 2016; Miralles-Guasch and Domene, 2010). Apart from these variables travel behavior is also affected by social and environmental concerns. Therefore, the success of these policies in achieving sustainability depends on public acceptance and engagement.

There are several applications of TDM strategies which are favored and used by university administrators on campuses. The most commonly utilized and implemented Transportation Demand Management (TDM) strategies in the existing literature include parking management and optimization, public transportation promotion, car-sharing programs, encouraging bicycle use, creating pedestrian-friendly campuses, park-and-ride schemes, advancing vehicle technology, incorporating innovative technologies and alternative fuels, and leveraging the internet and video platforms to offer online classes and transportation information (Markowitz and Estrella, 1998; Steg et al., 2014; Toor and Havlick, 2004; Litman and Burwell, 2006). Litman also categorized TDM policies into three broad groups which are positive, mixed, and negative. According to Litman, positive TDM policies aim to expand transportation options and access for all users, such as transit service improvements, flexible work hour scheduling, and carpool/vanpool programs. Mixed TDM strategies enhance options and access for a specific segment of the population without negatively impacting others. Examples include high-occupancy vehicle lanes, unlimited-access or fare-free transit programs, and traffic calming measures. Negative TDM strategies reduce options or increase costs, such as fuel tax increases, parking pricing, and auto-free zones (2003). Apart from Litman's content-based classification of TDM policies, Miralles-Guasch and

Domene have made an extended list of subject-based TDM measures specific for university campuses and exemplified these diverse subjects as below:

1. Modal substitutions
    a. Public transport improvements (time and cost) and incentives
    b. Walking, cycling improvements (safety) and incentives
    c. Car sharing infrastructure and service
2. Pricing incentives/disincentives
    a. Subsidies for public modes of transit (transit pass programs)
    b. Parking policies (increase the cost of parking relative to the cost of public transport)
3. Land use – transportation strategies
    a. Increasing the studying housing offer
    b. Mixed use development
    c. Higher development densities
    d. Transit, pedestrian bicycle friendly development
4. Telecommunications substitutions
    a. Distance learning
    b. Telecommuting
    c. Teleconferencing
    d. Flextime
5. Technology and efficiency improvement
    a. Replacement of the university fleets with alternative technologies
    b. Green purchasing
6. Information
    a. Intelligent transportation systems
    b. Routing and scheduling information

7. Education and participation
    a. Mobility web page
    b. Cost and benefits of different modes
    c. Educational and promotional campaigns (2010).

Many older universities and newly established urban universities have limited land due to the high cost or urbanization of the surrounding areas. In fact, the need for additional land and the extension of campus boundaries should be aligned with the expansion of academic facilities and the enhancement of the quality of life for campus residents. With the increase in car ownership during the latter half of the last century (Dargay, Gately and Sommer, 2007) university campuses face major issues such as parking shortages, land-use challenges, and problems related to pedestrian mobility and security as well (Deveci et al., 2022). Therefore, to summarize, major initiatives for sustainable transportation planning on university campuses include providing incentives for walking and bicycling, discouraging single-occupancy car use, promoting mass transit and ride sharing, reviewing parking costs, and integrating transportation planning with land-use planning (Abdul-Azeez, 2018). Lastly, voluntary travel behavior change programs, a new category within the Transportation Demand Management (TDM) initiative, aim to help individuals become more aware of their travel options and make choices that reduce private motor vehicle use whenever possible (Rose and Ampt 2003).

2.2.2.1 Parking Management

Parking management is one of the most significant components of sustainable transportation strategies in university campuses. Effective parking policies can significantly influence commuting behaviors, promote the use of alternative transportation modes, and consequently reduce greenhouse gas emissions within the campus environment. In the existing literature, there are various studies from which different approaches and insights could be explored for the economic and social

implications of parking management in universities, and also for highlighting the effectiveness of different strategies and the challenges faced in their implementation.

Universities incur substantial costs in providing parking facilities for commuters. These costs include salaries for parking attendants, administrative expenses, the asset value of the land used, taxes, capital costs for constructing parking lots, maintenance, and fees to clamping companies. Despite these high costs, detailed audits of university parking expenses are rare, making it challenging to draw firm conclusions about their financial impact. However, it is likely that the total costs of providing parking exceed the revenue from parking charges, effectively resulting in a subsidy for car users (Tolley, 1996).

Parking pricing is a powerful tool frequently used by universities to manage transportation demand (Bond and Steiner, 2006). It helps reveal the hidden social and environmental costs of driving decisions (Tudela-Rivadeneyra et al., 2015; Gärling, and Schuitema, 2007). Keeping parking rates low can encourage the purchase of annual permits, increase drive-alone rates, and elevate greenhouse gas emissions (Saelens, Sallis, and Frank, 2003). In contrast, higher parking costs can make alternative modes of transportation like walking, biking, or transit appear more attractive. Thus, rational pricing strategies can promote sustainable commuting behaviors (Riggs, 2017; Tudela-Rivadeneyra et al., 2015; Gärling, and Schuitema, 2007; Saelens, Sallis, and Frank, 2003; Ariely, and Loewenstein, 2003; Helbing, and Molnar, 1995).

Universities, given their well-defined communities, are in a strong position to measure transportation outcomes and solicit feedback. Effective methods for reducing driving and encouraging sustainable commute modes include optimizing parking prices to reduce demand and promoting alternative transportation (Shoup, 2008). However, changing commuting behaviors through parking policies can face significant resistance. Therefore, universities must actively engage their

communities in a thoughtful manner to ensure the successful and equitable implementation of these policies (Wiers and Schneider, 2022).

In densely populated areas like university campuses, managing parking supply and imposing restrictions is a highly effective strategy. By limiting parking availability, universities can directly influence travel behavior, reducing the number of automobiles accessing the campus (Bond and Steiner, 2006; Azzali and Sabour, 2018). When parking supply does not meet demand, users may park outside the campus or choose sustainable transportation modes like walking, cycling, and public transportation (Kumar and Bowman, 2022). This encourages a shift towards more sustainable commuting practices (Toor and Havlick, 2004; Bond and Steiner, 2006).

As campus enrollment increases, traffic demand also rises, leading to decreased parking capacity. The growing number of students worsens parking problems and necessitates the implementation of efficient parking management strategies to cope with increased demand (Browder, Chimba, and Boykin, 2014). Effective parking management can mitigate these issues by encouraging the use of alternative transportation modes and reducing reliance on personal vehicles.

Effective parking management is crucial for promoting sustainable transportation in university campuses. By understanding and addressing the economic costs, implementing rational pricing strategies, engaging the university community, and managing parking supply, universities can significantly influence commuting behaviors and reduce environmental impacts in relation with car ownership. However, the success of these strategies requires thoughtful implementation and continuous engagement with all stakeholders to overcome resistance and achieve long-term sustainability goals.

2.2.2.2 Telecommuting, Teleworking, and Online Education

A crucial strategy for managing transportation demand and reducing travel within a campus setting is the implementation of telecommuting and online classes. This method substantially decreases the frequency of trips and the dependence on motorized transportation.

Telecommuting and teleworking have emerged as significant strategies in transportation demand management (TDM), with the potential to significantly influence urban development and mitigate the challenges associated with conventional commuting patterns. Public decision-makers are increasingly turning to these alternative work arrangements, with financial limitations and environmental constraints in executing substantial transportation infrastructure improvements, as effective solutions to address urban congestion (Giuliano and Golob, 1990; Gurstein, 1996).

The rising trend of telecommuting and teleworking reflects the evolving nature of employment patterns, driven by advancements in information and communication technologies (Gurstein, 1996). This shift in work practices holds the potential to substantially impact daily life and the broader spatial organization of communities.

The benefits of telecommuting and teleworking are multifaceted, offering both personal and societal advantages. For individuals, these arrangements provide the flexibility to work from home, eliminating the daily commute and associated costs and environmental impacts (Arce and Quintá, 2013). From a broader perspective, widespread adoption of telecommuting can reduce urban congestion, decrease energy consumption, and lower greenhouse gas emissions, which are critical for effective transportation demand management (Tayyaran and Khan, 2003; Othman et al., 2019).

In conclusion, the rise of telecommuting and teleworking represents a significant shift with profound implications for transportation demand management and urban

development. As policymakers and urban planners address the complexities of these evolving work practices, it is essential to consider their multifaceted impacts on individuals, communities, and the broader urban landscape, including both the positive and negative aspects.

The Impact of COVID-19 on Online Classes and Teleworking

The outbreak of the COVID-19 pandemic has significantly altered the global landscape of education and employment. The sudden closure of campuses and the implementation of social distancing measures necessitated a swift transition from traditional face-to-face classes to online learning platforms (Rashid and Yadav, 2020). This shift has introduced both opportunities and challenges for students, educators, and institutions.

The COVID-19 pandemic has profoundly impacted the education and employment sectors, accelerating the adoption of online classes and teleworking. This transition, though presenting numerous challenges, has simultaneously unveiled new opportunities and highlighted the necessity for further research and adaptation in these areas.

2.2.3 University Campuses and Cities

The relationship between a university and its surrounding city is strategic for the university to achieve its targeted ambitions and vision. This partnership also benefits the city, as universities often serve as key drivers of progress, not only for local communities but for the nation as a whole. Despite the complexity, interconnection, and diversity of this relationship, maintaining a mutually beneficial partnership is crucial for realizing the strategic objectives of both the university and the city (Mohammed, Ukai and Hall, 2022).

The campus-city relationship can be categorized into two types: physical and functional (Den Heijer and Curvelo Magdaniel, 2018). The physical relationship

refers to the location of the campus in the city, which can be defined by the city's borders or the campus size. Campuses can be part of the city or considered a city themselves, with three main spatial configurations: outside the city, gated within the city, and integrated with the city. These configurations affect the city's topology, with the campus potentially equalizing, disjointing, touching, containing, or overlapping the city (Curvelo Magdaniel et al., 2018). The functional relationship involves the types of spaces and services available on or off-campus that serve both the campus and the city, such as residential, retail, leisure, academic, infrastructure, and related businesses. These functions also indicate the campus's dependency on the city. Both physical and functional relationships coexist and overlap, making it crucial to analyze them together when studying the campus-city relationship (Mohammed, Ukai and Hall, 2022).

The intrinsic campus-city relationship contributes to the flourishing of cities, but it also introduces challenges, particularly related to the student population and their service needs, which can change the neighborhood's character (Den Heijer and Curvelo Magdaniel, 2012). Transportation is a significant activity in students' daily lives, making the campus's physical relationship with the city crucial for determining transportation types and modes used by students, faculty, and staff. Campuses located in densely populated residential areas, along with nearby commercial and entertainment services, often place significant strain on the transportation system, leading to increased parking demand, traffic congestion, and accidents. This pressure underscores the need for universities and transportation planning agencies to develop targeted transportation programs, practices, and policies to address these challenges (Mohammed, Ukai and Hall, 2022).

The university is an ideal site for implementing sustainable development due to its relatively simple governance structure and local politics compared to the broader city scale. With its structured administration, a university can more effectively address local environmental problems where cities sometimes struggle (Finlay and Massey, 2012). Promoting sustainable transportation modes on university campuses has

environmental, social, and economic benefits. From an educational perspective, universities have a responsibility to prepare and educate the next generation of decision-makers (Velazquez, Munguia and Sanchez, 2006; Bond and Steiner, 2006) and spread progressive knowledge into general usage. Universities should act as laboratories for testing new ideas and strategies related to active transportation modes (Cortese, 1999; Beringer, 2006; Guasch and Domene, 2010; Norzalwi and Ismail, 2011). The transportation strategies introduced on university campuses often transfer to the broader community as students and staff carry these lessons into the wider world, influencing future attitudes and behaviors towards sustainable transportation systems and strategies (Dehghanmongabadi and Shirkhanloo, 2013).

In conclusion, the campus-city relationship is multifaceted and strategic for both entities. It involves a complex interplay of physical and functional relationships that affect transportation systems and sustainable development initiatives. Universities play a critical role in fostering sustainable transportation practices that benefit not only their immediate communities but also have far-reaching impacts on broader societal attitudes and behaviors.

2.2.4 METU Campus

2.2.4.1 General

The METU Campus is located on the Ankara-Eskişehir Highway. Since the 1960s, it has been completely reforested through the efforts of university staff and students. The campus covers an area of 4,500 hectares, with a forested area of 3,043 hectares. It also includes Lake Eymir, which is located 20 km from the center of Ankara. The main campus hosts accommodations for 7,000 students, a shopping center, banks, a post office, and various dining options. Additionally, the campus features facilities for a wide range of sports activities, including indoor sports halls, tennis courts, football fields, jogging paths, an Olympic-standard indoor swimming pool, and an

outdoor swimming pool. The main entrance gates of the METU Campus, located 7 km from the city center, are A1 and A2 on the Eskişehir Highway. Additionally, entry and exit can be made through gates A4, located on the 100. Yıl side, and A7 on the Bilkent road (https://www.metu.edu.tr/location-campus-map, 2024). A detailed campus map can be seen in Figure 2.1:

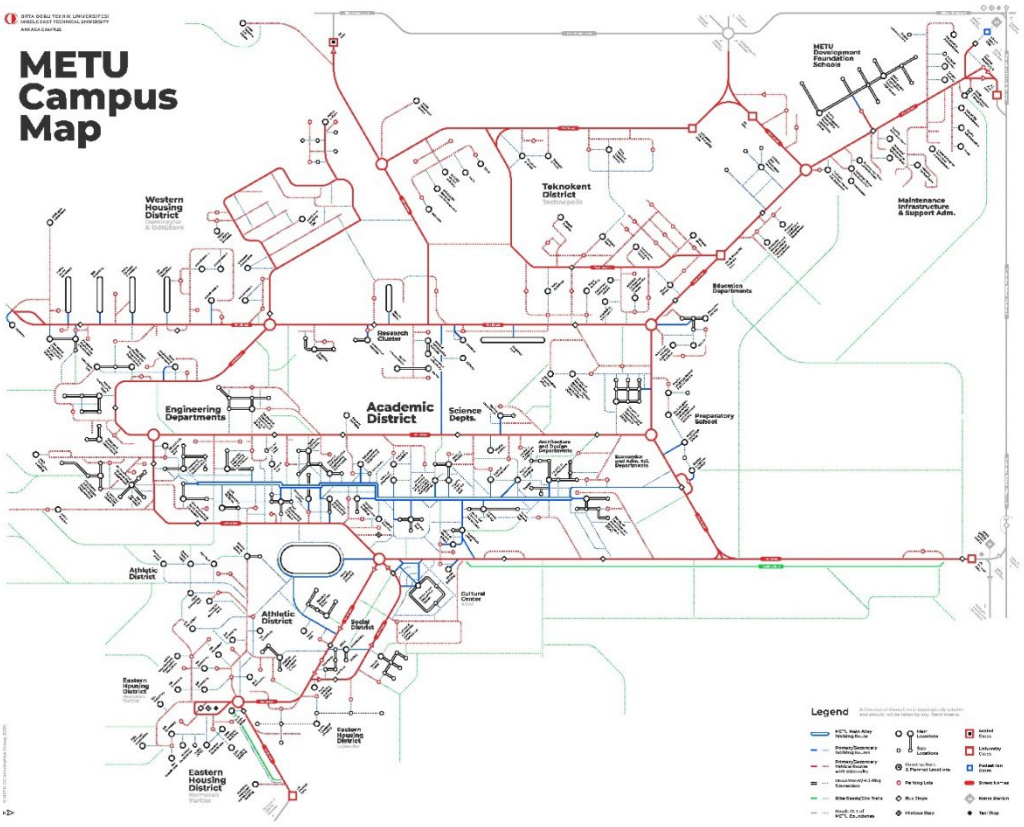


Figure 2.1. METU Campus Map (https://www.metu.edu.tr/system/files/odtu-kampus-haritasi.pdf, 2024)

2.2.4.2 History

The current layout of the Middle East Technical University (METU) campus was established in 1961 through a national project competition judged by an international

jury. The winning project, designed by Altuğ and Behruz Çinici, laid the foundations for the core campus area, divided into three main functional regions (see Figure 2.2):

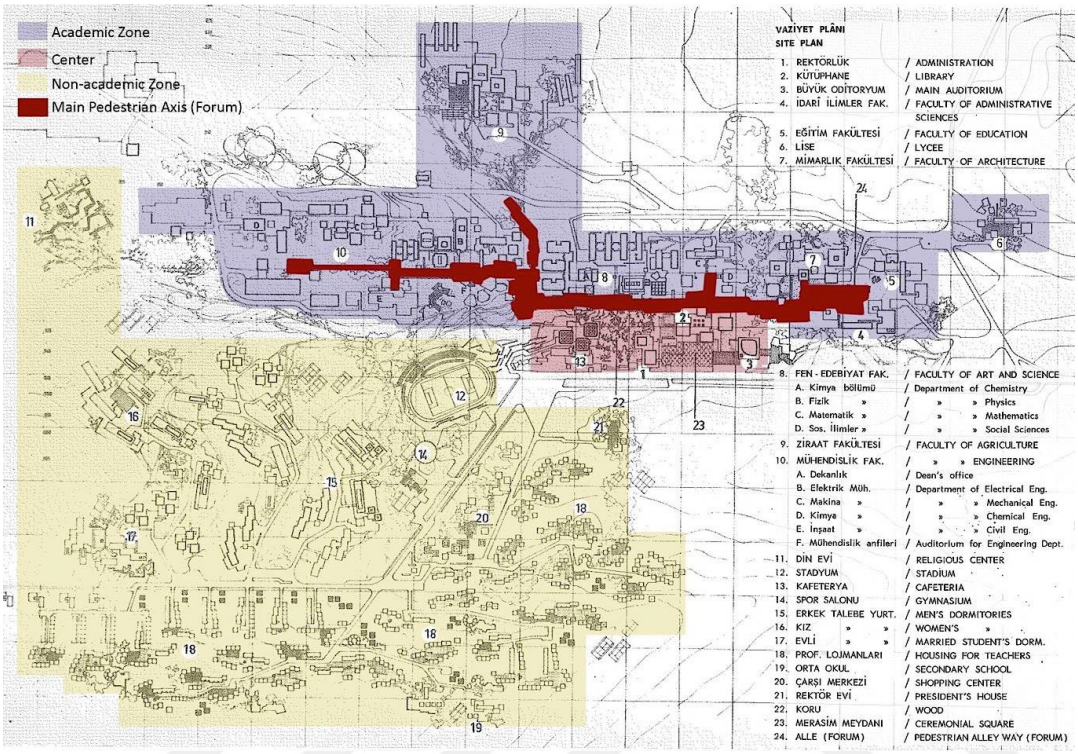


Figure 2.2. Altuğ-Behruz Çinici Plan (1961) and sub-regions according to main functional groups. Middle East Technical University, Ankara, May 1964 (Fanzin).

1. **Academic Area**: Situated on a ridge overlooking Ankara, this area includes the Faculties of Administrative Sciences, Education, Science and Literature, Architecture, Engineering, and Agriculture, connected by an open academic square termed the "forum." The forum is a pedestrian-only spine with intense activity.

2. **Central Area**: Designed as administrative and student centers in two locations, this area includes the central library, auditorium, fine arts galleries, administration building, cafeteria, and a symbolic cedar grove between them.

3. **Non-Academic Area**: This area consists of dormitories, residential buildings, social facilities, and sports fields.

The campus fabric is organized along a pedestrian circulation axis called the "Alley," forming the backbone of the settlement system (METU Ankara Campus Spatial Strategy and Design Guide, 2016).

In the report of *Development History of METU Planning*, Campus landscape architects Altuğ-Behruz Çinici described the Alley as follows;

> "The defining layout of the campus is formed along the pedestrian axis which is the spine of the campus, named as 'Alley' by the users. The Alley extends along the ridge from north to south in accordance with the soft terrain topography. Throughout the Alley, academic units are located on the west side and generate the education area, while the President's Office, The Main Library, and Cafeteria take part on the other side (on the east) and form the center. The focus of intense social activity occurs here, and this cultural and intellectual interaction place, the spine, can be named as 'Forum' or the main major class of the university where people continuously gather and interact. There are trees providing shade in front of the buildings and water elements arranging the microclimate along the Alley, with extensions of the Alley continuing inside the buildings. Therefore, continuity and permeability between inside and outside is provided, and the Alley increasingly affects the interior organization of the buildings" (Akman, 2016, p.63).

Within this framework;

- Pedestrian-prioritized transportation system,
- Separation of vehicle and pedestrian circulation in a complementary manner,
- Integration of indoor and outdoor spaces and spatial permeability,
- Use of water elements in open spaces, continuity of green areas, material and form integrity,
- Characteristic solid-void ratio (pattern of built and unbuilt areas) in the building pattern,

are planning and design principles established by the 1961 Çinici Plan for the METU campus, which need to be reproduced today (METU Ankara Campus Spatial Strategy and Design Guide, 2016).

2.2.4.3 Physical Resources

Since its establishment to the present, all faculties and departments of the university, except for the Northern Cyprus Campus in KKTC and the Institute of Marine Sciences in Mersin-Erdemli, are located within the same campus area in Ankara. The physical resources are listed as follows:

Table 2.7 Physical Resources of METU (http://ilkbakista.odtu.edu.tr/, 2024)

Physical Resources	2023
Campus area (km2)	45
Forested area (km2)	33
Classrooms and Lecture Halls	374
Laboratories	467
Indoor and outdoor sports areas (m2)	60.635
Dormitories	19
Dormitory capacity (number of residents)	7.695

Until 1986, the Vehicle Operations Directorate utilized 51 buses for various purposes, including neighborhood services, ring services, and intercity transportation. Today, the Directorate operates with a total of 131 official vehicles, comprising 28 buses and 73 various service vehicles (https://tim.metu.edu.tr/en/node/25, 2024).

2.2.4.4 Population

According to the 2023 activity reports, a total of 150,977 students have graduated from the METU campus, with the current student population standing at 25,089. To quantify the campus population: there are 1,892 academic staff (705 faculty members, including 378 professors, 171 associate professors, 156 assistant professors, 479 instructors, 708 research assistants, and 36 foreign faculty members) and 2,603 administrative staff. Additionally, in the METU Technopolis area, 436 companies employ 13,250 R&D personnel (https://kgpo.metu.edu.tr/tr/ilk-bakista-odtu, 2024).

2.2.4.5 Transportation

ODTÜ campus can be accessed via EGO buses, private public buses, minibuses, and taxis. Among these, the most convenient and widely serviced option is the EGO buses. The schedules and routes of buses operating between the campus and various districts in the city center can be seen in Figure 2.3. Additionally, it is possible to reach the A1 and A2 gates of the campus via the metro, with the metro line information available in Figure 2.4. Minibus routes and stop information are provided in Figure 2.5.

EGO ROUTE INFORMATION
The specified EGO bus routes have stops along Eskişehir Road.

Route No	Route Name
339-5 (ÖTA)	EGE MAHALLESİ - SIHHİYE - KIZILAY - ANKARA ŞEHİR HASTANESİ
419-5 (ÖTA)	AKTEPE - ANKARA ŞEHİR HASTANESİ
511-5 (ÖTA)	SİNCAN AHİMESUD BULVARI - BAKANLIK
512-5 (ÖTA)	SİNCAN AHİMESUD BULVARI - BAKANLIK
521-5 (ÖTA)	GOP (FATİH) - BAKANLIK
530-5 (ÖTA)	ETİMESGUT - KIZILAY - ULUS - ÖRNEK
532-5 (ÖTA)	ELVANKENT - KIZILAY
541-5 (ÖTA)	ERYAMAN - KIZILAY
602-6	SIHHİYE - KIZILAY - BEYTEPE - ÇAYYOLU - YAŞAMKENT

Figure 2.3. EGO Route Information

KIZILAY - KORU METRO LINE	
NO	**STATION**
1	KIZILAY
2	NECATİBEY
3	MİLLİ KÜTÜPHANE
4	SÖĞÜTÖZÜ
5	MTA
6	ODTÜ
7	BİLKENT
8	DANIŞTAY
9	BEYTEPE
10	ÜMİTKÖY
11	ÇAYYOLU
12	KORU

Figure 2.4. Metro Line Information

Minibus Routes

AYRANCI ROUTE	KIZILAY ROUTE	ULUS ROUTE
The AYRANCI-ODTÜ minibus operates from the cafeteria stop until 18:00 on weekdays and from the dormitory area stop after 18:00.	The Kızılay-ODTÜ minibus departs from the cafeteria stop until 18:00 on weekdays and from the dormitory area stop after 18:00.	The Ulus-ODTÜ minibus departs from the cafeteria stop until 18:00 on weekdays and from the dormitory area stop after 18:00.
PORTAKAL ÇİÇEĞİ SOKAK BAŞI	GÜVENPARK İLK KALKIŞ	CENTA PARK
KUZGUN SOKAK	KUMRULAR CADDESİ	İSTANBUL CADDESİ
ÇETİN EMEÇ BULVARI	NECATİBEY CADDESİ	ANKAMALL
HOŞDERE KÖPRÜ ALTI	DSİ'DEN ESKİŞEHİR YOLUNA DÖNÜŞ	MEVLANA BULVARI
DİKMEN KÖPRÜ ALTI	BAHÇELİ - MİLLİ KÜTÜPHANE	GAZİ HASTANESİ
BALGAT - MİGROS KAVŞAĞI	HAZİNE DIŞ TİCARET MÜSTEŞARLIĞI	AŞTİ
KONYA YOLU ÜZERİ KÖPRÜLÜ GEÇİŞ	ODTÜ KAVŞAĞI	ESKİŞEHİR YOLU
100. YIL MAHALLESİ	ODTÜ A-1 GİRİŞİ	ODTÜ KAVŞAĞI
KARAKURSUNLAR MAHALLESİ		ODTÜ A-1 GİRİŞİ
ODTÜ A-4 GİRİŞİ		

Figure 2.5. Minibus Route Information

2.2.4.6 METU Campus Ring Buses

The campus ring buses, serving as the primary component of internal transportation at METU, operate under the *Vehicle Operations Directorate.* There are 28 buses that circulate the campus, following specific routes and schedules to loop around the campus at designated times. These specialized ring routes are distinguished by color codes. Until recently, these ring buses also provided transportation for university staff from surrounding neighborhoods to the campus and back at the end of the workday, supported by private partnerships. However, the service related to staff shuttles has been discontinued for reasons mentioned in the following section.

The current ring bus system can be categorized into four groups based on their routes and associated color codes: (1) METU weekdays daytime bus ring routes (yellow-red ring and light brown ring); (2) METU weekdays morning bus ring routes (turquoise ring and orange ring); (3) METU weekdays evening and night bus ring routes (navy blue ring and purple ring); and (4) METU weekend bus ring routes (gray ring – day and gray ring – night) (https://tim.metu.edu.tr/tr/campus-rings, 2024).

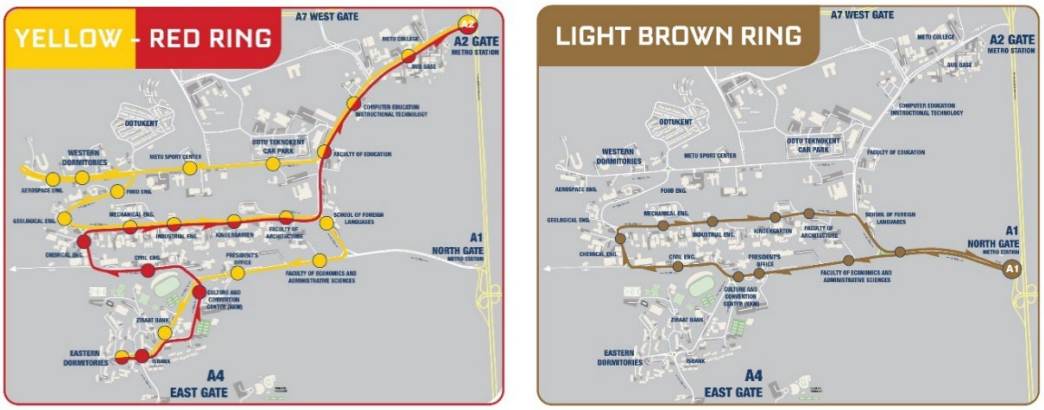


Figure 2.6. Yellow-Red Ring and Light Brown Ring Route Maps

Yellow signed ring buses depart from A-2 Metro Station every 20 minutes between 09:00 and 17:00 on weekdays. After completing first 19 stops, yellow sign turns red sign and complete its route with 13 more stops.

The departure point of the ligh brown signed ring bus is Gate A-1 and follows the route President's Office, Departments, School of Foreign Languages and Gate A-1. Additionally, Ankara Metropolitan Municipality - EGO buses provide ring service every weekday between 08.00-18.00 with 15 minutes intervals on the same route.

Figure 2.7. Turqoise Ring and Orange Ring Route Maps

Turqoise ring buses are in service every day at 08:20 – 08:25 during weekdays throughout the semester between A2 gate and western dormitories. Although orange ring buses departure and final destinations are same with turqoise ring buses, they follow a longer loop with 21 stops and they are in service every day at 08:15 – 08:20 – 08:25 during weekdays throughout the semester.

Figure 2.8. Navy Blue Ring and Purple Ring Route Maps

Navy ring buses are in service everyday during weekdays starting and ending the route at A2 metro station at 17.30 – 18.30 – 19.30 after the working hours. One hour later, purple signed ring buses continues a similar route and are in service every day between 20:30 and 23:30 during weekdays.

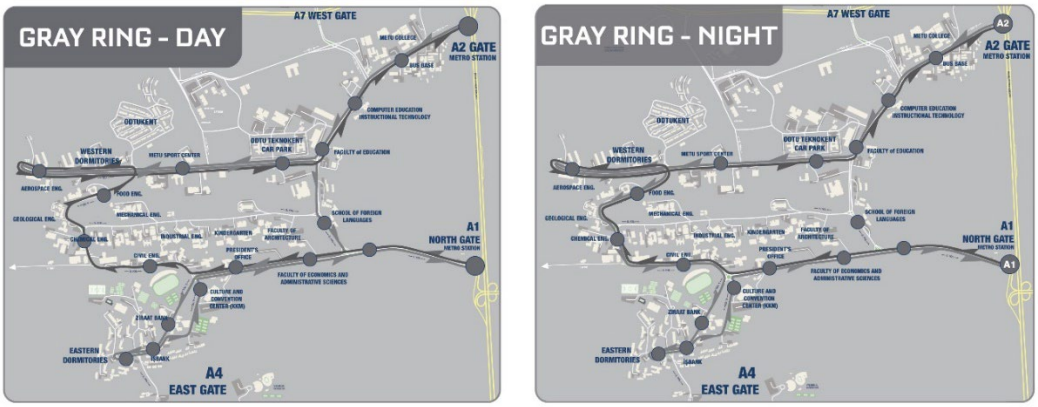


Figure 2.9. Gray Ring Day and Night Route Maps

Gray Ring Buses are in service on weekend at one-hour intervals between 09:30 and 18:30 and Grey Ring Buses are in service on weekend at intervals between 19:30 and 23:30 during the evening among A2 gate metro station, eastern dormitories and A1 gate metro station.

Additionally, the real-time locations of the ring buses can be tracked via the METU app or the ring.metu.edu.tr website. Users can access the schedule information online and filter by specific ring bus routes and their corresponding color codes to view the detailed route information along with the current bus location.

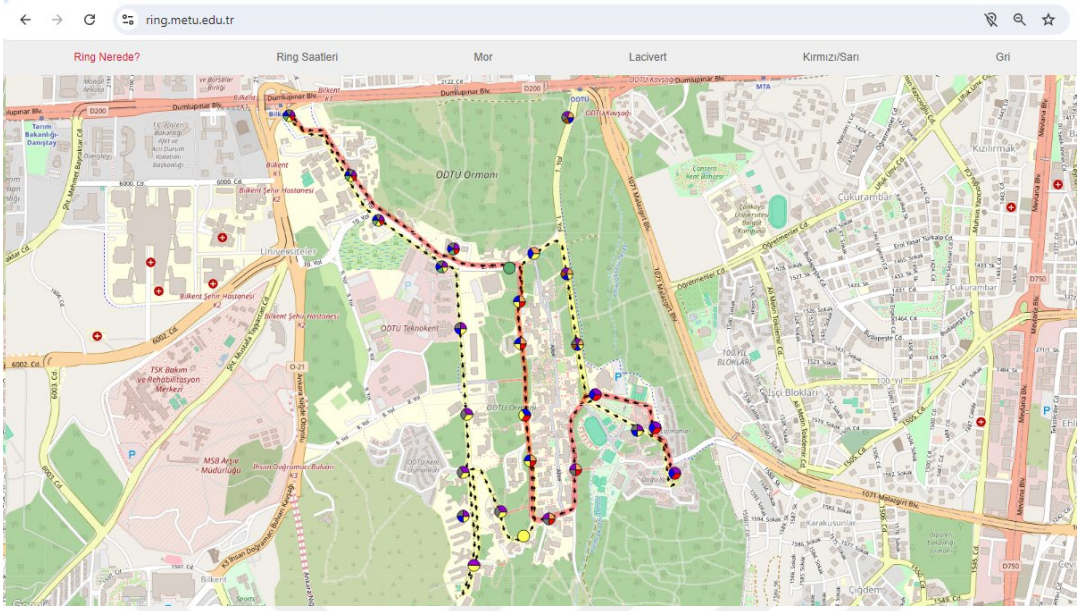


Figure 2.10. Real-time Locations of METU Ring Buses

Important Note: The changes related to the ring buses' service as personnel shuttles were announced to METU staff in an email sent on June 14, 2024. The email summarized the upcoming changes along with their reasons as follows:

"The service procurement contract for the transportation of our university staff will expire at the end of the working day on June 14, 2024. Based on Presidential Circular No. 2024/7 on Savings Measures, published in the Official Gazette No. 32549 dated May 17, 2024, the personnel neighborhood shuttle service will not continue after this date. Additionally, as per the same circular, the shuttles operating on the METU-Sıhhiye route have been discontinued as of June 15, 2024.

Furthermore, the campus shuttle services have been organized as follows:

- Between June 17-23, 2024: 7 trips at 09:30, 11:30, 13:30, 15:30, 17:30, 20:30, and 23:30.
- From June 24, 2024, onwards: 6 trips from Gate A1 at 07:00, 07:15, 07:30, 07:45, 08:00, and 08:15.

- From Gate A2 to inside the campus at 08:00, and from inside the campus to Gate A1 at 17:30 and 18:00 for personnel shuttles".

2.2.4.7 METU Campus Traffic

Entry and exit to the METU campus are monitored by the *Gate Control Directorate*, while traffic regulations within the campus are enforced by the *Traffic Department*. This ensures the implementation and monitoring of campus transportation strategies. The duties of the Traffic Department are detailed in the Appendix. The university has listed the traffic rules within the campus as follows:

- All drivers entering the campus must slow down at the university entrance gates and follow the directions of the security personnel.
- Drivers must obey traffic signs, signals, speed bumps, barriers, and the instructions of those assigned to direct traffic.
- Since pedestrian traffic has priority on our campus, vehicles must slow down at pedestrian crossings and wait until pedestrians have fully crossed.
- Motorcyclists and cyclists must wear helmets, and passengers on these vehicles must do the same.
- For the safety of drivers and passengers, seat belts must be worn at all times within the campus.
- The maximum speed limits on campus are 30 km/h in areas with high vehicle and pedestrian traffic, specifically between the Foreign Languages School intersection, A-4 gate and the Rectorate building, and between the Rectorate Building and the Environmental Engineering Department. For other areas, the limit is 50 km/h.
- Drivers who violate traffic rules while moving within the campus will be subject to action by the Traffic Department. Repeated violations may result in the temporary or permanent revocation of the vehicle permit with administrative approval.

- Forming convoys, unnecessary honking, playing loud music, driving under the influence of alcohol, conducting driving lessons, and engaging in behaviors that endanger traffic safety are prohibited on campus. Violators may have their vehicle permits temporarily or permanently revoked with administrative approval.
- Pedestrians must use the designated sidewalks and pedestrian paths within the campus.
- Drivers must display visitor cards prominently in their vehicles (https://ihm.metu.edu.tr/tr,, 2024).

In relation to these rules, the university has specified the traffic regulations and the penalties for violations as follows:

- In addition to the previously stated rules, the following traffic regulations and administrative measures, in accordance with the "Highways Traffic Law" enacted on 27.10.1996 with Law No. 4199, are in effect on the campus. These are designed to maintain traffic order and ensure the safety of drivers and pedestrians. Non-compliance will result in penalties, and repeated violations will lead to the cancellation of vehicle permits (stickers).
- Vehicles must stop at the campus entrances and show the sticker to the security personnel before entering. Stickers issued by the Internal Services Directorate must be affixed to the front windshield. Vehicles without a METU sticker can enter the campus by obtaining a guest card at the entrance gates.
- Vehicles must park in areas that correspond to the color of their sticker. The color code is indicated under the letter "P" on the signposts.
- Separate parking areas are designated for academic staff, administrative staff, and students. Vehicles must not park in spaces not designated for their use, even for short periods.

- Parking on main road sidewalks and edges is prohibited.
- Compliance with traffic signs, speed bumps, barriers, and warnings from traffic personnel is mandatory.
- Stickers assigned to individuals cannot be used by other vehicles or persons. Violations will result in the cancellation of the sticker, and no new sticker will be issued to the individual.
- Motorcyclists must obtain a sticker and wear helmets.
- The Traffic Department will take action against moving violations (speeding, illegal overtaking, wrong direction, illegal "U" turns, etc.). Repeat offenders will be banned from entering the campus.
- The maximum speed limit on campus is 50 km/h, and 30 km/h in areas with high pedestrian traffic.
- Giving priority to pedestrians and always wearing seat belts is essential for everyone's safety.
- Students with satellite stickers can only use the Cultural Center and Dormitories parking areas. Vehicles with a local sticker (yellow sticker) can use the satellite parking area.
- Students residing in the dormitories are not issued local stickers (https://www.metu.edu.tr/transportation, 2024).

Figure 2.11. Vehicle Stickers Provided by METU According to Purposes

The rules for the use of vehicle stickers and the information regarding designated parking areas provided by the university are detailed in the Appendix.

2.2.4.8 ODTÜPass

ODTÜPass is a system designed to automate vehicle and pedestrian access within the METU campus. The system manages sticker (vehicle permit) processes, visitor registration/acceptance procedures, and the monitoring and management of vehicle and pedestrian traffic.

ODTÜPass allows for pedestrian and vehicle entry through gates A1, A4, A7, and Metro A2. However, gates A2 and A9 are designated solely for vehicle exits (https://ihm.metu.edu.tr/tr/kapi-kontrol-amirligi, 2024).

According to the most recent information provided by the university based on 2023 data:

- A total of 4,659,479 vehicles and 1,372,347 pedestrians entered the campus.
- The total number of pre-registrations created through ODTÜPass was 182,397.
- Among those with ODTÜPass usage rights, 82% have made at least one invitation using the system.
- Pre-registrations for various purposes, including work and other activities, range from 0 to 1,839.
- The highest number of pre-registrations for visits ranges from 0 to 373

  (https://ktkb.metu.edu.tr/tr/odtupass, 2024).

The rules for using ODTÜPass can be found in the Appendix.

2.2.4.9 Parking Management within METU Campus

To enhance the existing transportation infrastructure within the METU campus, a comprehensive parking facility encompassing a total area of 157,469 square meters has been constructed, providing accommodation for 6,713 vehicles. This facility includes specifically designated spaces: 3,022 for faculty and staff, 1,391 for students (local stickers), 2,365 for satellite parking, and 85 for individuals with disabilities. Detailed information regarding the locations of these parking areas, the distribution of parking spaces according to sticker classifications, and the regulations governing parking usage are provided in the Appendix.

2.2.4.10 Environmental Situation Analysis and Core Values

In the 2023-2027 Strategic Plan presented by the university administration, the results of the Political, Economic, Social, Technological, Legal, and Environmental (PESTLE) analysis summarize the environmental situation of the METU campus as follows:

- The METU Forest being one of Ankara's natural resources.
- The Ankara Campus being an essential point of biodiversity in Ankara in terms of endemic butterflies and birds, in addition to the biodiversity and richness of steppe plants.
- The natural environment and the campus, together with its culture and history, create a positive effect on the employees of METU.
- The fact that the university buildings are old, and the number of students and employees per square meter is quite high due to the architectural structure of buildings and overall the increasing number of students and personnel.
- The increase in the population of the campus and the fact that the campus is located in the city.

- Security problems on campus, which is located in the middle of a large forest, due to insufficient human resources and limited technological resources (p.44).

Additionally, the same Strategic Plan outlines several core values that METU stakeholders should possess four of which are selected, reflecting the university's mission and vision within the context of the study:

Sensitivity to the Natural Environment

METU Family regards the forest cultivated on the university's land and the ecological diversity within as a value; they take great care of its conservation and improvement, and they strive to raise awareness regarding the natural environment and the necessity of protecting it.

Social Responsibility

METU Family is responsive to social problems. Members of this family provide solutions to these problems, conduct social responsibility projects and engage in outreach activities for the widespread internalization of science and the scientific approach by the society.

Innovativeness and Leadership

Members of the METU Family follow and implement novel methods and approaches in technology, education, research, and management, and develop unique systems, programs, and constructs that will serve as models in line with the needs of society and universities.

Commitment to the Campus Heritage

METU Family devotes itself to the METU campus and protects it as a cultural heritage, which ensures the internalization of the sense of aesthetics with its unique architecture, landscape, works of art and activities, in addition to its relatively autonomous location in a human-grown forest, its structure that brings all its units

together in spatial continuity, its places in the social memory and its deep-rooted history allowing the production and institutionalization of a common culture (p.54).

Chapter 2 of this study provides a comprehensive exploration of the background related to sustainable transportation within campus environments. It begins by examining the fundamental aspects of campus transportation, including the various modes of transport utilized by students, faculty, and staff. The chapter emphasizes the importance of *Transportation Demand Management* (TDM) strategies, which are crucial for optimizing transportation efficiency and reducing reliance on private vehicles in campus settings. Furthermore, the chapter explores the intricate relationship between university campuses and the surrounding urban areas, highlighting how these interactions shape transportation patterns and policies.

Finally, this chapter presents a detailed examination of the current transportation infrastructure at METU, outlining the existing network and identifying key areas for improvement. The dissertation then continues with chapters on *Social Innovation* and the *Transition Design Approach*, which construct the foundational framework for the study.

2.3 Summary and Discussion

The concept of sustainable campus transportation encompasses a range of strategies and practices aimed at reducing the environmental and social impacts of transportation systems within university environments. By prioritizing sustainability in transportation, campuses can serve as models for wider urban and regional mobility systems.

Firstly, a critical examination of the sustainability concept reveals that sustainable transportation is not merely about reducing emissions or conserving energy; it is a comprehensive approach that considers long-term ecological balance, social equity, and economic viability. The definition of sustainable transportation, as discussed, emphasizes the integration of systems that meet the mobility needs of current users

without compromising the ability of future generations to meet their own (Balsas, 2003). Performance indicators such as emissions reduction, energy efficiency, and user satisfaction become key metrics in evaluating the success of these transportation initiatives (Litman and Burwell, 2006).

In university settings, where diverse user groups such as students, faculty, and staff require efficient and flexible mobility options, understanding mode choices is essential. The discussion of public transport, walking, cycling, and car-sharing or ride-sharing programs highlights the range of options available to campus users. Sustainable modes like walking and cycling not only reduce environmental impacts but also promote public health and well-being. Conversely, car dependency continues to pose significant challenges to sustainability goals, exacerbating issues like congestion, parking shortages, and emissions.

Transportation Demand Management (TDM) strategies, such as parking management and telecommuting, are vital tools for controlling demand and managing the flow of vehicles. Effective parking management, for example, can reduce the need for expansive parking lots, freeing up land for other uses and encouraging the use of alternative transport modes (Shoup, 2008). Telecommuting and teleworking, on the other hand, offer long-term reductions in transportation demand by allowing students and staff to perform their roles remotely, further lessening the burden on campus transport systems.

The interaction between university campuses and their surrounding cities also plays a crucial role in shaping campus transportation systems. As self-contained communities, universities like METU are both contributors to and beneficiaries of urban transportation networks. Campus transport policies must therefore align with broader urban mobility strategies to ensure seamless integration and efficiency.

Finally, the specific case of METU Campus, with its unique geography and demographic characteristics, demonstrates the challenges and opportunities in implementing sustainable transportation solutions. The current transportation infrastructure at METU, while extensive, presents areas for improvement in terms of

reducing car dependency, enhancing public transport connections, and promoting non-motorized transportation modes.

In conclusion, achieving sustainable transportation within university campuses requires a multi-faceted approach that considers not only technical and infrastructural solutions but also behavioral changes among campus stakeholders. The integration of sustainable practices, along with continuous monitoring of performance indicators, will be key in creating long-lasting, effective transportation systems that contribute to a more sustainable future for both campuses and cities.

CHAPTER 3

SOCIAL INNOVATION

Social innovation refers to innovations specifically designed for the social and public good. It is driven by the desire to meet social needs that have often been inadequately addressed or unresolved by state-organized services (Murray, Caulier-Grice and Mulgan, 2010). According to the Young Foundation in the UK, a leading organization in promoting social innovation, current policies and structures seem insufficient to address some of today's most critical issues, such as climate change and chronic diseases (Murray et al., 2010). Consequently, an increasing number of actors, including non-profit organizations, politicians, and business leaders, are turning to social innovation for new solutions. The Young Foundation defines social innovation as "new ideas (products, services, and models) that simultaneously meet social needs and create new social relationships or collaborations. In other words, they are innovations that are both good for society and enhance society's capacity to act" (Murray et al., 2010, p.3).

In recent years, design professionals have pushed the boundaries of design beyond traditional consumer culture, exploring new forms of practice. This evolution is especially noticeable when design is employed to address social issues, leading to the development of innovative solutions (Margolin and Margolin, 2002; Fuad-Luke, 2013). Chick (2012) states that as design professionals and others increasingly focus on a range of social, cultural, and environmental challenges, design strategies, methodologies, tools, and language are evolving. Thus, the meaning of design is changing as it adapts to participate in these sustainable development fields. At that point, Fuad-Luke (2013) poses the question, could focusing on the creation of well-being become a new objective for design, instead of just producing goods or services? The further statement could be a response to the question by highlighting

the growing consensus that design functions as a form of innovation. It provides a set of skills, tools, and methods that enable individuals to develop new socially innovative solutions or enhance existing ones (Brooks, 2019; Emilson, Seravalli and Hillgren, 2011).

Emilson et al. (2011) assert that design has been increasingly recognized as a powerful innovation driver in recent years. Design methods and tools have been applied in new fields, such as social innovation, with the aim of developing new ideas and solutions in response to social needs. They also highlight that since the early 21st century, there has been a growing awareness worldwide of the complexity of the social, economic, and environmental challenges we face. It has become evident that old models and techniques do not adequately address these challenges. Consequently, both politicians and business leaders are increasingly recognizing social innovation as essential for developing new solutions, with designers playing an ever-growing role in this area. The design approach, which emphasizes a user-centered perspective, stakeholder engagement through participatory design, and rapid prototyping, has demonstrated its effectiveness in driving social innovation (Murray et al., 2010).

According to Mulgan (2006), there has been a growing interest in social innovations aimed at improving the well-being of people, communities, and society. Dawson and Daniel (2010) clarify that unlike innovations aimed at maximizing profit or competition in business, social innovations generally stem from a concern for people and communities rather than commercial gain. Emilson et al. (2011) note that designers have increasingly focused on social issues since the beginning of the 21st century. However, today's focus differs from the pioneering years of industrial design, which aimed to create democratic products for people through industrial production, mass consumption, and emerging welfare society. Today, designers working in social contexts address the negative impacts of industrial production, mass consumption, and the decline of traditional welfare models. Morelli (2007) states that social actors, such as designers, are encouraged to address the significant

social, cultural, political, and economic challenges posed by globalization. Jegou et al. (2008) offer a different perspective, noting that social innovation is "driven more by changes in behavior than by changes in technology or the market, typically emerging from bottom-up rather than top-down processes" (p.31). They also emphasize the role of networks, describing design as an activity performed by designing networks, which are "complex systems of interwoven design processes involving individuals, enterprises, non-profit organizations, local and global institutions who imagine and put into practice solutions to a variety of individual and social problems" (Jegou et al., 2008, p.42).

Emilson et al. (2011) acknowledge that while various initiatives have demonstrated the power of design in social innovation, concerns have arisen regarding systemic thinking, visualization, and prototyping. They note that although design methodologies have shown great potential for developing social innovation, some limitations have been identified through practice. McCulagh (2010) and Parker (2009) indicate that design can successfully address the complexity of social problems, but it must adapt to this new landscape. Geoff Mulgan (2006), former director of the Young Foundation, classifies the strengths and weaknesses of design for social innovation. The strengths of design in social innovation include the use of visualization techniques, generating novel insights, adopting a user-centered perspective, and rapid prototyping. However, its weaknesses include a lack of economic and organizational expertise, challenges in managing the implementation process, the high cost of design consultants who often lack long-term commitment to projects, and the superficiality of some proposals, as designers may "reinvent the wheel" by disregarding existing evidence and field experience.

3.1 Social Innovation Approaches Worldwide

Recently, design has been recognized as a valuable tool by social innovation organizations (Murray et al., 2010). Examining the origins of this new design field reveals three different approaches: transformation design in the UK, creative

communities and collaborative services in Italy, and social innovation for developing countries in the USA.

3.1.1 Transformation and Service Design in the UK

One early example of professional designers addressing social and economic issues through design-led innovation was the British Design Council's RED unit, active between 2004 and 2006 (Design Council RED 2004). The RED unit, comprised of individuals with backgrounds in design, social sciences, and policy, contributed to the theory of a new social focus in design, particularly through the reports "Health: Co-creating Services" (Cottam and Leadbeater, 2004) and "Transformation Design" (Burns et al., 2006). Burns et al. (2006) describe the RED unit's approach, known as transformation design, as involving heterogeneous stakeholders from the beginning through participatory design. They emphasize that "design is never done," meaning professional designers should transfer capacities among actors by leaving behind "the tools, skills, and organizational capacity for ongoing change" to enable continuous response, adaptation, and innovation. They also highlight the importance of prototyping as a way to "fail early to succeed sooner," especially when conducted in the actual context of use (p.21). Emilson et al. (2011) note that the RED unit evolved into the social enterprise *Participle* in 2007, along with service design companies such as *live|work*, *Think Public*, and *Engine*, making the UK a leading location in design for social innovation.

3.1.2 Creative Communities and Collaborative Services – Politecnico di Milano

In the development of design for social innovation, Politecnico di Milano, where Ezio Manzini and Francis Jegou lead an international network of design researchers and schools interested in design for social innovation and sustainability, has become another important center (Emilson et al., 2011). These network activities have been

manifested through the Sustainable Everyday Project (SEP 2010) platform for many years. Additionally, DESIS (Design for Social Innovation and Sustainability) is the international network based at Politecnico that promotes and supports social innovation through design (DESIS 2010). "These networks have identified and collected cases from creative communities worldwide" (Emilson et al., 2011, p.25). Jegou et al. (2008) define creative communities as "groups of people who cooperatively invent, enhance, and manage innovative solutions for new ways of living. They do so by recombining what already exists, without waiting for a general change in the system (in the economy, institutions, or large infrastructures)." The outcomes are typically collaborative services, which are "social services where final users are actively involved and assume the role of service co-designers and co-producers" (p.34).

3.1.3 Design for Social Innovation in the USA

In the USA, there is a growing interest in design for social innovation, offered by companies like *IDEO*, *Continuum*, and *Frog Design* (Emilson et al., 2011). Tim Brown, CEO and president of *IDEO*, has popularized and spread the concept of design thinking. The core ideas of design thinking—working with complexity, empathy, user perspective, interdisciplinary collaboration, experimentation, and prototyping—resemble those of transformation design (Emilson et al., 2011). However, design for social innovation in the USA often focuses on projects related to developing countries, differing from Europe, where it involves co-designing with communities or public servants to develop solutions for local needs (Brown and Wyatt, 2010; Jegou and Manzini, 2008). The DESIS Research Lab at Parsons The New School for Design in New York adopts a more European approach, working in the Lower East Side to develop collaborative services and sustainable lifestyles (New School's DESIS Lab, 2010). *Project H Design* collaborates with local communities in rural USA, bringing design skills into public education (Project H Design, 2010).

3.2 Stages of Social Innovation

In the "Open Book of Social Innovation," Murray, Caulier-Grice, and Mulgan (2010) outline six stages of design for social innovation (see Figure 3.1), guiding ideas from inception to impact. They note that these stages are not always linear, as some ideas may move directly to practice or scaling, with feedback loops occurring between stages.

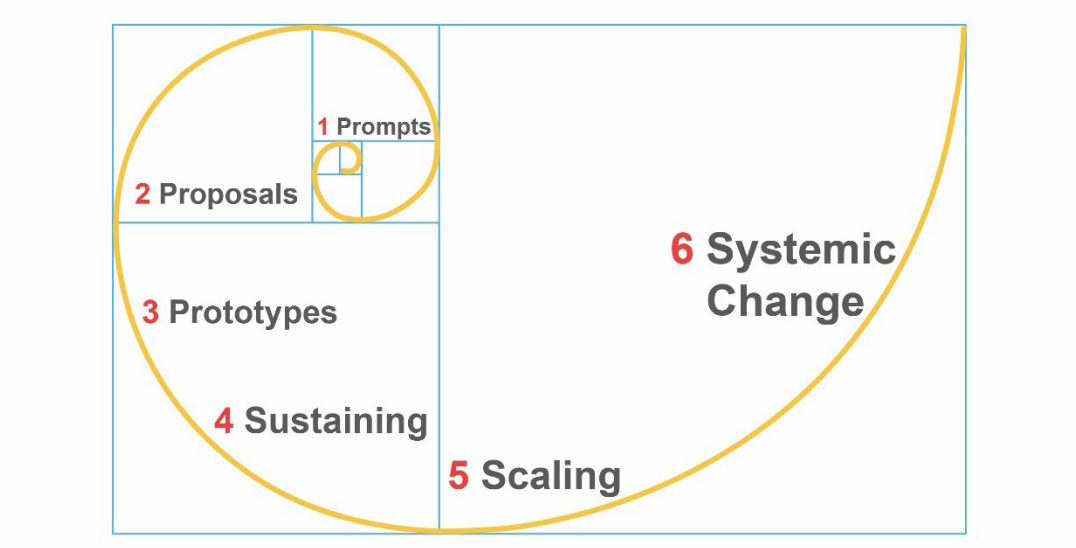


Figure 3.1. The Process of Social Innovation (Murray et al., 2010)

3.2.1 Prompts, Inspirations, and Diagnoses

This stage involves all the factors emphasizing the need for innovation. It also includes diagnosing the problem and framing the question by reviewing its root causes. Murray et al. (2010) assert that framing the right question is a critical step toward finding the appropriate solution, as it involves moving beyond symptoms to identify the underlying causes of a problem. Often, research, mapping, and data collection are employed to reveal these issues (Murray et al., 2010).

3.2.2 Proposals and Ideas

This stage focuses on idea generation. The success of innovation often depends on the involvement of various stakeholders, including users, beneficiaries, producers, and suppliers (Murray et al., 2010). The stage begins with finding the right answer, which requires asking the right question. Other elements include imagining solutions, thinking differently, open innovation, participation, and facilitating participation.

Mulgan et al. (2007) combines the first two stages under "generating ideas by understanding needs and identifying potential solutions." He states that the starting point for innovation is "an awareness of a need that is not being met and some idea of how it could be met" (p.21).

3.2.3 Prototyping and Pilots

This is the stage where ideas are tested in practice. Murray et al. (2010) state that this can be done through "simply trying things out, or through more formal pilots, prototypes, and randomized controlled trials" (p.12). Refining and testing ideas is crucial, as it is through iteration, trial, and error that associations between users and professionals are made, and conflicts among interests are resolved (Murray et al., 2010).

Two types of prototyping have been identified: fast and slow prototyping. Fast prototyping, initially developed in the software industry, focuses on rapidly testing new ideas to identify what might work (Dodgson et al., 2005). In contrast, slow prototyping is employed when new capabilities are required for a model's success, particularly in cases where fast prototyping methods tend to fall short.

3.2.4 Sustaining

At this stage, the idea becomes part of everyday practice. Before scaling and diffusing, every idea must prove its sustainability. Murray et al. (2010) state that only a minority of tested and piloted ideas will survive. Promising ideas may fail because they are not sufficiently effective or cost-effective. Public feedback can be a valuable tool for determining sustainability, but evaluation methods also play a crucial role. Since determining success or failure always involves some level of judgment, the ability to critically assess innovations is essential for the success of an innovation system (Murray et al., 2010).

3.2.5 Scaling and Diffusion

This stage involves strategies for growing and spreading an innovation. Dees et al. (2004) mention two types of spread and diffusion among social and market economies. In the market economy, innovations are structured to reserve benefits for the organization's private profit, often through licensing or franchising. In contrast, the social economy, focused on social missions, favors rapid diffusion of innovations rather than keeping them private. Mulgan et al. (2007) note that successful diffusion depends on effective supply and demand, persuading people that there is a need to be met and convincing organizations with the ability to pay to do so. Murray et al. (2010) explain that this is challenging because people often have good reasons to resist innovations and will only adopt them if there are strong pressures, incentives, or emotional motivations showing clear advantages over previous methods.

3.2.6 Systemic Change

Murray et al. (2010) define systemic change as the ultimate goal of social innovation. It involves the interaction of various elements, including social movements, business models, laws, regulations, data, infrastructures, and new ways of thinking and doing

(p.13). Social innovations often arise against the barriers of the old order, overcoming them by creating new conditions, such as technologies, supply chains, institutional forms, skills, and regulatory frameworks (p.13).

Murray et al. (2010) outline strategies for systemic innovation, including:

- Forming progressive coalitions that bring together different partners.
- Building shared diagnoses and visions.
- Growing a critical mass of practical examples.
- Establishing new rights.
- Training professionals with new skills and attitudes.
- Pre-empting inflexible conventional technologies.
- Accessing expertise to contest evidence.
- Implementing legal and regulatory devices to embed change.
- Empowering the beneficiaries of the new system (p.109).

Figure 3.2. Highlighted Issues regarding Social Innovation (Murray, Mulgan and Cauiler-Grice, 2010)

3.3 A Continuum of Design Approaches: From Social Innovation to Transition Design

The theoretical examination of complex systems and practical experience in social innovation demonstrate that tackling large, complicated problems should not rely on a single, overarching solution but rather on distributing complexity across various system nodes (Manzini, 2015). Josephine Green (2013) argues that instead of controlling complexity through top-down hierarchies, social innovation encourages embracing complexity by initiating local actions directly involving those (who know the problem best) affected. This strategy emphasizes 'making things happen' and learning from experiences, creating favorable ecosystems where initiatives can grow, expand, and interconnect (Manzini, 2015).

To further clarify, 'making things happen' involves not just initiating actions but also integrating multiple local projects through approaches which link various local initiatives and scales of intervention, aiming to influence and transform larger institutions and territorial systems. Additionally, creating a supportive environment for new projects, such as through infrastructure, standards, regulations, knowledge, visions, and shared values, enhances the probability of innovative solutions emerging and developing in synergy (Manzini, 2015).

Factors influencing design have led to the development of two significant areas in design research, practice, and education: Design for Service and Design for Social Innovation (also referred to as social impact design or social design). Terry Irwin argues for a third approach, Transition Design, which emphasizes long-term visioning and acknowledges the necessity for solutions grounded in new, more sustainable socioeconomic and political paradigms (Irwin, 2015).

Design for Service is a well-established field that utilizes a systems approach to solve problems within multi-stakeholder environments. This approach shifts the emphasis from individual artifacts and communications to the quality of interactions and overall experiences between service providers and customers, leading to more

meaningful, useful, enjoyable, and profitable solutions (Saco and Goncalves 2008; Forlizzi and Zimmerman 2013; Service Design Network 2014). On the other hand, Design for Social Innovation, a developing discipline (Penin et al. 2012; Sherwin 2012; Rettig and du Plessis 2013; Amatullo 2014), expands problem contexts and goals to address social, cultural, and economic issues, often extending beyond traditional business and consumer markets. Practitioners in this field are working to advance the discipline by codifying replicable skill sets and methodologies (Drenttel and Mossoba, 2013; LEAP Symposium, 2013; Smithsonian's Cooper-Hewitt et al., 2013).

Figure 3.3. A Continuum of Design Approaches (Irwin, 2015)

When comparing these three approaches, a continuum emerges (depicted in Figure 3.3), where time horizons, depth of engagement, and alternative socioeconomic and political contexts expand from left to right. On the left, Service Design features expert designers working on short-term, multi-stakeholder projects primarily within the business and consumer sectors. Moving along the continuum, Social Innovation

projects are typically situated within social and community contexts, involve longer-term engagements, and begin to challenge established socioeconomic and political paradigms (Irwin, 2015).

Transition Design, positioned at the continuum's end, embraces speculative, long-term visions of sustainable lifestyles that fundamentally challenge existing paradigms. These visions serve to inspire and guide the design of short- and mid-term solutions. Transition Design solutions originate from long-term thinking, are lifestyle-oriented, place-based, and always consider the natural world as the broader context for all design solutions. These transition visions can enhance projects in the service and social innovation sectors by networking and linking them to form more effective transitional steps toward a desired future (Irwin, 2015).

Transition Design is unique in its application of living systems theory to tackle wicked problems, with an emphasis on preserving and restoring both social and natural ecosystems. This approach views everyday life and lifestyles as essential design contexts, promotes place-based, globally networked solutions, and advocates for interventions across multiple time horizons and scales. Transition Design connects existing solutions as incremental steps within a broader vision, strengthens grassroots initiatives, and focuses on maximizing satisfiers for a wide range of needs. The designer’s mindset and posture are seen as critical elements in the process, emphasizing the reintegration of diverse transdisciplinary knowledge (Irwin, Kossoff, and Tonkinwise, 2015).

Acknowledging that we are living in a period of transition, Transition Design highlights the necessity of societal shifts toward more sustainable futures, with design playing a pivotal role in these transitions. The concept of transition is central to numerous discussions about change across ecosystems, organizations, communities, societies, economies, and individuals (Irwin, Kossoff, and Tonkinwise, 2015).

Transition Design proposes developing future visions that are dynamic, grassroots-based, and open-ended. These visions emerge from local conditions and involve a

circular, iterative process that informs both small and substantial solutions in the present. Visions of sustainable futures provide a framework against which current lifestyles and design interventions can be assessed and critiqued, informing design decisions today (Margolin, 2007).

Different design approaches have enhanced our ability to envision the future and inspire solutions across various timeframes. Examples include speculative design (Dunne and Raby, 2013), backcasting, and scenario-based initiatives like Manzini and Jégou's Sustainable Everyday (2003) and Jonathon Porritt's The World We Made (2013).

Design for social innovation has developed new skill sets and approaches that leverage social system dynamics to create effective solutions (Penin et al., 2012; Rettig and du Plessis, 2013). Transition Design extends this by examining the value systems of designers themselves, arguing that solutions should emerge from a holistic worldview that informs new, collaborative, and responsible interactions (Irwin, Kossoff and Tonkinwise, 2015).

In conclusion, the transition from social innovation to Transition Design marks a shift towards addressing complex, systemic problems through a comprehensive, multi-faceted approach. This involves understanding and leveraging the dynamics of change, developing long-term, locally grounded visions, and creating an interconnected ecosystem of solutions that drive societal transitions towards more sustainable and desirable futures.

CHAPTER 4

TRANSITION DESIGN

4.1 Introduction to Transition Design

In recent years, an increasing proportion of the world's population has been residing in urban areas (Barber, 2013; Rockefeller Foundation, 2019; Glaeser, 2011). These urban environments are facing a myriad of challenges collectively known as wicked problems (Irwin, 2011a, 2011b; Australian Public Service Commission, 2007; Coyne, 2005; Buchanan, 1992; Rittel and Webber, 1973). Wicked problems such as climate change, drought, obesity, poverty, racism, waste management, homelessness, crime, and biodiversity loss are complex and interconnected, necessitating systemic responses (Rockefeller Foundation, 2019).

At the urban level, these issues are further complicated due to their interrelated and interdependent nature, affecting an increasing number of people. Addressing these challenges requires innovative approaches, one of which is transition design. Transition design is an emerging, design-led approach aimed at addressing these complex, wicked problems and facilitating societal transitions towards more sustainable and desirable long-term futures (Kossoff, Irwin, 2021).

Transition design is not merely a process but an approach. This distinction is crucial because designing interventions for transitioning entire systems necessitates a diverse array of tools and methodologies, tailored to specific circumstances. No single, prescribed process can effectively address the myriad of issues presented by wicked problems (Irwin, 2019).

The primary challenge of our time is the transition to sustainability, a concept that must be understood in its broadest sense. This transition is a complex endeavor, encompassing political, social, economic, cultural, scientific, and technological

dimensions. As critical issues such as climate change, inequality, resource depletion, and biodiversity loss intensify, the urgency to adopt sustainable practices becomes ever more pressing (Irwin, Kossoff, and Tonkinwise, 2015).

In response to these challenges, the School of Design at Carnegie Mellon University has integrated transition design into its curricula at undergraduate, graduate, and doctoral levels. The central premise of transition design is the necessity for societal transitions to more sustainable futures, with a fundamental belief that design plays a critical role in facilitating these transitions (Irwin, 2015).

4.2 Wicked Problems

Civic and governmental leaders are often highly motivated to direct significant amounts of social, economic, and political power toward resolving wicked problems due to their direct impact (Barber 2013; Katz and Nowak 2018). The concept of "wicked problems" was introduced in 1973 by urban planner Horst Rittel. He coined this term to describe a class of problems considered "unsolvable" due to their high degree of complexity. Rittel contrasted wicked problems with "tame" problems, which he argued could be solved using traditional, linear processes based on predicted outcomes (Rittel and Webber 1973).

Transition design investigates the phenomenon of mindset and worldview and their connection to wicked problems (Capra and Luisi 2014; Kearney 1984; Linderman 2012; Tarnas 2010; Irwin 2011). This approach suggests that a change in mindset or worldview can lead to new modes of behavior, action, and interaction, which are crucial for addressing wicked problems effectively.

In summary, wicked problems are characterized by their complexity and interdependence, making them resistant to traditional, linear problem-solving approaches. Transition design offers a comprehensive framework to address these issues by focusing on systemic change and the transformation of mindsets and worldviews.

4.2.1 Characteristics of Wicked Problems

Wicked problems are multifaceted, intricate challenges that require comprehensive and systemic responses due to their complex nature. These problems manifest at various levels and are interconnected with other wicked problems, creating a network of issues that complicates their resolution. Reviewing the existing literature, characteristics of wicked problems could be summarized as follows:

Multi-Scalar and Multi-Causal Nature

Wicked problems operate on multiple scales, from neighborhoods to entire regions, and have numerous root causes. Issues such as crime, poverty, homelessness, and others not only occur at different levels but also are linked to each other, forming a web of interrelated problems (Kossoff, Irwin, 2021). This interdependence makes it difficult to address one problem without considering its impact on others.

Self-Organizing Features and Emergent Properties

These problems are characterized by their self-organizing nature and emergent properties. They are composed of various elements including designed artifacts, communications, infrastructure, technology, and human interactions. The complexity of their structure and behavior is highlighted by chaos and complexity theories, which show that social systems are highly self-organizing. Their responses to external disruptions are often self-directed and unpredictable (Wheatley, 2006; Byrne, 1998).

Multiple Stakeholders with Conflicting Agendas

Wicked problems involve multiple stakeholders, each with their own conflicting agendas and concerns. These stakeholders can include any group affected by the problem, extending to other species and ecosystem members. Differences in socio-economic and political status, access to resources, beliefs, values, assumptions, expectations, and needs contribute to the conflicting definitions and proposed

solutions for these problems (Seed and Macy, 2007; Driscoll and Starik, 2004; Andersen and Nielsen, 2009; Hiemstra, Brouwer and Van Vugt, 2012).

Governed by Feedback Loops

Feedback loops, both positive and negative, play a significant role in wicked problems. Positive feedback loops can exacerbate issues, as small changes or interventions can rapidly amplify, leading to growth, chaotic behavior, disequilibrium, and overall system instability (Briggs and Peat, 1989; Goodwin, 2002; Capra and Luisi, 2014). Negative feedback loops, on the other hand, often hinder the resolution of these problems by preventing positive changes from taking hold, often due to entrenched attitudes, beliefs, values, behaviors, and practices (Kossoff, Irwin, 2021).

Straddling Institutional, Disciplinary, and Sectoral Boundaries

Wicked problems transcend institutional, disciplinary, and sectoral boundaries. They manifest at multiple levels of scale and connect to various other wicked problems. Traditional problem-solving approaches, which typically operate within disciplinary silos, are often inadequate for addressing these complex issues comprehensively (Kossoff, Irwin, 2021).

Place, Culture, and Ecosystem-Specific Manifestations

These problems are inherently tied to specific places, cultures, and ecosystems. They form complex clusters that manifest uniquely depending on the context. This specificity adds another layer of complexity to their resolution, requiring tailored approaches that consider the unique characteristics of the environment in which they occur (Kossoff, Irwin, 2021).

Fundamental Indeterminacy

Horst Rittel, who coined the term "wicked problem," emphasized the inherent indeterminacy of these challenges. Unlike "tame" problems, which can be solved using traditional, linear processes, wicked problems lack definitive conditions and

solutions. They are characterized by a lack of definitive formulations, no stopping rules, and solutions that cannot be categorized as true or false, only good or bad. Each wicked problem is unique and often symptomatic of higher-level issues, making them resistant to conventional problem-solving methods (Rittel and Webber, 1973; Buchanan, 1992).

Responsibility and Accountability

Those tackling wicked problems have a heightened sense of responsibility, as they are fully accountable for their actions and decisions. The complexity and interconnectedness of these problems mean that solutions often have wide-ranging and sometimes unforeseen consequences, further emphasizing the need for careful and considered approaches (Rittel and Webber, 1973).

4.2.2 Challenges in Defining and Addressing Wicked Problems

Wicked problems, characterized by their complexity and interconnectivity, present significant challenges in their identification, framing, and resolution. These difficulties can be summarized as follows:

1. **Problem Framing**: Wicked problems are intertwined at various scales, spanning multiple time horizons and crossing disciplinary boundaries, making them difficult to frame accurately. Traditional problem-solving methods often simplify problem frames to achieve quick, efficient, and profitable solutions. However, this approach can fail, exacerbate the problem, or create new issues elsewhere. Bardwell (1991) highlighted that the way problems are framed influences how they are understood and addressed. Solving complex systems problems with non-systemic, cause-and-effect methods often leads to failure (Kossoff, Irwin, 2021).
2. **Problem Context**: Wicked problems arise over long periods and within intricate socio-technical-ecological systems. Simplified contexts fail to capture the extensive spatio-temporal evolution of these problems. Such

systems are complex webs of interactions between living and designed elements, embedded within the natural world. These interactions are in constant flux, influenced by technological advances and ecological changes (Grin, Rotmans and Schot 2010; Trist and Murray 1993; Trist, Emery and Murray 1997).

3. **Unintended Consequences of Solutions**: Viewing the problem and its larger context as a single, evolving system reveals that interventions can have unpredictable outcomes due to nonlinear dynamics. Traditional linear approaches often ignore these dynamics, leading to unintended negative consequences. Historical interventions can manifest in present challenges, making it difficult to distinguish between root causes and symptoms. Understanding both the present manifestation and historical evolution of a problem is crucial (Kossoff, Irwin, 2021).

4. **Solutions versus Systems Interventions**: Effective resolution requires shifting from one-off problem-solving to continuous system interventions. Wicked problems demand multiple solutions at various scales and over extended time horizons. These interventions should destabilize entrenched systems and guide socio-technical transitions towards desirable futures. The process is similar to iterative software development, where each version advances the system towards improved outcomes. It's an ongoing process rather than a final destination (Kossoff 2011, 2019a).

5. **Extended Resolution Timeframes**: Socio-technical transitions that give rise to wicked problems develop over long periods and require equally extended efforts to resolve. Traditional approaches, focused on clear problem definitions and rapid solutions, are insufficient. Government and funding institutions often support short-term projects, which are inadequate for addressing these deep-rooted issues. There is a need for funding paradigms that support long-term interventions across multiple levels and time horizons,

aiming to resolve complex problems and enable sustainable transitions (Kossoff, Irwin, 2021).

These points illustrate the inherent complexity of wicked problems and the necessity for comprehensive, long-term, and systemic approaches to address them effectively.

4.3 Transition Design Framework

The Transition Design Framework is a comprehensive approach that integrates various practices, knowledge, and skill sets necessary for fostering and catalyzing systemic change. This framework, as outlined by Irwin (2015) in Figure 4.1, consists of four interrelated and co-evolving areas:

1. **Mindset and Posture**: Living in times of transition requires self-reflection and embracing holistic ways of "knowing" and "being." Fundamental change often results from a shift in mindset or worldview, leading to new behaviors, actions, and interactions (Meadows, 1999). Individual and collective mindsets, shaped by experiences, cultural norms, and socio-economic-political paradigms, profoundly influence problem identification, framing, and resolution (Crompton, 2016). Transition Design explores how shifting values and postures can be part of an intentional process of self-reflection and change (Boehnert, 2019).

2. **Theories of Change**: Transition Design emphasizes the necessity of understanding and directing change within complex systems. The social, economic, political, and technological systems must transition toward sustainable futures, necessitating a deep understanding of change dynamics (Eguren, 2011). Any planned action inherently contains a theory of change, and acknowledging this is essential for driving significant societal transformations. Misguided or outdated notions of change lie at the core of many wicked problems (Escobar, 2011; Irwin, 2011; Scott, 1999).

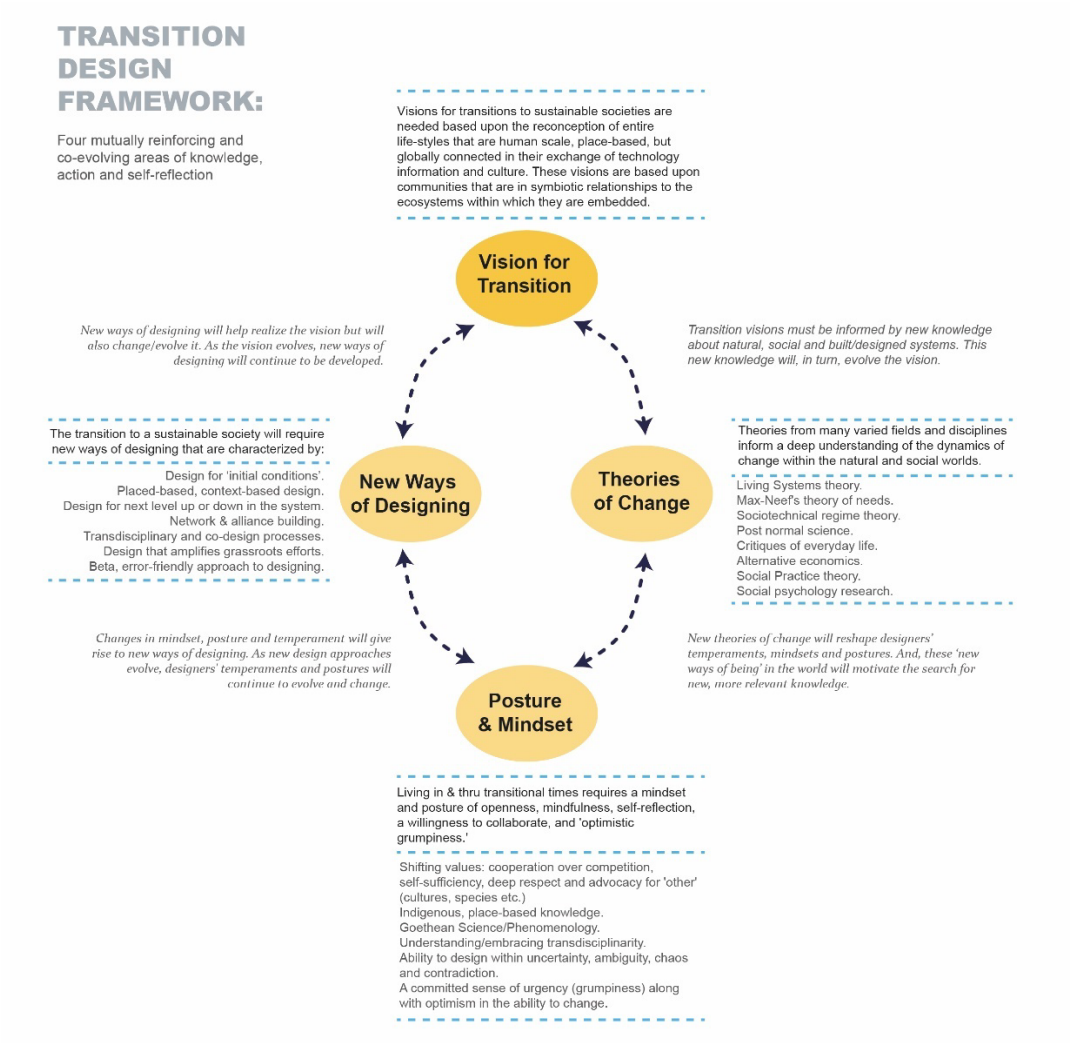


Figure 4.1. Transition Design Framework by Terry Irwin (2015)

3. **Vision**: Transition Design advocates for creating compelling, co-created visions of long-term sustainable and equitable futures. These visions, developed through foresighting and visioning methods, help stakeholders transcend present conflicts and focus on a shared desirable future (Candy and Kornet, 2019; Candy and Lockton, 2019). These co-created visions act as both motivational "magnets" and guiding "compasses" for transitioning towards the desired future (Irwin, 2019).

4. **New Ways of Designing**: Transitioning to a sustainable society requires new problem-solving approaches informed by diverse values and knowledge. Addressing systemic problems necessitates "ecologies" of solutions implemented across multiple scales and time horizons. Some solutions may be short-lived, serving as steps towards long-term goals, while others evolve over extended periods (Irwin, 2019). Transition Designers seek to connect existing efforts and solutions to enhance their impact and establish a unified path toward sustainable futures.

4.4 Phases of Transition Design

Transition design is a framework aimed at understanding and addressing complex, wicked problems through a phased approach. These phases, which include reframing the present and future, designing interventions, and waiting and observing, contribute to creating sustainable and equitable futures. The phases are detailed below and can be seen in Figure 4.2.:

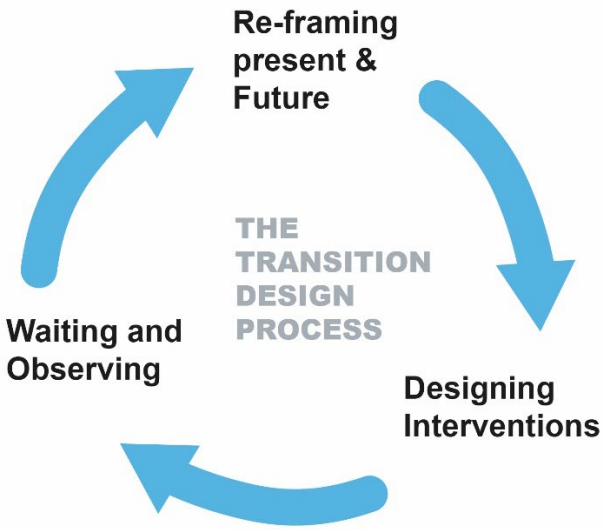


Figure 4.2. Phases of Transition Design by Terry Irwin (2015)

4.4.1 Phase I – Reframing: Present and Future

In this phase, stakeholders engage in a multi-step process to reframe the problem in both the present and the future. The goal is to achieve a shared understanding among stakeholders, which is crucial for coordinating both short- and long-term actions. Reframing the problem in the present helps in understanding the current context and issues, while reframing the future involves co-creating visions of a desired future where the problem has been resolved and developing "transition pathways" to reach that future (Irwin, 2018; Quist and Vergragt, 2006, p. 1028).

Each stakeholder impacted by a wicked problem holds either an implicit or explicit vision of the future as it relates to that issue (Rawolle, Schultheiss, Strasser, and Kehr, 2016). In the context of 21st-century challenges, these visions are often dystopian or merely extensions of the current situation. However, positive future visions are powerful motivators (Irwin, 2018). Nanus (1992) argues that a vision, the mental image of a desirable future, can mobilize people into action geared toward achieving it. Early futurist Polak (1973) maintained that the rise and fall of images of the future precede or accompany the rise and fall of cultures. Co-creating visions of desirable futures helps stakeholders transcend their present conflicts by creating a shared future space they can all agree upon. These visions can guide current interventions and projects, acting as steps toward the desired futures (see in Figure 4.3.)

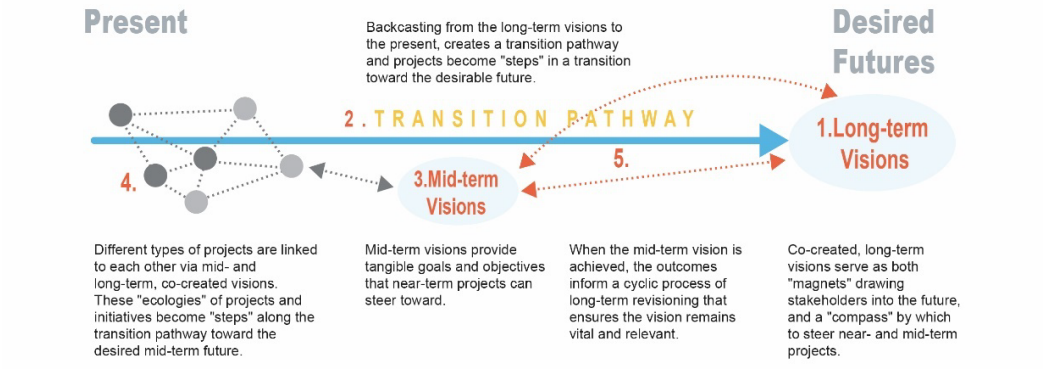


Figure 4.3. Linking Projects and Initiatives to Future Visions (Irwin, 2015)

Bateson (1972) first introduced the concept of framing, which was later adopted in various disciplines such as psychology, linguistics, and sociology. Lakoff describes frames as mental structures that shape how we see the world. These cognitive models are influenced by metaphors, norms, mass media, political movements, and personal history (2004).

4.4.2 Phase II – Designing Interventions

After stakeholders establish a shared understanding of the problem and a collective vision for a desired future, the second phase involves placing both the problem and vision within a broader, multi-level, spatio-temporal context. This phase utilizes tools and methods from disciplines beyond design to comprehend large-scale problem frameworks and to devise interventions aimed at resolving the issue (Irwin, 2018).

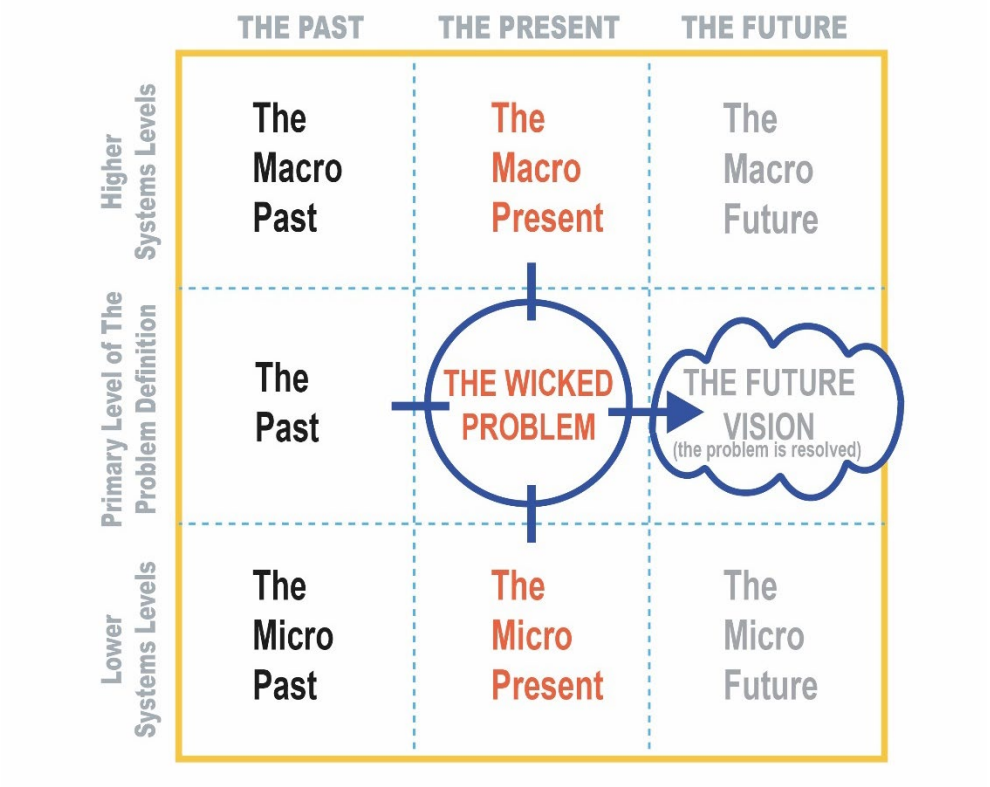


Figure 4.4. Wicked Problems within Large Spatio-Temporal Context (Irwin, 2018)

Traditional design-led approaches often situate problems within small, manageable contexts and aim for swift, profitable solutions. However, resolving wicked problems requires numerous interventions at multiple levels within extensive spatio-temporal contexts (see in Figure 4.4). Wicked problems exist at multiple scales and are rooted in the past, often taking years or even decades to fully emerge as wicked. To understand their present-day ramifications and consequences, it is essential to examine both higher and lower system levels, while also looking to the past to uncover their root causes and evolution (Irwin, 2018).

4.4.3 Phase III – Waiting and Observing

To initiate and accelerate change in complex systems and address wicked problems, multiple interventions are necessary at various levels of scale and over different time horizons. Engaging with large, slow-moving systems requires alternating between active interventions and periods of observation and reflection to assess how the system responds to these perturbations (intervention) (Irwin, 2018).

This approach contrasts with traditional, design-led methods characterized by fast-paced, linear processes aimed at achieving clear, predictable, and often profitable results. In transition design, observing and reflecting on the system's response is crucial for understanding the impact of interventions and adjusting strategies accordingly (Irwin, 2018).

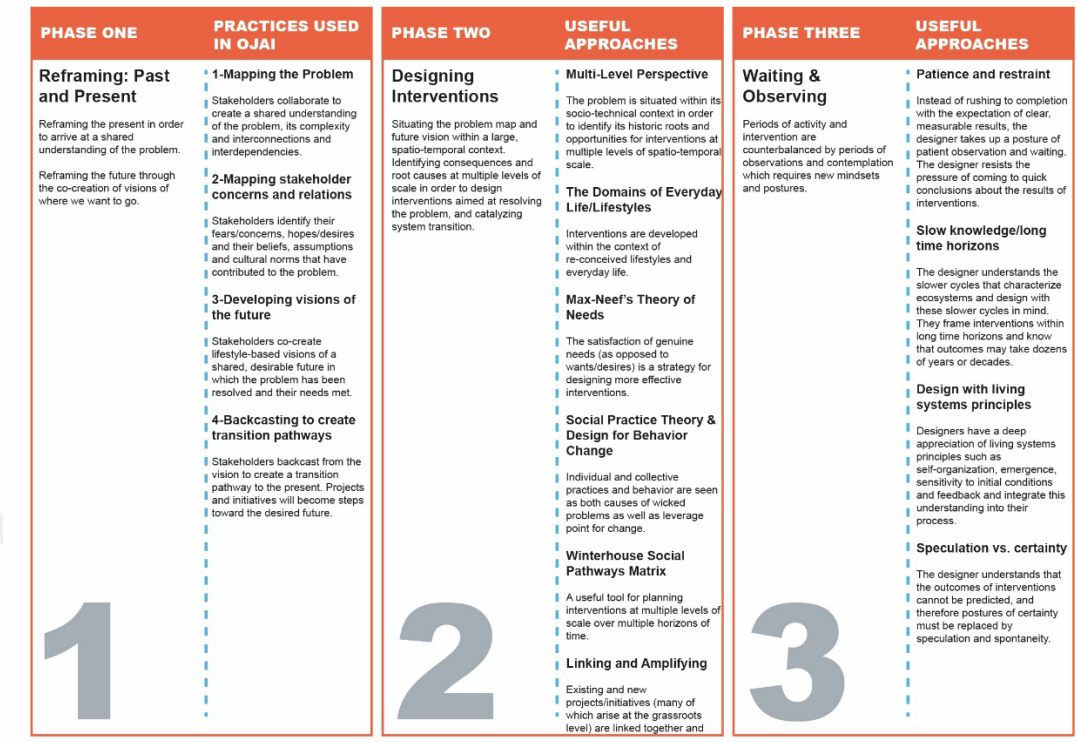


Figure 4.5. Overview of Transition Design Approach (Irwin, 2018)

4.5 Transition Design Objectives

The transition design approach is positioned as a method for addressing wicked problems and facilitating societal shifts towards more sustainable futures. Unlike linear processes, this approach necessitates recognizing the unique cultural, socio-economic, political conditions, and local ecosystems. Transition design emphasizes understanding problems in appropriate contexts and employing a systems approach for solution development (Rohrbach and Steenson, 2019; Irwin and Kossoff, 2020).

Mapping Wicked Problems and Stakeholder Relations

A fundamental objective of transition design is to map wicked problems and stakeholder relations. This involves two interconnected steps: mapping the problem and mapping stakeholder relations.

1. **Mapping the Problem**: This step leverages diverse perspectives, knowledge, and expertise to identify as many issues related to the problem as possible. These issues are categorized into five key areas: social issues, infrastructure and technology issues, economic and business issues, policy, governance and legal issues, and environmental issues. This comprehensive problem map is developed through direct interaction with stakeholders and continuous research, evolving as a knowledge storehouse (Rohrbach and Steenson, 2019).
2. **Mapping Stakeholder Relations**: This step identifies all stakeholder groups affected by the problem, both human and nonhuman. It aims to understand the complex web of interactions among these groups, which can either hinder or facilitate problem resolution (Irwin and Kossoff, 2020).

Understanding the Evolution of Problems

Transition design argues that wicked urban problems emerge over time within complex socio-technical-ecological systems. These problems result from interactions at various scales between people, artifacts, infrastructure, laws, and the natural environment. Understanding the historical evolution of these problems within a large, spatio-temporal frame informs more appropriate and synergistic interventions in the present (Irwin and Kossoff, 2020).

Visioning and Back-Casting

A key objective of transition design is to develop compelling visions of sustainable futures to guide societal transitions. This involves several steps:

1. **Co-Creating Future Visions**: Stakeholders affected by the problem co-create visions of long-term, lifestyle-based futures where the problem has been resolved.
2. **Back-Casting**: From the future vision, stakeholders create a "transition pathway" by identifying milestones and mid-term goals that can inform present solutions.

3. **Designing Interventions**: Developing "ecologies of interventions" that act as steps on the transition pathway toward the future.
4. **Iterative Process**: Analyzing outcomes from interventions and starting the process again to refine solutions and pathways (Quist and Vergragt 2006; Dreborg 1996; Carlsson-Kanyama et al., 2008; Porritt 2013).

Designing Ecologies of Synergistic Systems Interventions

Transition design emphasizes the creation of interventions that address wicked problems within the context of everyday life and lifestyles. These interventions:

1. **Contextual Solutions**: Address problems at multiple scales of everyday life, from households to regions (Kossoff 2011, 2019a).
2. **Amplifying Grassroots Efforts**: Look for emergent possibilities and support grassroots solutions (Irwin and Kossoff, 2020).
3. **Ecology of Solutions**: Link interventions to long-term visions to act as steps on a transition pathway (Irwin and Kossoff, 2020).
4. **Material and Immaterial Interventions**: Utilize worldviews, mindsets, and behaviors as leverage points for change (Meadows 1999).
5. **Distinguishing Needs and Desires**: Base solutions on maximizing satisfiers for the widest range of needs (Irwin and Kossoff, 2020).

Key theories and knowledge informing these solutions include (see some of those in Figure 4.6): Manfred Max-Neef's theory of needs and satisfiers (Max-Neef 1991); practice theory (Shove and Walker 2010; Shove *et al*. 2012; Kuijer and De Jong 2011); design for behavior change (Lockton 2014; Niedderer, Clune and Ludden 2017); values and frames (Crompton 2016); design for the circular economy (Chapman 2017; Ellen MacArthur Foundation 2017; Royal Society of Arts 2013); commoning and the sharing economy (Tonkinwise 2018; Bauwens 2017; Gruber 2018; Thackara 2015; Harvey 2012); Causal Layered Analysis (Inayatullah 2013, 1998); and the Domains of Everyday Life Framework (Kossoff 2011, 2019a).

Addressing Interconnected Wicked Problems

Transition design recognizes that wicked urban problems are interconnected, forming "problem clusters." These clusters contribute to each problem's intractability but also present "zones of possibility" where synergistic interventions can address multiple problems simultaneously (Irwin and Kossoff, 2020).

This comprehensive framework and its objectives underscore the need for innovative, context-sensitive, and holistic approaches to addressing complex, wicked problems and steering societal transitions towards sustainable futures.

Tools & Practices for Designing Systems Interventions

PRACTICE	WHAT IT IS	WHAT IT IS USEFUL FOR	REFERENCES
MLP The Multi-level Perspective	Conceptual framework use to investigate how large socio-technical systems transition over long periods of time. Describes 3 distinct systems levels in which events unfold, infrastructure and artifacts arise, and webs of interaction occur.	Useful in exploring large, spatio-temporal contexts; identifying the historical roots of complex problem(s) and "entrenched"/intractable areas within a large system; reveals opportunities for disruptions (designed interventions); provides large enough context to reveal connections between multiple wicked problems.	Geels, 2006 Author, Tonkinwise & Kossoff, 2015 Gaziulusoy & Brezet, 2015 Grin, Rotmans & Schot, 2010 Rotmans & Kemp, 2003 Trist & Murray, 1993
Max-Neef's Theory of Needs	Proposes that needs are ontological, non-hierarchical, finite and universal, but how they are satisfied is limitless and specific to culture, place, gender, age, and era. "Poverties" of unmet needs are the root of many problems.	Can be integrated into problem frames to ascertain if the proposed solution is meeting genuine needs (in sustainable ways) or whether it might be undermining the ability to meet other needs. Can be used as an approach to socially and environmentally responsible design. Useful in designing systems interventions at mezzo and micro levels.	Max-Neef, 1991 Author, 2011a, p.50 Kossoff, 2011, p.130
Social Practice Theory	Considers the entire ecology of elements that are involved in practices: materials, competencies and meanings. Used as a strategy for sustainability, it looks particularly at how practices arise and then become inertial.	Can be used at the micro-systems level to understand how people's practices contribute to wicked problems and systems entrenchment. Because practices are so ubiquitous, they can be used as a leverage point for change within complex systems like wicked problems and socio-technical systems.	Shove & Walker, 2010 Shove et al., 2012 Kossoff, 2015 Scott et al., 2011 Kuijer & De Jong, 2011 Bourdieu, 1997 Giddens, 1984
Design for Behavior Change	Focuses on people's attitudes, behaviors, motivations and understandings to leverage psychological principles in the design of products and services that can influence users' behavior for social benefit.	Understanding how individuals' and groups' beliefs, attitudes and behaviors contribute to both wicked problems and systems intertia or entrenchment can become a strategy for systems-level change. Useful in combination with social practice theory in examining the social interactions and interdependencies found within large, socio-technical systems and wicked problems.	Lockton et al., 2013 Jana, 2010 Abraham & Michie, 2008
Domains of Everyday Life & Lifestyles	Everyday life and lifestyles refer to the way in which individuals, communities and societies meet their needs. The Domains Framework proposes that everyday life is comprised of nested systems levels in which particular types of needs are best satisfied: The household, the neighborhood, the city, the region, the planet.	Can be used as a more appropriate context within which to conceive sustainable solutions and design interventions and catalyze systems-level change. Solutions can be intentionally situated in a particular domain of everyday life to become more effective systems interventions. Long-term visions are more powerful when developed within the context of everyday life and lifestyles.	Lefebvre, 1991 Debord, 2002 SPREAD, 2012 a, b, c Kossoff, 2011 de Certeau, 1984
Social Pathways Matrix The Winterhouse Institute	A model developed by design educators to map the territories in which designers now work. The matrix shows the scale of engagement and the range of expertise required of types of projects and their impact.	Can be used as a guide in designing interventions in large, spatio-temporal systems. The tool can inventory existing and proposed interventions in order to ensure that interventions are situated at multiple levels in the system (wicked problem) and over multiple time horizons.	Winterhouse, 2017 Author, 2015 Amatullo, 2016

Figure 4.6. Designing Systems Interventions Practices (Irwin, 2018)

4.6 Summary and Discussion

In the context of this study, *Transition Design* plays a significant role in addressing the complexities of developing sustainable transportation solutions for METU Campus. Transition Design, as outlined in the review, is a framework that is particularly well-suited for tackling *"wicked problems"*—issues that are inherently complex, involving multiple stakeholders, long timeframes, and deep-rooted systemic challenges. Sustainable transportation for a large university campus like METU, with its diverse stakeholders and complex infrastructure, exemplifies such a wicked problem.

Wicked Problems and Campus Transportation

The review emphasizes the characteristics of wicked problems, which include *ambiguity, interconnectedness, and evolving objectives.* Sustainable transportation on a university campus is similarly multifaceted, involving the interplay of environmental, social, and operational challenges. For instance, reducing car dependency while maintaining the convenience and accessibility of the campus for all stakeholders poses a significant challenge. Traditional approaches often fail to address these interwoven issues adequately, making the *Transition Design* approach necessary.

The *challenges in defining and addressing wicked problems* are reflected in the difficulties of creating transportation policies that meet the needs of various groups (students, faculty, and staff) while promoting sustainability. The diverse transportation behaviors on campus—ranging from car usage to biking and public transport—make it hard to create a one-size-fits-all solution. In this regard, Transition Design allows for *iterative, long-term thinking*, where solutions are constantly revisited and adjusted by multiple stakeholders based on evolving conditions.

Phases of Transition Design Applied to METU Campus

Phase I – Reframing: Present and Future: This phase focuses on understanding the current transportation challenges at METU and envisioning future possibilities. By analyzing the *current transport modes, infrastructure, and behaviors* on campus, this study identifies pain points such as traffic congestion, parking issues, and the underutilization of sustainable transport options like biking and public transit. The long-term vision in this phase is to create a *sustainable transport network* that reduces car dependency while enhancing accessibility for all campus users.

Phase II – Designing Interventions: In this phase, design interventions are proposed to address the issues identified in Phase I. For METU Campus, interventions could include the implementation of *Transportation Demand Management (TDM) strategies*, *improvement of public transport accessibility*, and *promotion of cycling and ridesharing.* These design interventions align with Transition Design's principle of *engaging diverse stakeholders,* as they are developed with input from the campus community, including students, staff, and administrators.

Phase III – Waiting and Observing: This phase is critical in Transition Design, as it involves implementing the proposed solutions and observing their effects over time. For METU Campus, this would mean *monitoring the success of new transport policies* and *infrastructure improvements*, such as the expansion of bike lanes or the introduction of ridesharing incentives. However, in the scope of this dissertation, this phase would not be applicable as a temporal limitation, yet this phase could be implemented through the further studies based on this dissertation in the long-term. Transition Design emphasizes the importance of patience in this phase, as behavioral changes in transportation habits are often slow and require ongoing adjustments.

Objectives of Transition Design in METU Transportation

Transition Design aims to create *long-term systemic changes.* In the case of METU Campus, the objective is not only to solve immediate transportation issues but also

to diffuse *sustainable behaviors and policies* that can evolve with the campus's needs. By involving stakeholders in each step of the process, the framework ensures that the solutions are not only sustainable but also *socially and culturally relevant* to the METU community.

In conclusion, the review of literature on Transition Design provides a *comprehensive framework* for developing sustainable transportation solutions for METU Campus. Through its phased approach, it allows for the *gradual transformation* of the transportation system, addressing both the immediate needs of the campus and its long-term sustainability goals. This approach, deeply rooted in *systemic thinking and stakeholder engagement,* ensures that the solutions developed are adaptable, scalable, and resilient to future challenges.

CHAPTER 5

UNDERSTANDING USE BEHAVIORS, EXPERIENCES, AND EXPECTATIONS

The participatory design process should not be limited to merely consulting users, citizens, and stakeholders, but should prioritize their active involvement. This principle is fundamental to social innovation design (Burn et al., 2006; Szebeko and Tan, 2010). Chick (2012) explains that this approach ensures the final solution meets actual needs and requirements and is usable by its intended audience. 'Designing networks' is an answer to the necessity for new thinking to address complicated problems and involves various actors and stakeholders working together to promote open innovation solutions (Manzini, 2009; Murray et al., 2010; MacDonald, 2013). According to Chick (2012), supporters commonly share the view that 'every participant is an expert in what they do, has valuable insights the designing network can learn from, and has a voice that needs to be heard' (p.55). Another important aspect of the research and design process involves spending time with users or citizens in their own environments, rather than developing a project theoretically from a distant location (Manzini, 2006; Thackera et al., 2007; Pilloton, 2009). The common belief is that the expertise does not reside merely with design professionals, but also with those whose interests are affected by the problem and its proposed solution (Chick, 2012). MacDonald (2011) characterizes the process as a participative *co-research* and *co-design* approach, emphasizing that it should be an ongoing, iterative process throughout the duration of the project.

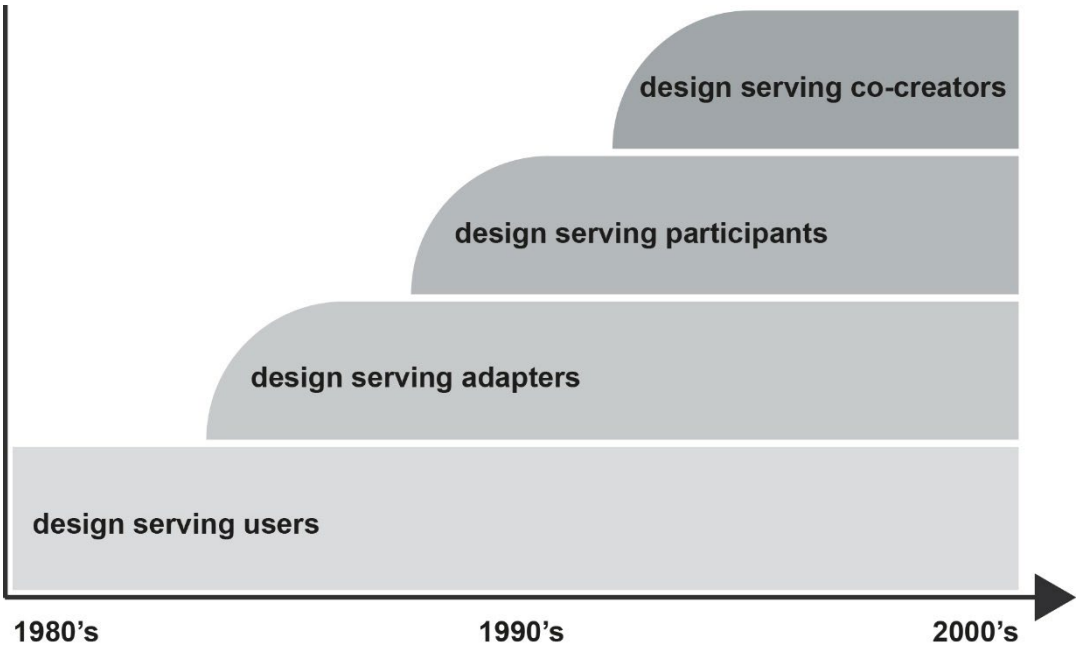


Figure 5.1. Increasing Levels of User Involvement in Design (Sanders, 2006)

In this research, the transportation patterns of METU Campus commuters have been focused to explore the reasons behind their mode choices, aiming to develop design directions that inspire sustainable use behaviors among diverse users. The framework of the research is illustrated in Figure 5.2. From left to right, it highlights the focus of the study by emphasizing the prominent problem areas, main goals of the research, corresponding research questions and proposed research stages to answer these questions.

One of the concerns of the study is to receive campus commuters' understandings of and attitudes towards their mode choices for travelling (from/to campus and within the campus) to reveal the latent reasons for unsustainable commuting behaviors. Therefore, the first stage of the research involves *context mapping* in order to explore individual's attitudes towards their daily transportation motives along with their use behaviors. Based on the findings and insights from this overall exploration, the second stage of the research involves a *generative workshop* where gathered and analyzed findings and insights are used to create alternative suggestions. These

suggestions aim to address disadvantageous points and improve advantageous points, forming possible sustainable prototypes for the identified problem.

In the final stage of the research, these early prototypes (design interventions) are evaluated by administrative stakeholders regarding their feasibility, applicability, and sustainable added value for the METU Campus transportation network with individual suggestions through *expert reviews* on the dimensions and variables accumulated from the previous stage. After this expert reviewing of potential sustainable transportation directives, lastly, alternative design interventions consisting in the short, mid and long-termed visions are created. These interventions aim to develop more sustainable transportation solutions within METU Campus.

This research aligns with the principles of *Transition Design*, which emphasizes a systemic and long-term approach to addressing complex societal challenges, such as sustainable transportation. Transition Design is centered on fostering transitions toward more sustainable futures through design interventions that consider both the present state and long-term visions. It involves a deep understanding of the system in question, inclusive stakeholder engagement, and the iterative development of strategic interventions.

At METU, this research reflects Transition Design by integrating *stakeholder involvement*, *systemic analysis*, and the *creation of short, mid, and long-term intervention areas* for sustainable transportation. The process embodies the Transition Design approach by engaging diverse stakeholders in the evaluation and refinement of early prototypes, ensuring that the solutions are feasible, applicable, and add sustainable value to the METU campus transportation network. Finally, the research systematically addresses the complex challenge of sustainable transportation through an approach that evolves over time, aiming to lead METU toward a more sustainable future.

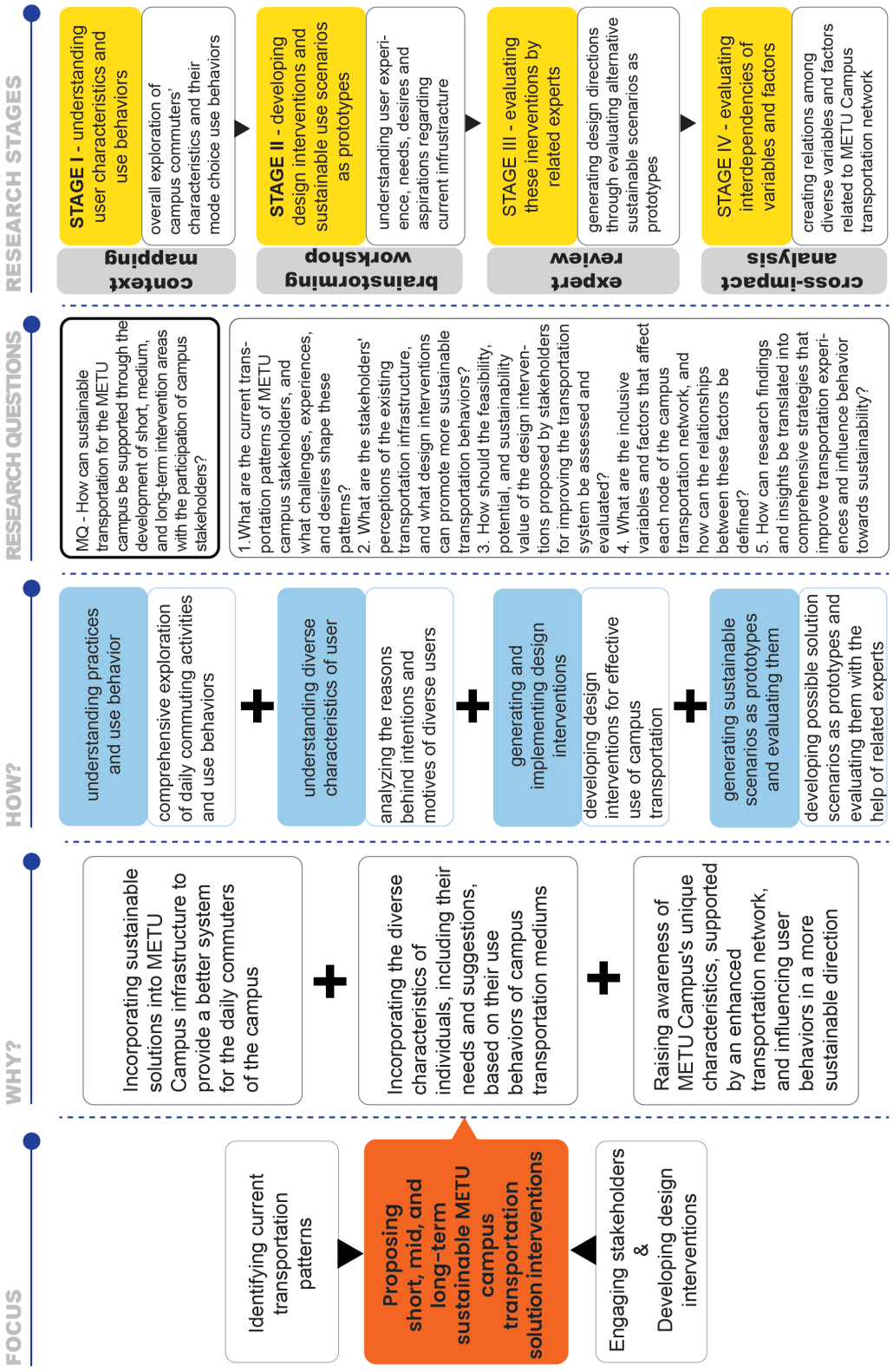


Figure 5.2. Framework of the Study

5.1 Stage I – Context Mapping

"Human-centred design is premised on empathy, on the idea that the people you are designing for are your roadmap to innovate solutions. All you have to do is empathize, understand them, and bring them along with you in the design process" (IDEO field guide to human-centred design, 2015).

Esser (2019) states that people are experts regarding their own lives and experiences. Understanding users in their context is critical for creating truly innovative products. In this sense, the context mapping technique is used in the early stages of a project to inspire and build empathy. Froukje Sleeswijk-Visser, a design researcher and one of the founders of this technique, describes context mapping as:

- Allowing designers to get to the latent needs, dreams, and aspirations of a target group.
- Including probes that enable users to show you their world, their reflections on it, and their dreams about its future, all in an active way.

According to Sleeswijk-Visser et al. (2005), even though the terms context and experience are closely related, they differ slightly. A description of a context around a product use relies on the experiences of people. A context has elements of time and space, whereas experience always takes place in the context of time. An experience can be a brief moment where memory and imagination meet, felt only by the person who has the experience. Generative techniques essentially let people construct a view on the context by recalling their memories of the past and eliciting their dreams of the future. Figure 5.3 illustrates this experience realm consisting of memories, the present moment, and dreams. Experience includes past, present, and future (2002).

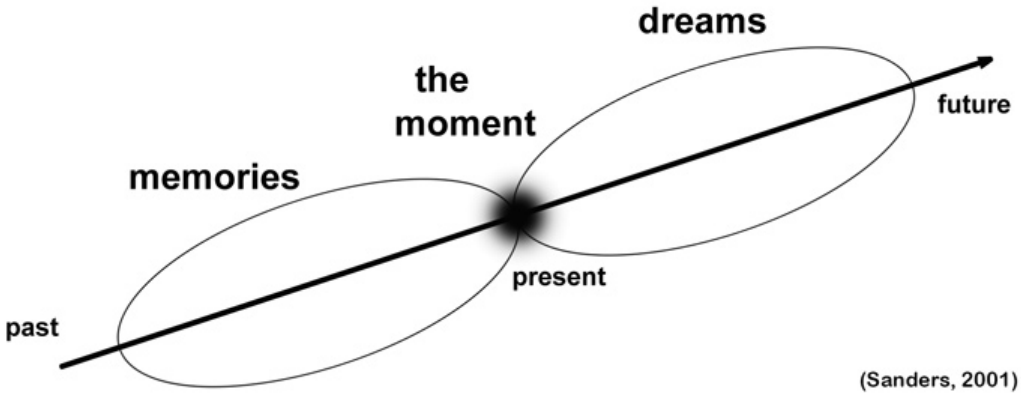


Figure 5.3. The Experience Domain (Sanders, 2002)

Interviews, observations, and focus groups, like conventional user study techniques, uncover explicit and observable knowledge about contexts. However, as far as designers of future products are concerned, the main limitation of these conventional techniques is that they only provide insight into people's current and past experiences but offer little insight into the future. To learn about potential future experiences, people's dreams and fears, their aspirations, and ideas need to be included (Visser, Stappers, Van Der Lugt and Sanders, 2005).

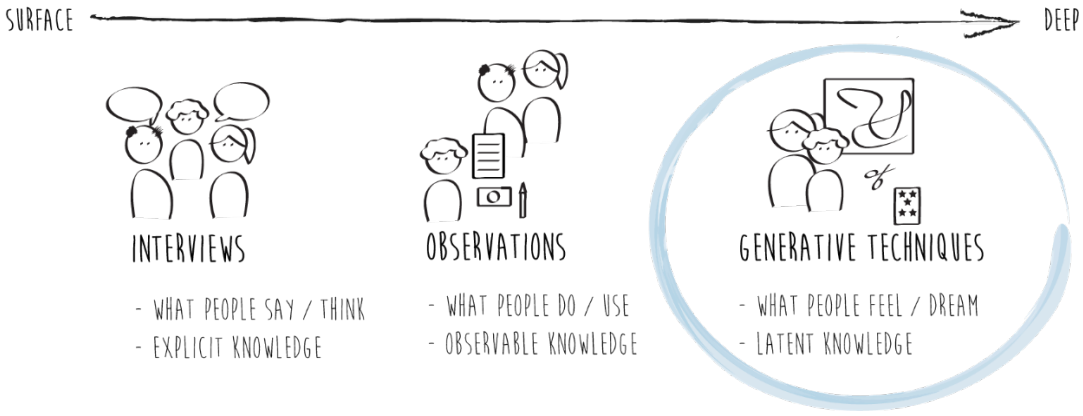


Figure 5.4. Experiences from Practice (Sleeswijk-Visser et al., 2005)

Sanders introduced generative techniques in the early 1990s (Sanders, 1992) to fill the gap in gaining knowledge about what people know, feel, and dream. These

techniques can reveal tacit knowledge and expose latent needs, providing a view to uncover future states of people (Sanders, 2002). Tacit knowledge is knowledge that people can act upon but cannot readily express in words (Polanyi, 1964), and latent needs are those that people are not yet aware of but will realize in the future (Sleeswijk-Visser et al., 2005).

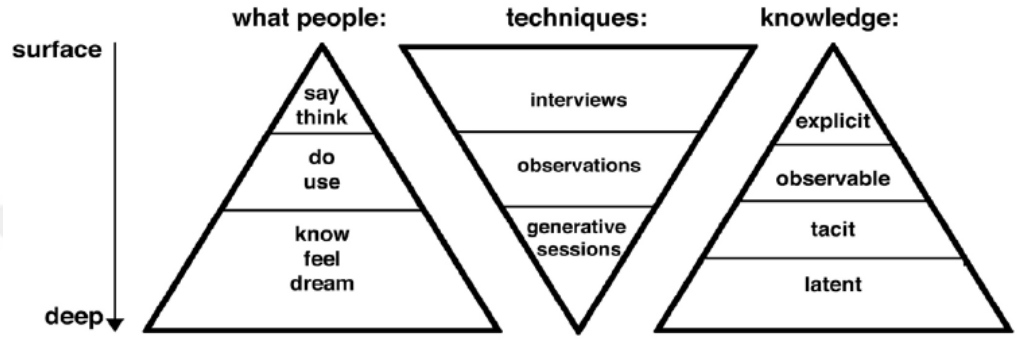


Figure 5.5. Different Levels of Knowledge about Experience are Accessed by Different Techniques (Sleeswijk-Visser et al., 2005)

The diagram in Figure 5.5 presents the relationships between various forms of data gathering and their ability to access different types of understanding of the user experience. The generative techniques are located in the lower parts of the triangles.

Sleeswijk-Visser et al. (2005) state that what people experience is often driven by tacit knowledge or latent needs, which are typically hard to express in words. With generative techniques, participants are guided in small steps to establish and express deeper levels of knowledge about their experiences. This approach makes it possible to access a hidden world of user experience, thereby producing a better understanding that can be used for design purposes.

Interviews, observations, generative techniques, and elements from probes are diverse research methods included in context mapping to produce rich experience material for the study. With the implementation of generative techniques and probes, explicit and implicit knowledge can be generated through people's self-expression about their experiences via context mapping.

To create intensive and personal contact and to value the personal stories, the number of participating users is kept relatively small, ranging from 6 to 20 people (Sleeswijk-Visser, 2009). Tools and techniques included in context mapping provide these participating users with means to explore, reflect on, and express their experiences. These experiences, relying on functional, personal, cultural, and social aspects of users' everyday life, are utilized to generate data and insights via applied specific tools and techniques.

"The outcomes are full of anecdotes, containing the feelings, values, needs, and dreams of people" (Sleeswijk-Visser, 2009, p. 5). People are invited, encouraged, and stimulated to record their own lives and experiences through generative techniques. Generally, people are unaware of many aspects influencing their experiences. Through the implementation of these techniques, they become aware by being stimulated to reflect on those underlying aspects.

People are provided with tools and expected to make things such as collages, mind maps, or velcro models through which they express themselves and generate information about their individual experiences by explaining why they made them that way (Schifferstein and Sleeswijk-Visser, 2013). Designers can create products and services with the help of these deep insights into contextualized experiences, which fit into and enhance people's daily lives.

The analogy of using a route map towards the terrain of user experience can be utilized by the designer navigating through; however, the map promotes discovery rather than providing a fixed route (Sleeswijk-Visser et al., 2005).

Sanders et al. (2012) describe the purposes of generative techniques through four dimensions:

- Probing participants for a research topic,
- Priming participants to immerse them in the domain of interest,
- Understanding their current experiences, and

- Generating ideas or design concepts for the future.

According to Sleeswijk-Visser et al. (2005), a context mapping study involves a sequence of research steps including preparation, sensitizing participants, group sessions, analysis, sharing or communication, and conceptualization (see Figure 5.6).

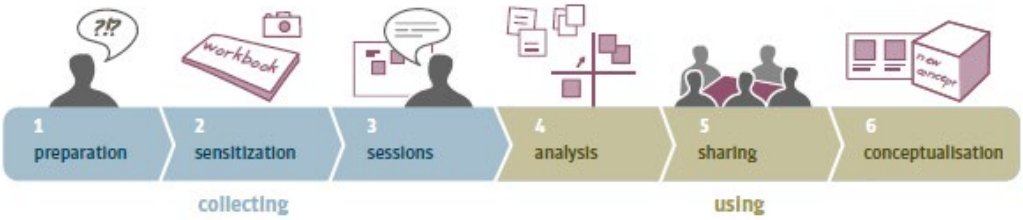


Figure 5.6. Procedure of a Context Mapping Study (Schifferstein and Sleeswijk-Visser, 2013)

5.1.1 Preparation

Preparation entails organizing the study by setting clear goals, developing a detailed plan, selecting participants, and determining the appropriate techniques to be used. Generative techniques, in particular, require extra attention for goal formulation. In this stage, participants are recruited, and preparations for subsequent stages are made according to the time planning for the context mapping phase (Sleeswijk-Visser et al., 2005).

5.1.2 Sensitization

The term "sensitize" refers to making people aware of certain practices they engage in. People are often not conscious of their everyday experiences or what is meaningful to them. The sensitizing phase enables participants to engage in a series of small exercises aimed at encouraging them to reflect on their past experiences and become more mindful practitioners of their present experiences (Sleeswijk-Visser et al., 2005). Additionally, this process benefits other stakeholders by revealing

people's true needs and wishes. Sensitizing involves prompting, encouraging, and motivating participants to reflect on and explore aspects of their personal context, allowing them to engage with these thoughts at their own pace and within their familiar environment. The primary goal of this step is to foster self-reflection among participants, which can then be utilized during the generative sessions.

The most commonly used types of sensitizing tools in the literature of context mapping include photos, workbooks, diaries, and postcards. Cameras are used to capture relevant images from users' contexts, providing instant reasoning for an appealing situation or object with a short caption. Workbooks are small booklets in which users answer open-ended questions and draw diagrams related to their activities in a specific context. Users are also provided with small stickers to express their feelings in relation to these activities. A diary is similar to a workbook but requires users to write or draw something each day, encouraging continuous reflection on the subject. Postcards are sent to participants to answer a question or complete a small exercise, which are collected after completion. This fun and engaging method requires relatively little effort from users.

5.1.3 Sessions

During the session phase, participants engage in generative exercises either individually, in pairs, or in groups (see Table 5.1 for some advantages and disadvantages of various types of sessions). Sensitized participants convene in group sessions to share their experiences, typically completing two to three exercises within a two-hour timeframe. Individual and pair sessions follow a similar structure but are conducted over a comparatively shorter duration. Each exercise in these generative sessions is designed to trigger participants to express deeper levels of feelings or knowledge. Various toolkits are available for different exercises, including picture and word sets for collaging, simple colorful abstract 2D forms for cognitive mapping, and 3D forms for Velcro modeling (see Figure 5.7) (Sleeswijk-Visser et al., 2005).

Table 5.1 The Advantages and Disadvantages of Group, Pair or Individual Sessions (Sleeswijk-Visser et al., 2005).

	ADVANTAGES	DISADVANTAGES
Group sessions	Participants can react to each other's experiences;	Without professional moderation, one dominant participant can influence the group;
	A global view of the context and various user experiences will be created;	It is difficult, although possible, to obtain individual responses.
	A large amount of diverse information is generated in one session.	
Pair sessions	Participants feel comfortable because they are with a friend, spouse, parent, etc.;	Less diversity in the total range of participants since members of the pair are related or acquainted.
	Participants may reveal things about each other;	
	The session can take place at the participant's home or workplace.	
Individual sessions	A lot of attention and time can be devoted to a participant, and this can bring out detailed information;	A participant can feel inhibited, because it may feel as if a psychologist is testing him/her about feelings, experiences and needs;
	The session can take place at the participant's home or workplace.	It is more time-consuming than groups.

The range of materials within a toolkit can be extended by incorporating colored pens, markers, glue, and scissors, which participants use to create artifacts that express their thoughts, feelings, and ideas. Possible outcomes of these sessions include drawings, collages, maps, models, stories, storyboards, and plans. Participants introduce the stories behind their artifacts, which are created through making, mapping, or modeling, and these stories uncover their latent needs and desires for the future (Sleeswijk-Visser et al., 2005).

Figure 5.7. Some Generative Techniques Used in Practice by SonicRim (Sleeswijk-Visser et al., 2005).

5.1.3.1 Collaging

Collaging is a technique employed to elicit memories and emotional responses from participants, facilitating a deeper understanding of their experiences and feelings toward a specific subject (Stappers and Sanders, 2003). A collaging toolkit typically includes a collection of words along with both realistic and abstract images. While participants can be given a magazine to choose images, this process can be confusing and tiring. Therefore, using pre-selected or prepared images is generally more suitable for this method, ensuring a smoother and more focused experience for participants (Sleeswijk-Visser et al., 2005).

The images used for collaging are intentionally diverse, including a variety of content such as people, animals, interactions, fantasy elements, and objects. The individuals depicted in the images represent a range of ages, genders, and races. To maintain balance, an equal number of positive and negative, as well as abstract and realistic images, are included, while overly aesthetic visuals are avoided to ensure suitability for an expressive moodboard. Subject-specific images are either excluded or minimized, such as using a picture of a man shaving to represent the shaving experience. The images are designed to be open to interpretation; ambiguous visuals, in particular, are valuable as they can be understood in multiple ways, allowing participants to express their emotions and aspirations freely (Sleeswijk-Visser et al., 2005).

In addition to words and images, participants are supplied with various tools such as cardboard, scissors, tape, glue, pens, and pencils to assist in arranging the selected images and words according to the provided instructions (Figure 5.8). The arrangement process is intentionally flexible, and the instructions are designed to be open-ended to avoid misunderstandings (Stappers and Sanders, 2005).

Figure 5.8. Collage Making in a Generative Session (Hanington, 2012)

Once participants complete their word and image arrangements, they are asked to present their collages verbally, explaining their rationale for selecting specific images or text. Since visual representations are challenging to interpret without the creator's perspective, these verbal presentations are essential for gaining a deeper understanding of participants' insights and for effectively integrating these insights into the further design process (Stappers and Sanders, 2005).

5.1.3.2 Mind Mapping

Mind mapping, also known as flowchart mapping or cognitive mapping, is an effective technique for uncovering intuitive relationships between patterns or processes related to a product or system. This approach enables participants to articulate their ideas and give shape to their unmet needs. It involves several ambiguous components that can be interpreted and used in various ways (Sleeswijk-Visser et al., 2005). While a pencil and paper are generally sufficient for creating a mind map, additional materials such as scissors, glue, tape, word collections, and

simple abstract shapes (e.g., circles, squares) in various sizes and colors can also be incorporated into a mind mapping toolkit to enhance the process (Stappers and Sanders, 2005).

Mind mapping is conducted with participants to investigate and comprehend their thoughts and experiences related to a product or system (Sleeswijk Visser et al., 2005; Stappers and Sanders, 2005). Additionally, this technique serves to facilitate the understanding of how a particular process or system functions (Sanders, 2000) through a diagrammatic form of representation (Figures 5.9 and 5.10). Typically, the main subject to be explored is located at the center of this diagrammatic representation, with all related connections radiating outward from this central point.

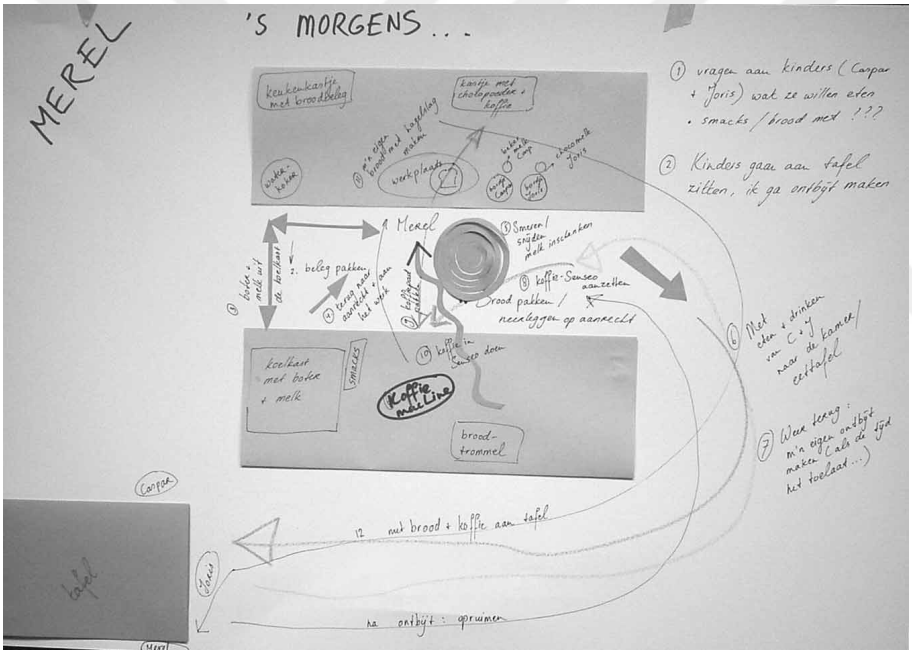


Figure 5.9. Mapping Exercise of a Routine in the Kitchen (Sleeswijk Visser et al., 2005)

Participants organize, sketch, and connect the provided components of the toolkit according to the instructions given by the researcher. They then verbally explain the reasons behind their decisions regarding these arrangements during the mind mapping process (Levitt and Richards, 2010).

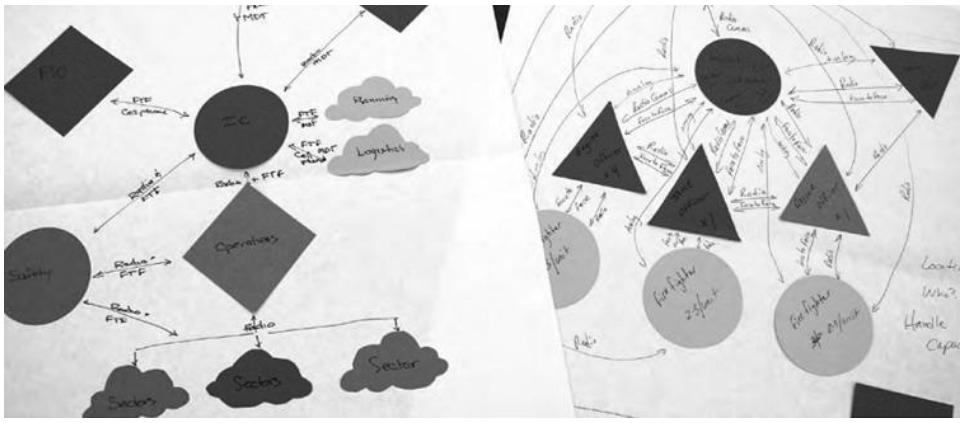


Figure 5.10. Collage map examples (Levitt and Richards, 2010)

5.1.3.3 Velcro Modelling

Velcro modeling is an interactive generative research method that enables participants to translate their ideas, experiences, needs, and expectations into three-dimensional physical representations using a Velcro modeling toolkit (Sanders, 1992). The toolkit is composed of basic and abstract 3D blocks, along with various 2D attachable shapes equipped with Velcro fasteners, symbolizing different elements of a product or system (Levitt and Richards, 2010; Stappers and Sanders, 2005) (Figure 5.11).

Figure 5.11. Velcro Modelling Toolkit (Sanders, 2006)

It should be noted that researchers do not take the outputs of Velcro modeling sessions too literally (Levitt and Richards, 2010). Similar to other generative tools mentioned, analyzing the outcomes of Velcro modeling sessions is directly related to the explanations given by participants while assembling the provided toolkit components. The process through which participants reflect their insights, priorities, and intentions is more significant for obtaining inspirational data for the ideation phase of the design process than the final output (Turhan, 2013). Sessions can be conducted within a group of people (Figure 5.12) or individually.

Figure 5.12. Velcro Modelling Session Example (Levitt and Richards, 2010)

5.1.4 Analysis

The qualitative data gathered from the sessions are anticipated to be both rich and diverse for the analysis. Verbal protocols are transcribed, and the artifacts produced by participants, which include numerous stories and anecdotes relevant to the subject, provide valuable support for the researcher. These artifacts assist in exploring the context, revealing unforeseen insights, and broadening the perspective of the design research.

5.1.5 Sharing and Communication

The final step is sharing or communication, where the insights are integrated into the design process. In this step, the overall gathered inferences are communicated and employed for building personas and scenario components to be utilized in the second stage of the research. This step is crucial as it translates the rich qualitative data and findings obtained from the previous phases into actionable design inputs. The insights gathered are communicated to the design team and other stakeholders to ensure a shared understanding of the user experiences, needs, and aspirations.

5.2 Designing the Setup and Conducting Pilot Studies for the Context Mapping Stage

5.2.1 Designing the Setup of First Phase

The context mapping study was planned in two phases. The first phase involved a diary stage where participants were sensitized, followed by a subsequent interview. The second phase comprised generative sessions with the same participants. Initially, the infrastructure for the first phase (diary and follow-up interviews) was established and a pilot study was conducted. Based on the data obtained from this phase, the second phase was designed to complement the first phase. This phase was then tested with different participants, and their observations and feedback were incorporated. Ultimately, the final two-phase study framework for the first stage of the study (context mapping stage) was structured based on the context mapping framework.

Stage-I of the proposed methodology involves conducting a context mapping study aimed at understanding the diverse characteristics of users, their campus-related transportation practices, and their behaviors and experiences during commutes. To achieve these objectives, using a diary was deemed the most appropriate method for collecting users' experiences in their contexts. Thus, as a sensitizing tool, the diary was planned to be utilized in the initial phase of the study to gather data from

participants about their daily transportation-related activities around METU Campus.

The diary prepared for pilot users was initially created in a physical format. The diary's content included: the purpose of the research, personal information, and descriptions of the transportation behaviors adopted by the participants. Participants were expected to record their journeys and related experiences over a week in four stages. These stages were designed to capture:

1. **Identifying Habits**: Recording the campus transportation modes used, satisfaction levels of the transportation, and average travel times over a week.
2. **Identifying Concerns**: Determining the concerns that shape habitual behaviors in campus transportation.
3. **Assessing Awareness**: Evaluating habitual behaviors against sustainable transportation performance criteria.
4. **Identifying Expectations**: Collecting positive and negative experiences during travel and describing the ideal journey.

Upon completing the diary entries over a week and sensitizing the participants, individual interviews were planned. However, it was later realized that maintaining a physical diary might require excessive effort from participants, as carrying it at all times could be challenging. Due to its impracticality and the high level of commitment required, the diary content was further revised and improved. It was transformed into an interactive format accessible via mobile phones through online tools, making it easier for participants to use and ensuring more accurate data collection.

For these reasons, mobile application-based diary solutions were explored. Initially, *Atlan Collect* software was tried, but ultimately, *Typeform* was deemed more suitable for the study due to its specific features. *Typeform* is compatible with both Android and iOS and offers various data collection options, including text, numbers, multiple

choice, Likert scale, time, image, audio, and video. *Typeform* is a web-based platform that can be accessed via mobile phones, desktop, tablet, or other devices.

Based on these features, two types of forms were constructed for the participants. The first form was designed to collect personal information, while the second form aimed to gather records of their daily transportation-related activities. After completing the first form once, participants were expected to fill out the second form for each trip over three days. Both forms were kept short and user-friendly to ensure that participants did not feel overwhelmed while recording their daily practices and experiences.

5.2.1.1 Diary Structure

Firstly, participants who were willing to contribute to the study were introduced to the study subject and informed about the expectations through an email or a message. All stages and guidelines of the process were clarified through mutually descriptive conversations with each participant. Once participants understood the subject and how to fill out the two separate forms during their journeys, the diary completion process started for all participants, almost within the same week, which would be followed by interviews.

1st Form: In the first form, after participants received the form link via both email and messaging mediums, they were asked to provide consent to participate in the study. Upon accepting the terms and conditions, participants were requested to provide some basic information about themselves, including their name, contact information, age, gender, occupation, individual car availability, total years in relation to the campus, and average monthly transportation expenses related to campus commuting.

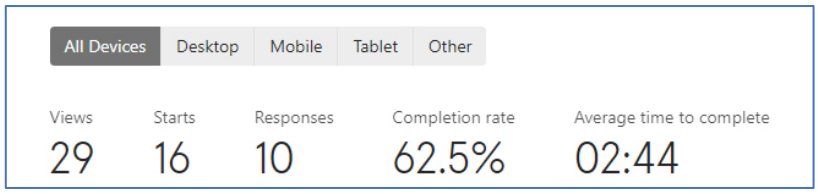
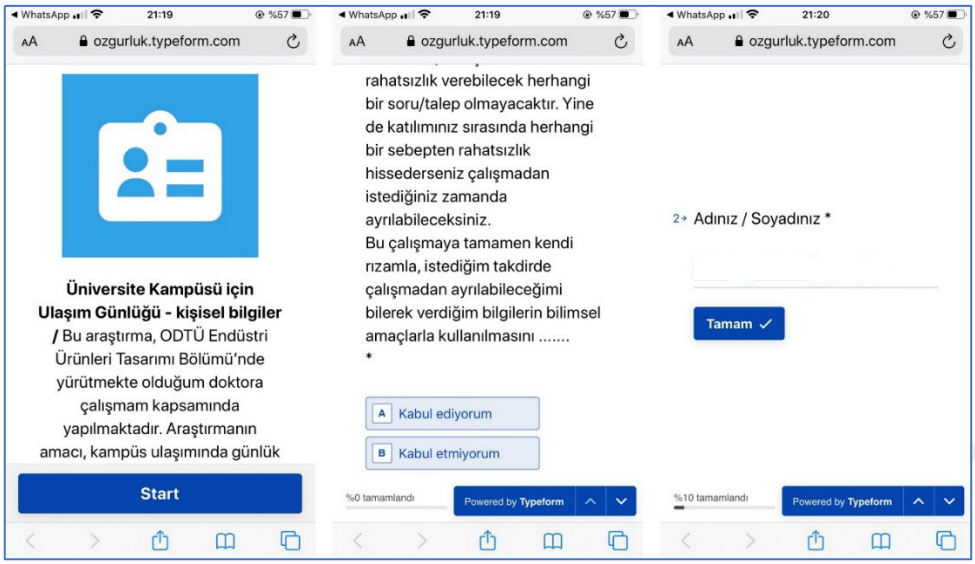
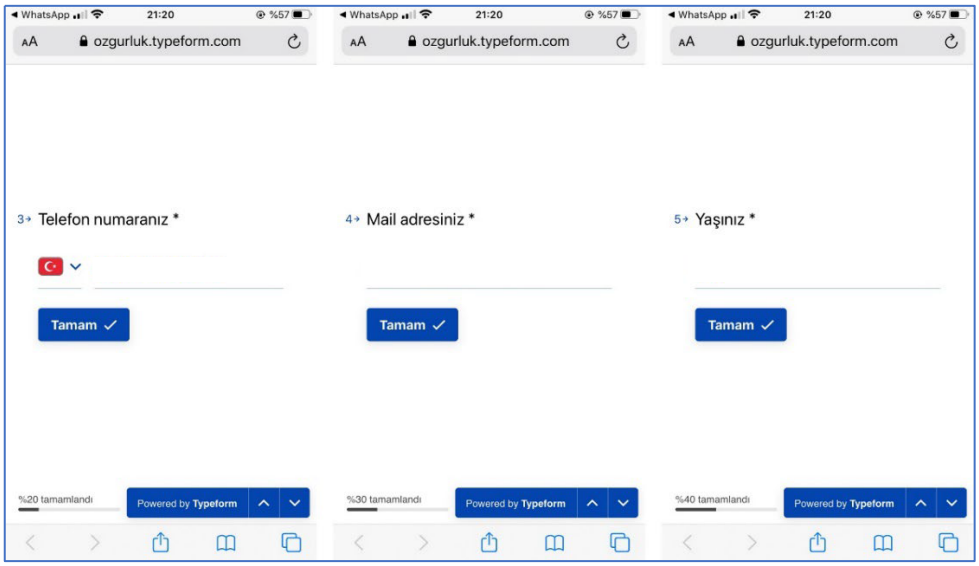


Figure 5.13. Participant Responses for the 1st Form

The first form was designed to be very easy and quick for the participants, resulting in an average completion time of about 3 minutes.





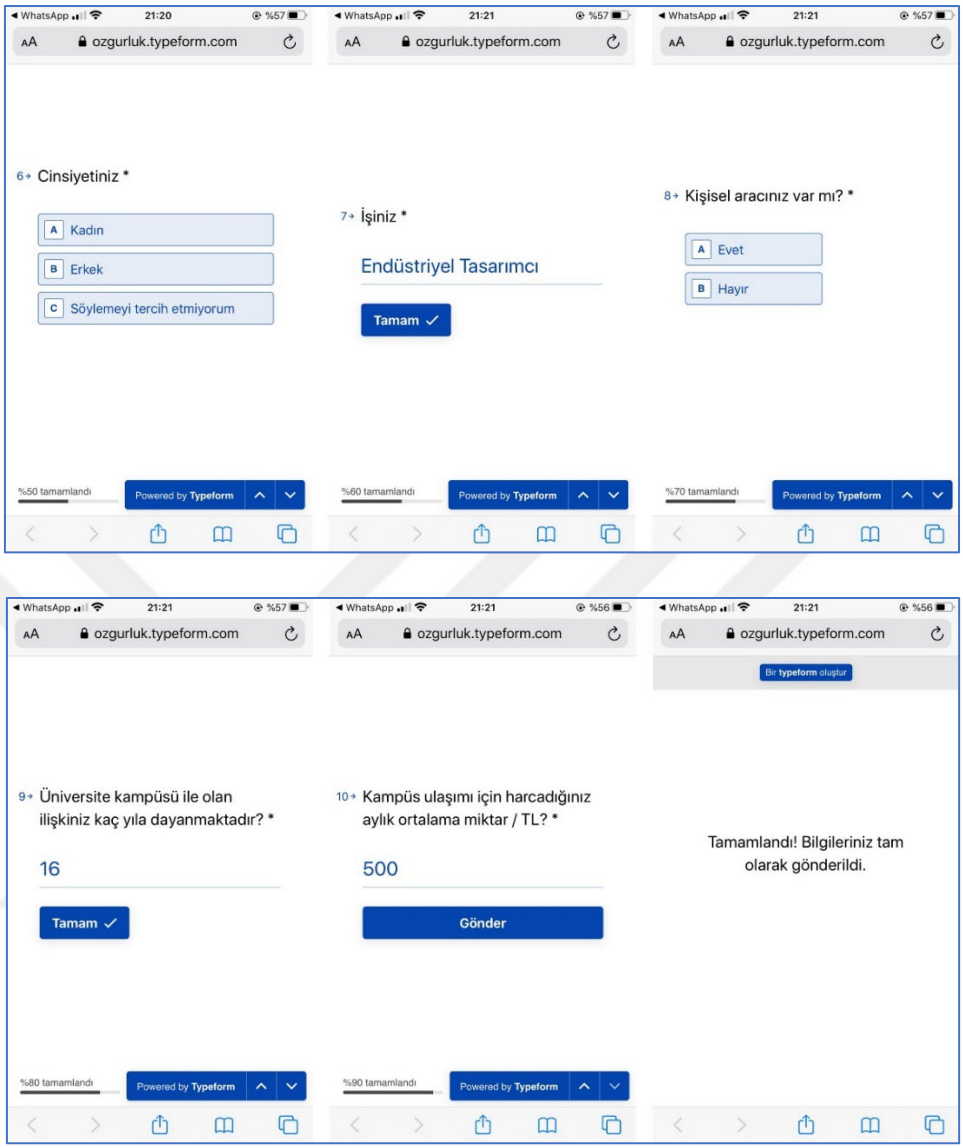
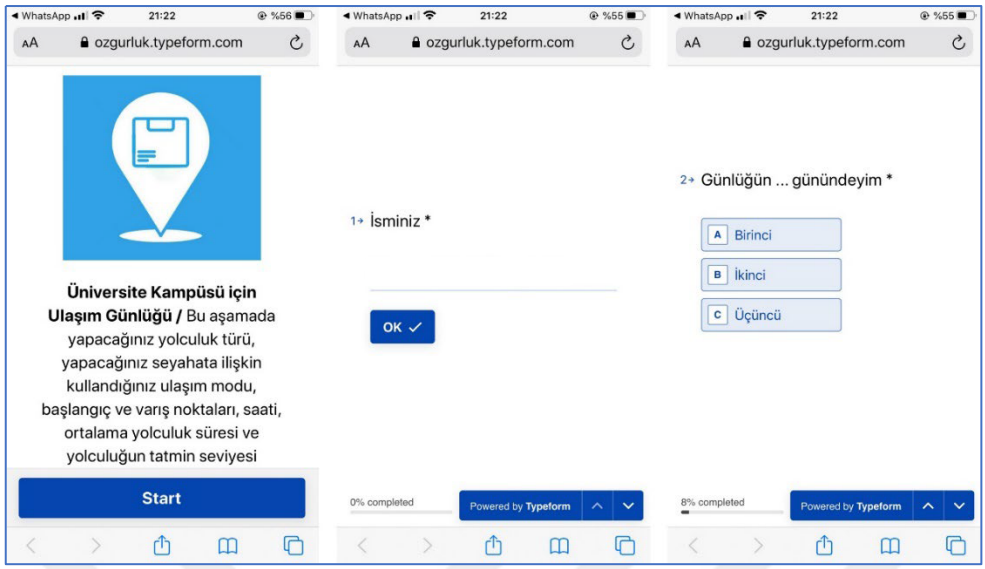
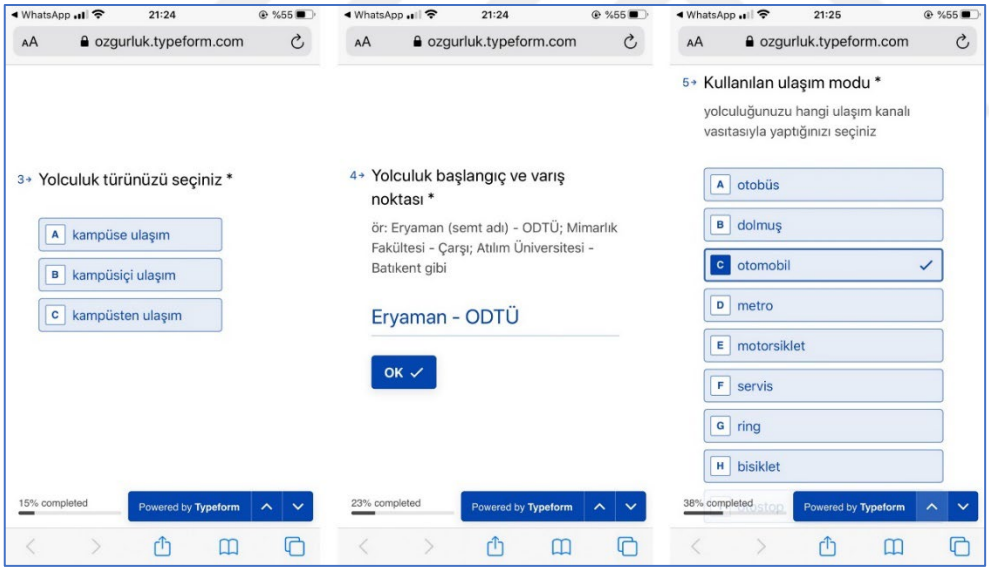


Figure 5.14. Structure of the 1st Form

2nd Form: The diary study was conducted over a period of three days among the participants. After collecting the initial personal information through the first form, participants were provided with the link to the second form. In the first question of this form, participants were asked to provide their names to match the results with the corresponding individuals. As the participants were required to fill out the form for each trip and on a day-by-day basis, the second question inquired about the specific day for which they were providing data.



As each participant needed to provide information about every trip they made in a day, the form then asked about the trip type, specifying whether it was to, within, or from the campus.



Furthermore, trip-based questions followed, asking for the starting and destination points, the mode of transportation used, the average trip duration, and an evaluation of the journey using a Likert scale, along with the reasons for that evaluation. Lastly, participants were requested to capture and provide relevant pictures related to their experiences during their daily commute.

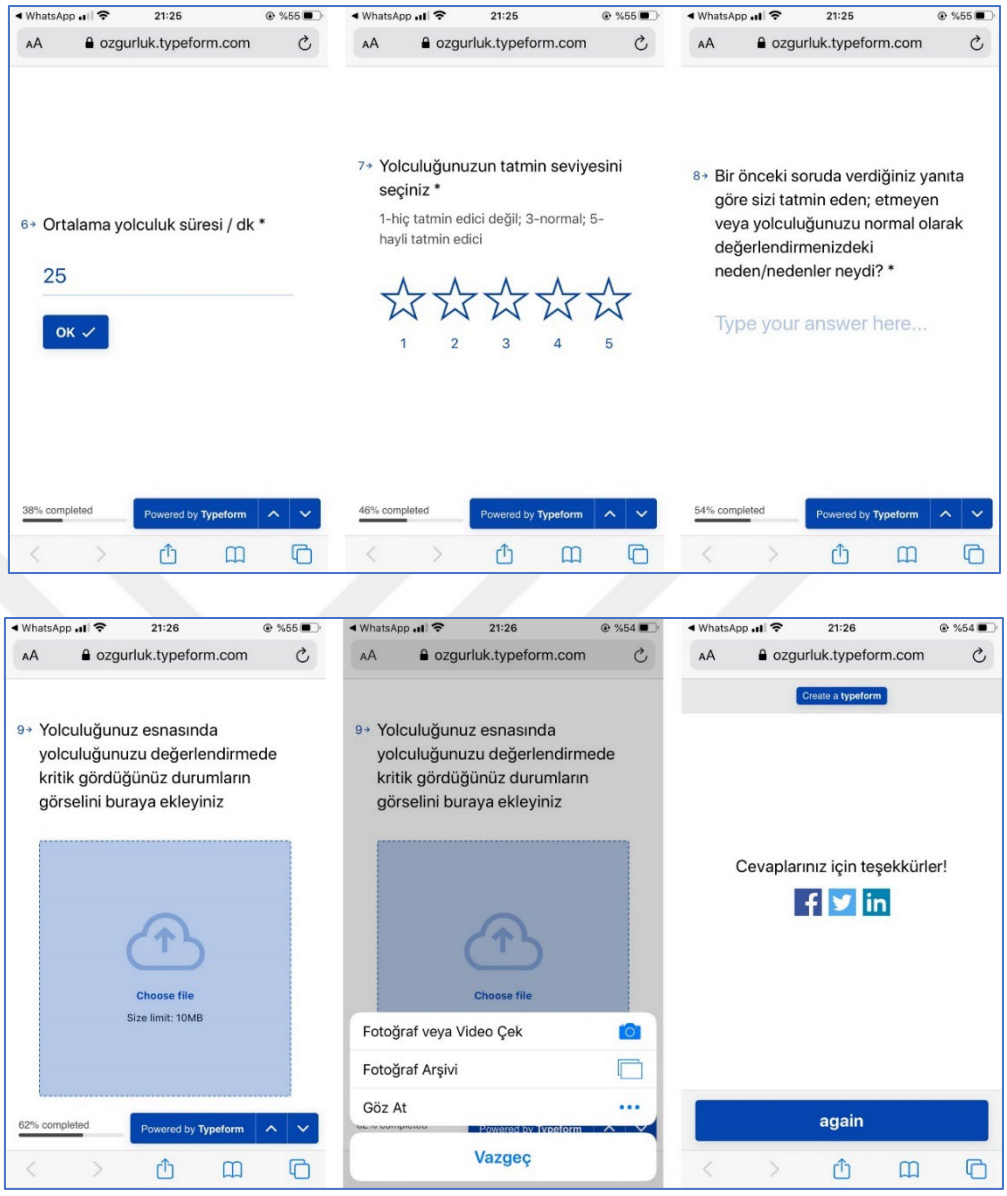


Figure 5.15. Structure of the 2nd Form

As participants were guided about completing the forms after their trips, they were also informed at the beginning to take pictures during their journeys and upload them immediately after completing their trips. For photo uploading, five extra slots were available in the second form, although it was not compulsory to fill all of them.

5.2.1.2 Sampling Strategy of the Pilot Study

As a result of the Covid-19 pandemic, transportation activity around the METU Campus has dramatically changed. Face to face educational practices have been suspended for an unknown duration. This extraordinary condition impacted whom to contact for the pilot study. To conduct the diary study with follow-up interviews as a trial to develop the structure of methodological plan Stage-I, participants from other universities in Ankara with a campus network and employing a hybrid system for education were included. Active users of campus transportation networks were expected to provide useful and more efficient data for the study.

For this reason, in the first phase, six industrial design students from Atılım University, two instructors from TED University, two Teknokent personnel, and two instructors working at an administrative level from METU's Department of Industrial Design were contacted. Although 12 participants seemed ideal for the pilot study, the final sample size was defined with the participation of seven users due to reasons that will be mentioned in the limitations section.

Table 5.2 Sample Distribution for the Pilot Study

Origin of The Participant	Sample size	Gender	Participant Code
Middle East Technical University	2	M	P1
		F	P5
METU Teknokent	2	F	P2
		M	P6
Atılım University	2	F	P3
		M	P4
TED University	1	F	P7

5.2.1.3 Follow-up Interviews

After participants were sensitized with a three-day diary process, they were interviewed with open-ended questions through individual, separate *Zoom* meetings. The interviews were scheduled according to the available spare time of the participants' preferences. These interviews aimed to delve deeply into the participants' motivations, worries, desires, expectations, and levels of sensitivity concerning their transportation-related practices and experiences around their campuses, thus providing a basis for further generative sessions. The average duration of each interview was about half an hour, and they were recorded as *Zoom* videos for further analysis to obtain significant insights on the subject. The interview questions that would lead to the design of generative sessions are as follows:

1a. In your daily routine, you mentioned using ..... vehicles for commuting to and from the campus. Do these reflect your general preferences?

1b. Are there any mandatory factors that determine your preferences? What are they?

1c. What are the reasons behind your personal preferences?

2a. In your daily routine, you mentioned using ..... vehicles for in-campus transportation. Do these reflect your general preferences?

2b. Are there any mandatory factors that determine your preferences? What are they?

2c. What are the reasons behind your personal preferences?

3. Have your transportation preferences for commuting to campus always been the same (excluding the pandemic period)? If you have changed your preferences (excluding the pandemic), what are the reasons for this change?

4. What problems did you encounter with campus transportation before the pandemic? What are the current problems?

5. What are the personal benefits and drawbacks of your transportation preferences?
6. How do you evaluate the environmental impact of your preferences?
7. What do you think could be more environmentally friendly transportation options?
8. Would you sacrifice your personal priorities to adopt a more environmentally friendly transportation choice?
9. If I asked you to describe adopting a more environmentally friendly transportation choice for your campus commute using five different adjectives, what would they be? Adopting a more environmentally friendly transportation choice for me would be like .....
10. What are the essential elements of campus transportation for you?
11. What criteria play an important role in forming your transportation preferences?
12. Can you describe your ideal campus commute?

After interviewing a few participants, questions 10 and 11 seemed quite similar, with responses that were very close and repetitive. The collected answers were transcribed individually, and the analysis of the transcribed data and finalized questions in Turkish can be found in the Appendix.

5.2.1.4 Limitations of the Pilot Study – First Phase

There were certain limitations in conducting the pilot diary study regarding its execution, sample size, and sample distribution according to participants' mode choices.

Firstly, the major limitation was accessing active users of METU Campus. As a result of the pandemic, most transportation-related activities decreased or changed

dramatically. The suspension of face to face education on the METU Campus kept students away from the campus environment and their regular daily trips to the campus. Thus, the sample distribution was slightly altered and expanded to include commuters from two other university campuses.

Mode choice behaviors of the selected participants were also affected by the pandemic, leading them to use individual cars rather than mass transportation. Consequently, only two participants out of seven used alternative modes to individual car use, which disrupted the harmony of mode choices among the participants.

Initially, 12 users were contacted to participate in the study. However, five of them withdrew during the data collection stage due to the long-term commitment required. Additionally, some users' data were excluded as they provided very few and incomplete data for the three-day diary study, which would affect the reliability of insights since they did not fulfill the entire three-day requirement.

Lastly, there was a limitation regarding one section of the diary concerning trip type. Under normal conditions, participants were asked to fill out the diary form for every trip over three different types: trips made to, within, and from the campus. However, there was almost no feedback about trips made within the campus since all facilities were shut down during the pandemic, which meant participants did not need to make such trips within the campus.

5.2.1.5 Analysis of the Pilot Study Follow-up Interviews

The responses of follow-up interviews from the recorded sessions were first transcribed using the *Google Docs* voice transcription tool. After this automatic transcription, all recordings were manually edited as a cross-check. All answers were gathered question by question in a *Google Sheets* document for individual analysis. In the *Google Sheets*, each complete answer to the questions was summarized in the

next right column and elaborated into a one-word capitalized code in the subsequent column as a descriptive code (see Appendix).

5.2.2 Revisions and Improvements on the Study-I Set-up

After completing the first phase of the two-stage pilot study with contributions from seven participants and analyzing the collected data, the study design was revised and finalized along with the second phase, the *generative session*. Due to the suspension of face to face education during the COVID-19 pandemic, the diary format used for sensitizing participants proved ineffective, necessitating alternative methods to prepare participants for the study. Sensitizing participants is essential to help them recall their past habits and routines and to trigger them reveal in-depth knowledge about the subject through the context mapping study. As previously mentioned, the temporary halt of face-to-face education during the pandemic forced most METU stakeholders to stay away from the campus environment. Therefore, a METU Campus transportation network video was prepared to remind participants of all relevant transportation modes around the METU Campus.

Mapping Stakeholder Relations: Before preparing the video narrative intended to sensitize users, an analysis of the METU campus transportation network was conducted. This analysis included mapping all relevant transportation mediums that are part of the system, as well as all stakeholders affected by the system and their interrelationships. Considering approximate values *(see 2.2.4 METU Campus for detailed values)* for each node within the system, the relationships and weights were mapped to create a METU campus stakeholder relationship map (see Figure 5.16). These relationships were then utilized in the preparation of the video.

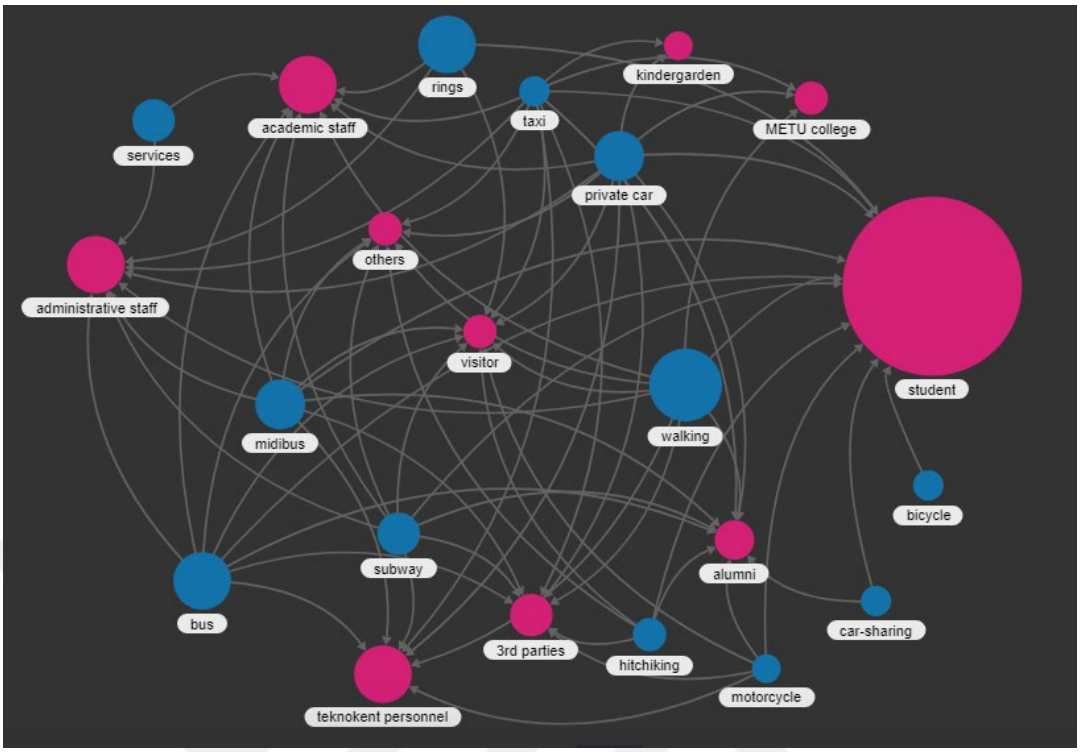


Figure 5.16. Stakeholder Relations Mapping regarding METU Campus Transportation Network

This stakeholder relations map illustrates the relationships between METU Campus commuters and the available transportation mediums. Items labeled in red represent the users of the current METU Campus transportation network, including students, academic staff, administrative staff, alumni, METU College parents and students, Teknokent personnel, kindergarten attendees, third parties (e.g., Çarşı, Bank, Mediko personnel), visitors, and others. The items labeled in blue denote the currently available modes of transportation within the METU infrastructure, such as buses (EGO and private), midibuses, the subway, taxis, bicycles, car-sharing, hitchhiking, shuttle rings, personnel shuttles, walking, private cars, and motorcycles. In addition to these system users, other stakeholders include planners, administrators, and regulators of the system.

Development of a Transportation Overview Video for METU Campus: To create this video, extensive searches were conducted on the *YouTube* platform to access and review various transportation modes available around the METU Campus. Multiple video clips featuring buses, minibuses, individual car use, metro, motorcycle, ring, bicycle, hitchhiking, walking, and taxis were compiled. The selected clips were edited and combined using *Adobe Premiere*, with background music and informational covers added at the beginning and end. The final product was a 5-minute video designed to be shown at the start of the initial interviews.

Follow-up Interviews: After watching the video, which helped participants recall the campus network's regular operations with many active users, participants were asked to narrate their transportation routines on a typical day using the interview questions below:

1. Could you please narrate a typical day of your commute to campus?
    - What time and from where did you start your journey?
    - What types of transportation did you use during your journey?
    - How long did your journey take?
    - What were the things that came to your mind, bothered you, or pleased you during your journey?
    - Were your journeys always like this, or did they change over time? If you changed your preferences, what were the reasons?
2. How do you evaluate the environmental impact of your transportation choices?
3. What do you think could be more environmentally friendly transportation options?
4. Would you be willing to give up your personal priorities to adopt a more environmentally friendly transportation choice?

5. If I asked you to describe adopting a more environmentally friendly transportation choice with five different adjectives, what would they be? (e.g., Adopting a more environmentally friendly transportation choice for me would be like ...).

Both the video and narrating a typical day of campus commuting prepare participants to reveal their tacit knowledge and latent needs for the subsequent generative sessions. Some of the interview questions previously given were decided to be explored more deeply during the *generative session*.

The new Stage-1 design is as follows: First, after contacting the participants, their personal information is collected through a form. Then, on mutually agreed days and times, individual meetings are conducted via the Zoom online platform and Miro, which includes sensitizing with the video, follow-up interviews, and generative sessions. After finalizing this design, the generative session phase was also piloted to make further improvements.

5.2.3 Pilot Study of Second Phase

The final version of the Stage-I context mapping study second phase has been pilot tested with the participation of three researchers in a collaborative manner. Initially, different time slots were arranged with each participant for meetings on *Zoom* to cover the sensitizing process through initial interviews right before the generative session. The interview began with the presentation of the METU Campus transportation network video to remind participants of their relevant commuting experiences before the pandemic. After the video, participants narrated a typical day of their commute experiences in as much detail as possible, followed by further questions. All sessions were recorded and transcribed for analysis (see Appendix). After completing each session with the three participants, they were gathered on both the *Miro* platform and *Zoom* for the collaborative generative session.

All three participants are individual car users. Throughout the generative session, they made word collages regarding the reasons for adopting such a transportation habit, problems they faced with their transportation mode choices, and the advantages and disadvantages of their choices in the first part of the session. After a 20-minute 'make' part, they shared their commuting experiences aloud with each other one by one. In the second part, participants were asked to prioritize their campus transportation-related criteria and make a visual collage of their dream and ideal way of campus commuting experiences. In the next 'say' part, they shared their visual stories, expressing their expectations and desires for better experiences at METU Campus.

After completing these two stages, extensive discussions were held about the structure of both the initial interview and the generative session. As the participants are also researchers, their insights and comments were valuable for further developing the study setup. Based on their feedback, the campus transportation network video was enhanced, interview questions were revised, and the generative session *Miro* board was significantly changed. From the perspective of a foreign user, all tools were made easier to use, and all explanations and guidelines were clarified.

Additionally, a major change was made to conduct the study individually rather than in a group. This decision was made because an efficient discussion environment, which requires the participation of six users simultaneously, could not be achieved. Moreover, arranging for six users to be available at the same time would be difficult and would extend the duration of the total session significantly, which could burden the participants. Furthermore, separating the initial interview from the generative session would require participants to be contacted twice. Since the interviews were individual and the generative session was collaborative, they would not follow each other immediately, potentially weakening the sensitization of users. For these reasons, the initial interview and the generative session were combined to be conducted consecutively, with individual participation from 24 participants separately.

5.2.4 Ethics Committee Application for the Study

Before the actual study commenced, an application was submitted to the ethics committee, as confirmation typically requires 3-4 weeks before the initial launch (the evaluation process for applications requires this time span). For the application, a very detailed setup of the study was presented, including its sample type, sample size, aim, tools to be used, and the benefits to society and the discipline. Additionally, all questions to be used in the interviews, the consent form for the participants, and even the invitation text for participation were prepared and attached to the application. After four weeks, the ethics committee confirmed the study and provided a protocol number (see Appendix).

5.3 Stage-I: Context Mapping

5.3.1 Sampling Distribution for the Study

After pilot testing and refining the study stage-I for its final implementation, a sample group of 24 participants was formed. To obtain diverse and rich data, all stakeholders around the METU Campus were invited to participate. Considering that different locations within the METU Campus exhibit distinct transportation characteristics, the campus map was analyzed, and the campus was divided into four distinct zones (see Figure 5.17). It was expected that each zone would be represented by six participants, reflecting the diversity in their transportation mode choices.

With the help of the aforementioned campus map, a balanced distribution was planned, taking into account the frequency of departments, dormitories, METU dwelling houses, METU Teknokent, and their close proximity towards the different METU gates (A1, A4, A7). The sample distribution of 24 participants was designed to reflect different mode choices, distinguishing between individual car users and alternative mode users, with a ratio of 1/3 of total participants being individual car users.

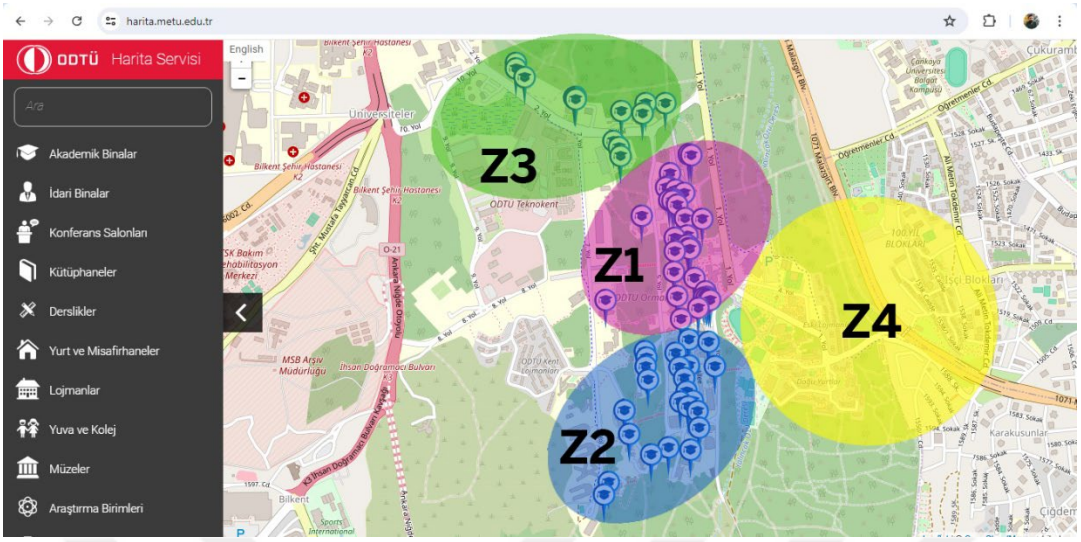


Figure 5.17. METU Map and Proposed Sample Distribution through Four Zones

Sampling Strategy of the Study:

Quota sampling is a technique employed to obtain representative data from a population. Unlike random sampling, it involves selecting each participant based on predetermined subgroups to ensure proportional representation within the sample (Moser, 1952).

These six participants within each group were chosen to reflect a diversity of mode choice behaviors. This approach aims to yield more diverse insights for the study by ensuring that the participants' transportation behaviors are harmoniously represented. Dividing METU Campus into four zones and selecting participants based on their mode choice behaviors is expected to provide a richer and more comprehensive understanding of the transportation dynamics within the campus.

For the first three zones, which primarily consist of departments, the sample distribution includes 4 participants using alternative modes and 2 participants using individual cars. However, for the 4th zone, which encompasses dormitories, the 100. Yıl and Çiğdem neighborhoods, all participants were selected as alternative mode users.

Z1	4A – 2ICU
Z2	4A – 2 ICU
Z3	4A – 2 ICU
Z4	6A

Figure 5.18. Proposed Sample Distribution through Four Zones

After defining the sample distribution, a call poster was prepared to invite participants to the study. This poster was announced on the Facebook group '100. Yıl Evleri.' Interested individuals were asked to fill out a *Google Drive Form* for application, indicating their location and mode choices. The invitation poster specified the four zones and provided an overview of the frequency distribution and the locations of various transportation modes, corresponding to the different gates of the campus (see Appendix).

Participation Form for the Workshop on Developing Sustainable Transportation Scenarios for the METU Campus

Zone	Scope of the Zone	Participant ID	Modes	Primary Transportation Hub
Z1	Faculty of Economic and Administrative Sciences Faculty of Architecture Social Sciences Faculty of Arts and Sciences Civil Engineering (CE) Electrical and Electronics Engineering (EE) Computer Engineering (CENG) Industrial Engineering (IE)	P01	Alternative Mode	Faculty of Economic and Administrative Sciences
		P02	Alternative Mode	Social Sciences
		P03	Alternative Mode	Humanities Building
		P04	Alternative Mode	Faculty of Architecture
		P05	Individual Car Use	Faculty of Architecture
		P06	Individual Car Use	Faculty of Architecture
Z2	Food Engineering (FDE) Petroleum and Natural Gas Engineering (PETE) Mining Engineering (MINE) Geological Engineering (GEOE) Metallurgical and Materials Engineering (METE) Mechanical Engineering (ME) Civil Engineering (CE)	P07	Alternative Mode	Mechanical Engineering (ME)
		P08	Alternative Mode	Civil Engineering (CE)
		P09	Alternative Mode	Food Engineering (FDE)
		P10	Alternative Mode	Mechanical Engineering (ME)
		P11	Individual Car Use	Mechanical Engineering (ME)
		P12	Individual Car Use	Civil Engineering (CE)
Z3	METU Teknokent METU Housing Guesthouses and Graduate Guesthouse Western Dormitories (ID, FD, RA, 19th) Faculty of Education Aerospace Engineering (AE)	P13	Alternative Mode	Graduate Guesthouse
		P14	Alternative Mode	METU Teknokent
		P15	Alternative Mode	METU Teknokent
		P16	Alternative Mode	METU Teknokent
		P17	Individual Car Use	METU Teknokent
		P18	Individual Car Use	METU Teknokent
Z4	Eastern Dormitories 100. Yıl Neighborhood Çiğdem Neighborhood	P19	Alternative Mode	Çiğdem Neighborhood
		P20	Alternative Mode	100. Yıl Neighborhood
		P21	Alternative Mode	Çiğdem Neighborhood
		P22	Alternative Mode	100. Yıl Neighborhood
		P23	Alternative Mode	Eastern Dormitories
		P24	Alternative Mode	100. Yıl Neighborhood

- The alternative mode includes various forms of transportation other than personal car use, such as public transportation (buses, minibuses, metro, etc.), hybrid-multiple modes, biking, hitchhiking, car-sharing, and walking.
- Please remember to fill out the participation form for the study at https://ozgurluk.typeform.com/to/oCHI9zqc after entering your name and primary transportation hub in the designated area!
- Interviews will be conducted starting from 25.08.2021, scheduled according to the priority of form submission and mutually agreed upon dates and times.

Figure 5.19. Participant Distribution through Four Zones in the METU Map

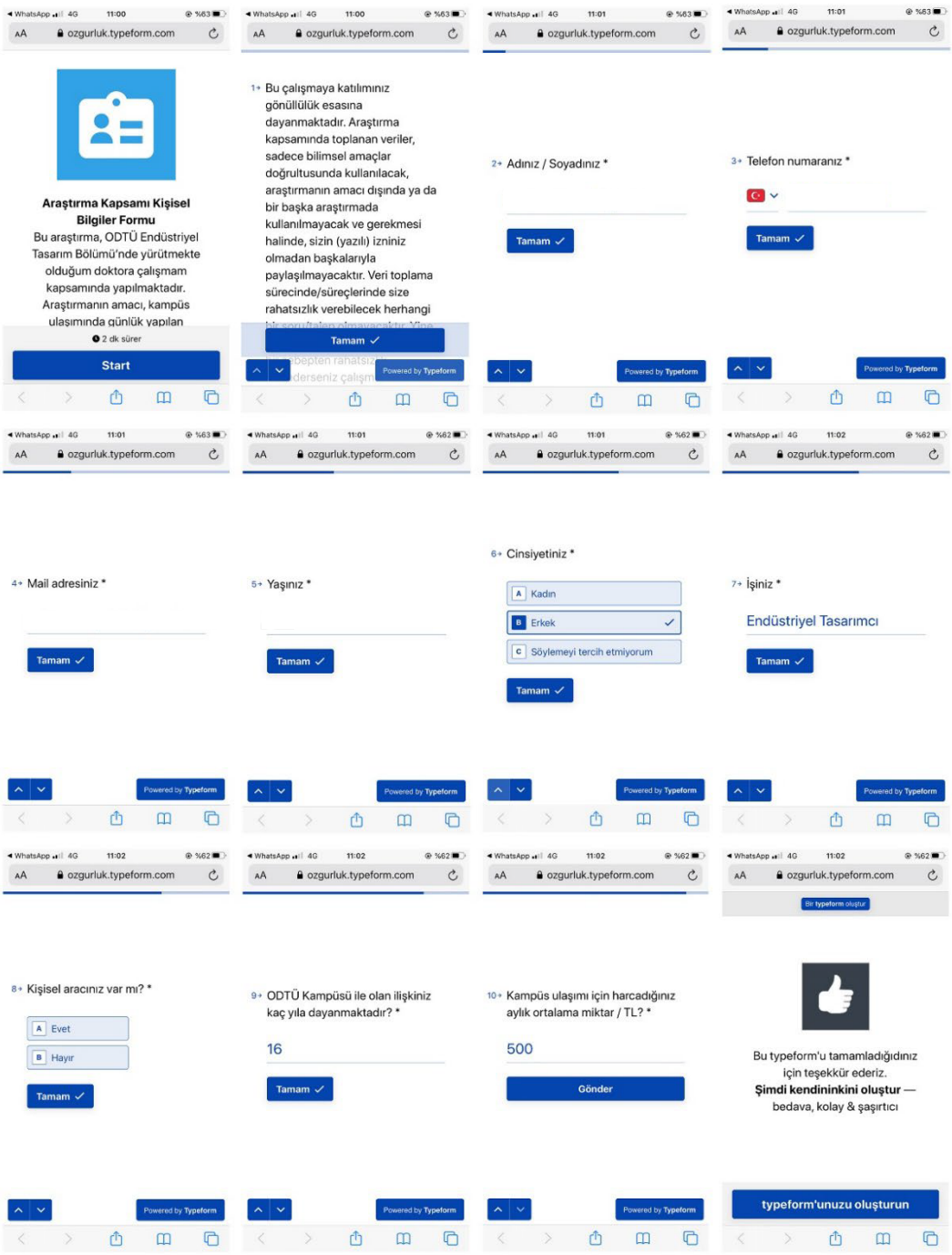


Figure 5.20. Personal Information Form Structure via *Typeform*

In the *Drive* form, there are notes below the table guiding participants to complete their personal information via the *Typeform* platform using a quick form. Participants' personal information is not requested through the *Drive* form, as it is a public platform and individual information must be kept confidential. This approach ensures that personal data is not shared with others who use the same form.

With an invitation call, participants were informed that the workshop will take place online, utilizing both *Zoom* and *Miro*, and will last approximately two hours. They are also notified that, as a token of gratitude from the researcher, each participant will receive an online gift card sent to their email addresses after their participation.

After the invitation call, 24 participants accepted to take part in the study, their participant ID, transportation preferences and primary trasportation hubs are presented in Figure 5.19.

5.3.2 Stage-I: Context Mapping / Conduct

Twenty-four participants were contacted via *WhatsApp* to schedule the meetings. Each meeting began with a 20–30-minute interview where participants described their mode choice behaviors and answered questions immediately after watching the campus transportation network video. Following the interview, participants were offered a 10-minute break if needed.

The generative session then commenced with an introduction to the subject on their individual *Miro* boards. For participants unfamiliar with *Miro*, the session included a brief tutorial on the tools to be used and a quick exercise to ensure they would not encounter any difficulties during the workshop. Finally, participants completed two sequential parts of the workshop: a word collage on certain subjects (past behaviors) and a visual collage (future expectations), with a 10-minute break in between.

Table 5.3 Generative Session Schedule

STAGES	DURATION	EXPLANATION OF THE STEP	EXPECTED OUTCOME OF THE STEP
Introduction	5 min	Introduction of the research	Participants are given the highlights about the project
Miro Introduction	10 min	Introduction of Miro interface and use	Participants are made familiar to use Miro properly
Miro - Quick Exercise	5 min	Practice of tools to be used in the study	Participants are expected to use Miro on their own to accomplish a task
Exercise 1 Introduction	5 min	Explanation of Exercise 1, Introduction of other tools	Participants get familiar to the tools they would use and understand the exercise
Make Part	20 min	In-depth story milestones	Participants create stories about their routines about campus related transportation activities
Say Part	5 min	Explanation of past user transportation behaviors	Participants tell and reflect on their stories deeply
BREAK (10 min)			
Exercise 2 Introduction	5 min	Explanation of Exercise 2	Participants are made familiar with the exercise 2 process
Make Part	20 min	Collage	Participants create a collage about their ideal routines
Say Part	5 min	Presentation of Collages	Participants tell and reflect on their stories deeply

The completed sessions with 24 participants took approximately 1.5 to 2 hours, varying slightly from one user to another. Each session was recorded for further analysis. After completing the sessions, participants were asked about their thoughts on both the subject matter and the session itself, with particular attention given to feedback from those using *Miro* for the first time. All participants mentioned that they enjoyed participating in the study and expressed a desire to recommend it to their friends.

5.3.3 Generative Sessions *Miro* Structure

Through the investigation of the previously mentioned generative session techniques, word collaging (for the first exercise) and visual collaging (for the second exercise) were favored for use in the study. In broader terms, participants were expected to narrate their past and current experiences in the first exercise using word phrases. In the second exercise, they projected their ideal campus journeys for the future using visual collaging techniques.

For conducting the generative sessions, online platforms such as *Miro* and *Zoom* were utilized. A premium *Zoom* account, provided by METU, was available to support meetings exceeding 40 minutes. Additionally, the *Miro* platform had been upgraded to an education board, allowing up to 100 participants to collaborate simultaneously.

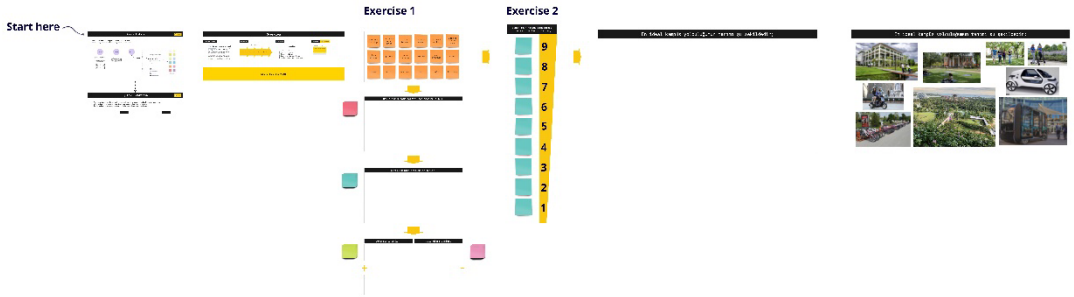


Figure 5.21. Generative Sessions *Miro* Template

The above figure provides a first glance at the overall draft cycle of the generative session template. As outlined, the session begins with an introduction to the study, designed to familiarize participants with the topic.

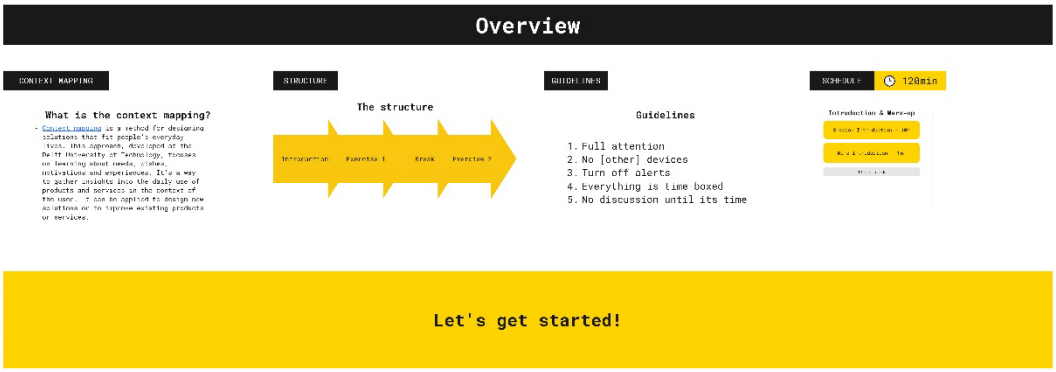


Figure 5.22. Generative Sessions Overview Instructions

For a five-minute overview, participants are introduced to the subject, the structure of the session, the session guidelines, and the session schedule.

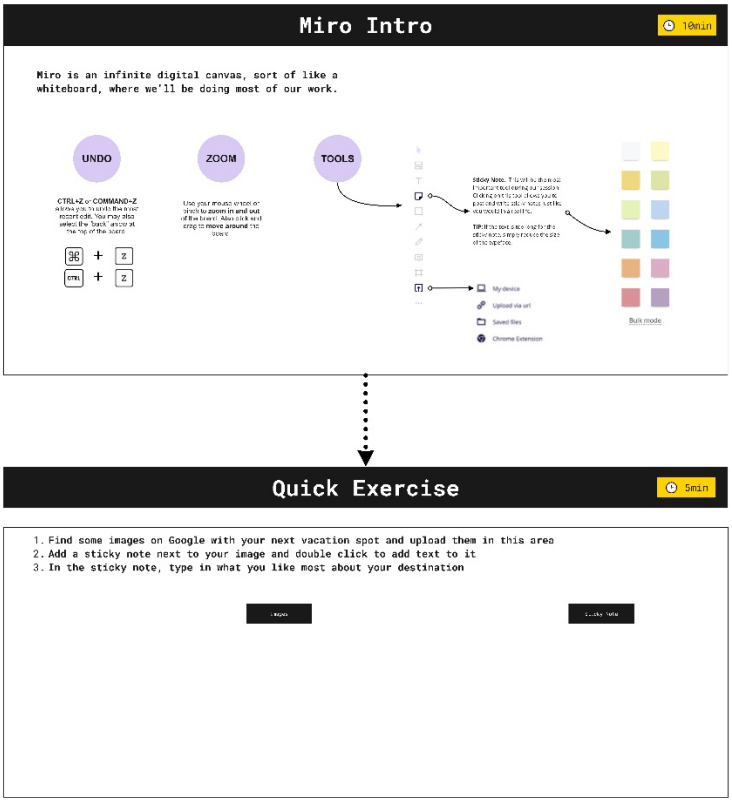


Figure 5.23. Generative Sessions Miro Introduction and Quick Exercise Brief

After the introduction of the research and the session, participants would be familiarized with the *Miro* platform and its basic tools, as some may not be acquainted with this specific platform. Following a brief introduction, participants would be asked to perform a simple exercise on *Miro*, utilizing certain tools to ensure they could navigate the platform smoothly. This exercise aims to ensure that the rest of the session can continue without any interruptions.

After Miro exercise, there is a 10-minute introduction to exercise-I of the session. During this introduction, participants are informed about the tasks they need to complete. Exercise-I consists of three parts. Drawing on their accumulated knowledge and experiences regarding their daily campus transportation behaviors, participants are expected to answer three questions in order using words and phrases. They can either use the provided examples at the top of their boards or add new ones based on their past and current experiences. These examples are intended to prompt participants and enhance the efficiency and diversity of the insights gathered.

The questions for each part and related column are:

A – I have adopted such a behavior on mode choices because…

B – The problems I face with this mode choice decision are…

C – The advantages and disadvantages of my decisions through my behaviors are…

Answering these questions and filling in the empty slots would take approximately 20 minutes, resulting in various individual stories from participants, referred to as ‘my journey story’. After completing this part, participants are expected to narrate their stories to the researcher, based on what they have assembled on their boards. Afterwards, there will be a second 15-minute break before beginning exercise-II.

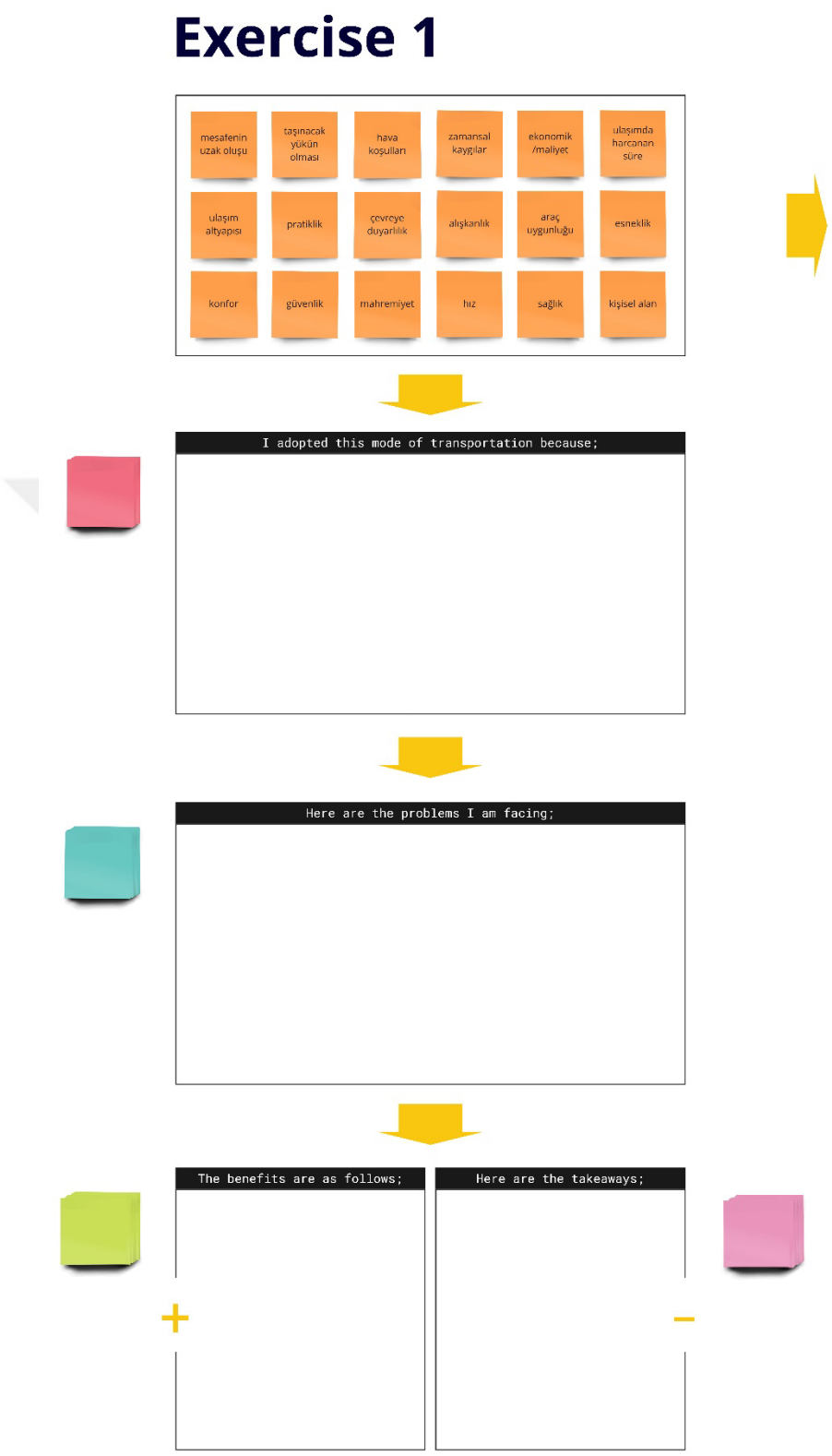


Figure 5.24. Generative Sessions Exercise-I Template

Later, participants are introduced to exercise-II after the break for 15 minutes. Following a similar timeline, they are expected to answer one question and create a collage based on it. This time, the aim is to obtain participants' future projections and desires for their ideal campus commute practices, differing from exercise-I. Exercise-II has two parts, the first of which involves answering the following question and making a priority order with words and phrases:

A – The most significant criteria about my campus-related transportation pattern are…

Participants are required to mention some individual criteria for an ideal journey scenario for themselves, in priority order. Then, they are expected to create a collage using images they find on the internet to express and reflect their ideal 'dream journey story'.

Similarly, in exercise-I, participants would narrate their individual stories to the researcher. They are expected to explain their stories using their collages, detailing what they want to express with each specific image they have placed on their boards.

Figure 5.25. Generative Sessions Exercise-II Template

Above, the structure of the generative session, exercise-II template can be seen. For the second exercise of the session, an example of a visual collage is provided for

those unfamiliar with creating such a board. The results of the individual Miro boards completed by all participants during the study can be found in the Appendix.

5.3.4 Data Transcription and Coding

Firstly, the recordings of all of the participants were manually transcribed. Both the initial interviews and the subsequent narratives of their past experiences (word collage) and future expectations (visual collage) were transcribed sentence by sentence into *Word* documents. Although participants were expected to document their experiences in phrases, in-depth reasoning and underlying motives were revealed as they narrated their stories in response to each question.

Once the transcriptions of all participants were completed, the data were reviewed thoroughly, and all significant points were highlighted for further coding (as shown in the Appendix). This detailed process ensured that the richness and depth of the participants' experiences and expectations were captured comprehensively for subsequent analysis.

5.3.5 Analysis

After completing the context mapping study with all 24 participants, the raw data, which had been transcribed and created, was transferred to the *Airtable* platform for further analysis and coding. The various items questioned during the stages were categorized under specific columns, and each statement made by the participants was coded under main themes and subthemes. These statements were then converted into codes, which were organized under main topics as a concluding remark of the analysis (see in Appendix).

As a result of the analysis, six different main topics emerged from the data: (1) infrastructural, (2) comfort, (3) temporal, (4) safety and security, (5) economical, and (6) environmental aspects. These codes were decomposed into two types of sources:

advantageous points (Pros) and pain points (Cons), under clusters of diversified groups of transportation modes. The transportation modes identified were: (1) More sustainable transport modes (walking, cycling, and scooters); (2) METU-related modes (METU ring shuttles, personnel shuttles, and hitchhiking); (3) Mass transport (minibus, bus, and metro); and (4) Car use (individual car use and taxis).

The analyzed sources, grouped under these transportation modes, were examined and elaborated upon. Similar pros and cons were combined and refined, resulting in approximately 50 sources (both pros and cons) to be used for Stage-II of the methodological plan of the study.

Figure 5.26. Stage-I Outcomes: More Sustainable Transport Modes

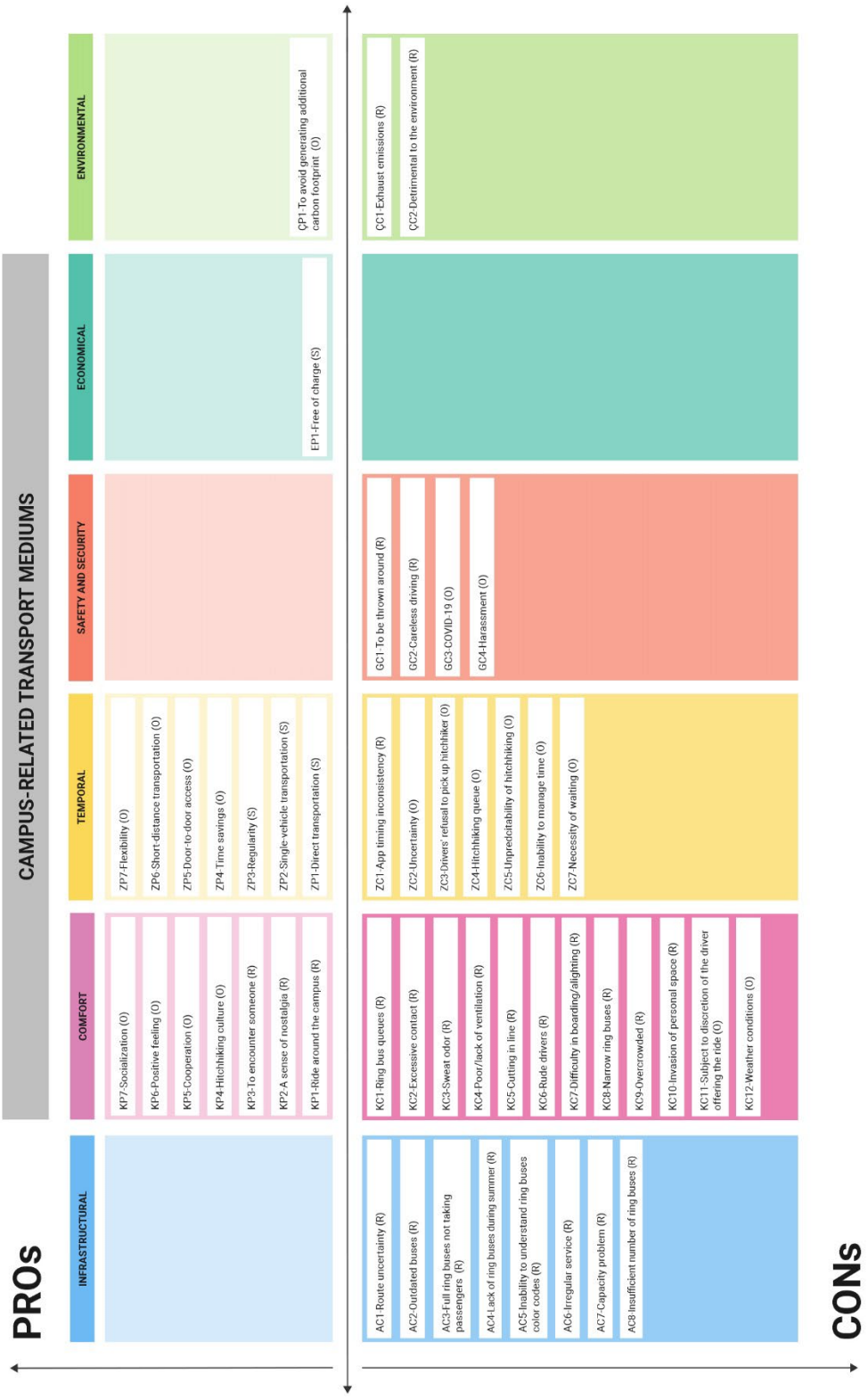


Figure 5.27. Stage-I Outcomes: METU related Modes

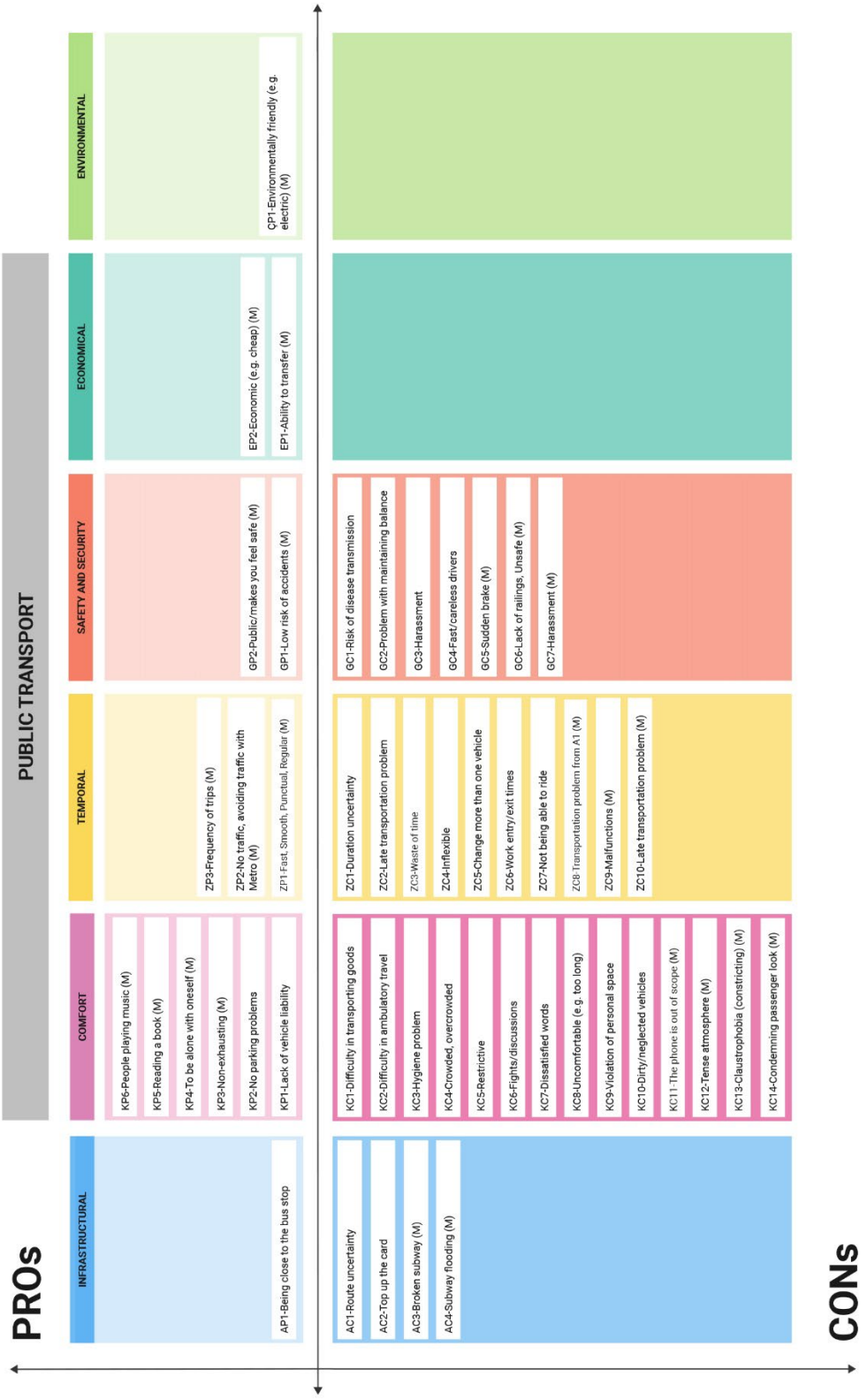


Figure 5.28. Stage-I Outcomes: Mass Transportation

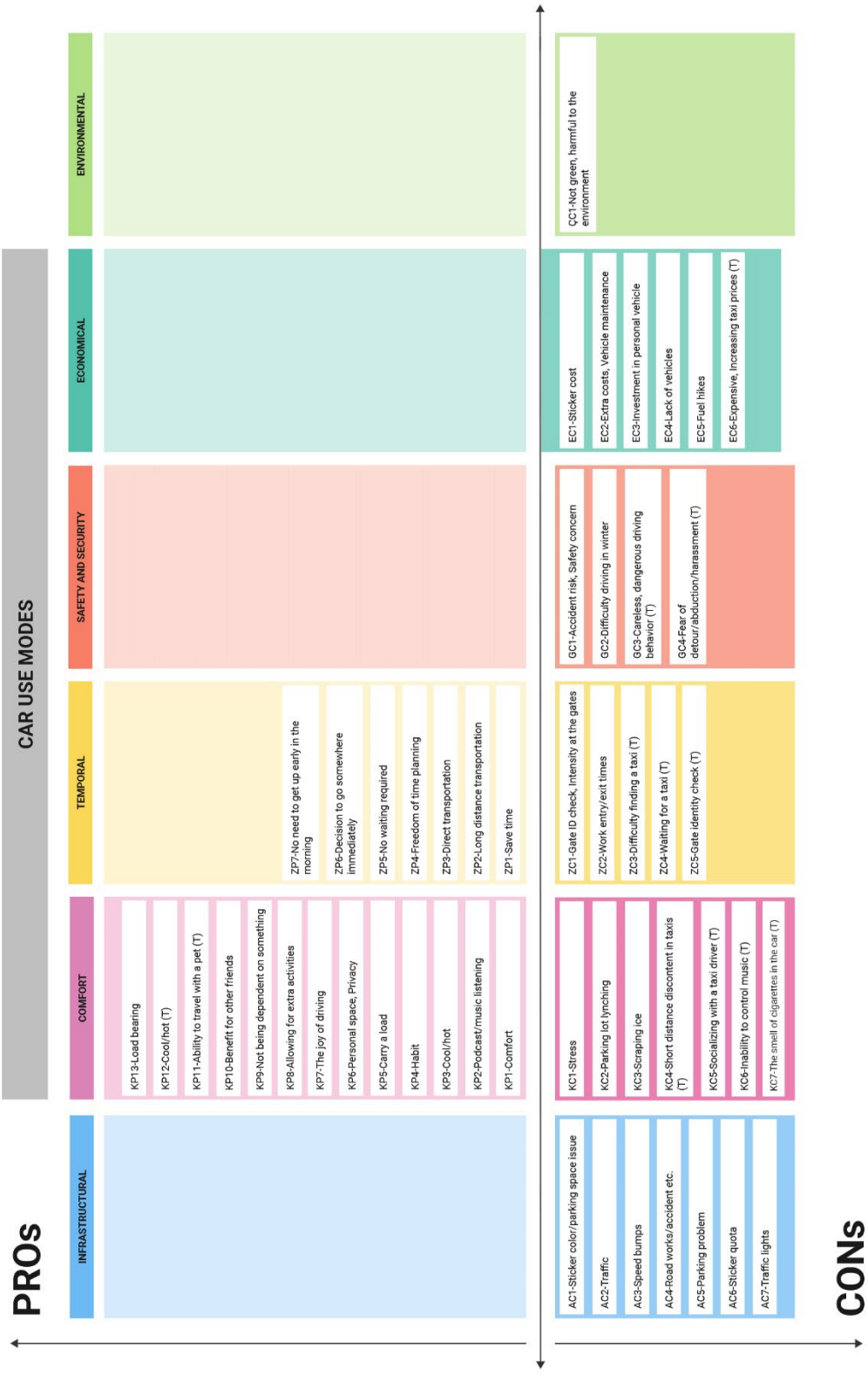


Figure 5.29. Stage-I Outcomes: Car Use Modes

CHAPTER 6

DEVELOPING DESIGN CONSIDERATIONS AND SUSTAINABLE USE SCENARIOS AS EARLY PROTOTYPES

Designing sustainable campus transportation systems requires a thoughtful and collaborative approach that leverages the expertise and insights of various stakeholders. One effective method for this process is through brainstorming sessions, which can generate innovative ideas and uncover practical solutions for reducing the social, economic, and environmental impact of campus mobility.

Brainstorming sessions in the design discipline can be particularly valuable for creating sustainable use scenarios for campus transportation. By engaging students, faculty, staff, and facilities planning professionals, these sessions can unlock a wealth of knowledge and diverse perspectives on the unique challenges and needs of the campus community (Luo, 2012).

A key aspect of these brainstorming sessions is the emphasis on "learning by doing". Involving end-users, such as students, in the decision-making process not only provides valuable input to campus planners but also has a profound impact on student learning and personal growth (Luo, 2012).

Furthermore, these brainstorming sessions should take a holistic approach to transportation planning, accounting for the complex and interrelated nature of different transportation modes. Rather than focusing on isolated actions, the sessions should strive to develop comprehensive strategies that address the overall mobility needs of the campus while prioritizing sustainability (Hipogrosso and Nesmachnow, 2020).

By fostering collaborative brainstorming sessions that bring together diverse stakeholders and emphasize sustainable design principles, campus communities can

generate innovative solutions for reducing the environmental impact of campus transportation (Velázquez et al., 2015; Luo, 2012).

In this chapter, the study continues according to the methodological framework by advancing into Stage-II of the research, which focuses on conducting *generative brainstorming sessions* aimed at developing design considerations and initial sustainable use scenarios. This chapter outlines the structure and execution of these sessions, provides a detailed analysis of the results, and concludes with a discussion of the key findings.

Stage-II: Brainstorming Workshop

For the second stage of the study, a workshop has been designed to develop possible suggestions for all sources of the four groups of clustered transportation modes [(1) Sustainable modes (walking, cycling, and scooters); (2) METU-related modes (METU ring shuttles, personnel vehicles, and hitchhiking); (3) Mass transportation (minibus, bus, and metro); and (4) Car use (individual car use and taxis)], focusing on both pain points and advantageous aspects. The METU Campus transportation network comprises diverse and numerous components, each requiring individual consideration and improvement through distinct and varied suggestions from its stakeholders. By collecting and analyzing these suggestions, a comprehensive understanding of sustainable transportation system solution intervention areas can be achieved. Therefore, each source is aimed to be covered by multiple participants to generate unique and diverse suggestions.

6.1 Sampling Strategy for the Study

Qualitative research prioritizes inductive theory development, subjective interpretation, and in-depth data collection, which is generally accomplished through the examination of systematically chosen small sample groups (Crouch and Pearce, 2013). Purposive sampling, which involves strategically selecting a population of

data sources deemed suitable for the research topic, is the most common sampling strategy in qualitative research studies (Crouch and Pearce, 2012; Mills et al., 2010).

For this study, purposive sampling has been adopted for study stage-II, which are specific to their participants and align with the study's objectives. This method ensures that the selected participants have relevant experiences and insights necessary for the research.

Senior industrial design students from the Department of Industrial Design at METU have been selected as the sample group for this workshop. In the year of 2023, 58 senior students were enrolled in the Industrial Design V course, which involved a studio project focused on service design solutions for electric vehicle (EV) charging in collaboration with *Aselsan UGES (Transportation, Security, Energy, Health, Automation)*. Given that this project addresses sustainable transportation system solutions, participants' extensive research on literature and field research phases had already sensitized them to the topic of sustainable transportation. The workshop was scheduled to take place between the ideation phases of their design proposals, following their initial explorations in both the literature and the field related to the subject scope.

6.2 Brainstorming Workshop Setup

An interactive online set-up using the *Miro* platform has been designed for the workshop, similar to stage-I of the study. Boards have been created for each cluster of transportation modes, with their sources inserted into these boards. Participants were provided with five different design intervention strategies, according to the categorization presented by Oğur Aydın (2021), for promoting sustainable use behavior while creating their suggestions for each source item. These intervention strategies are: (1) Informing; (2) Motivating; (3) Guiding; (4) Determining; (5) Engaging.

Participants were also expected to define user profiles associated with their system solutions if their solutions were user-oriented. These user profiles are characterized as follows:

- Critical-Careless (for infrastructural concerns)
- Mindful-Insensitive (for environmental concerns)
- Penny Pincher-Generous (for economic concerns)
- Worried-Carefree (for safety and security concerns)
- Comfort-Mania-Ignorant of Comfort (for comfort concerns)
- Punctual-Lazy (for time-related concerns)

Moreover, participants were expected to adjust their suggestions under different conditions such as daytime vs. nighttime, weekday vs. weekend, regular day vs. specific day, and peak hour vs. regular hour. Multiple suggestions were anticipated from participants for each source.

By engaging senior industrial design students in this workshop, the aim was to leverage their expertise and creativity to develop innovative and practical solutions for enhancing the sustainable transportation system at METU Campus. The outcomes of this workshop would contribute to understanding and addressing the transportation needs and challenges within the campus environment.

6.3 Brainstorming Workshop Conduct

The workshop was conducted during a regular ID 401 Industrial Design V course class session with the participation of 56 out of 58 enrolled senior industrial design students in a studio setting. All participants were informed about the workshop and its prerequisites beforehand, and consent forms (see Appendix) were shared with them prior to the session. The workshop was planned to last approximately four hours, effectively taking up half a day.

The session began with a brief overview of sustainability and sustainable transportation. Following this, the researcher explained the study's subject, detailing what had been accomplished so far and outlining the expectations for the workshop. Three additional colleagues assisted the researcher by facilitating the workshop, having been briefed beforehand.

First, a *Google Drive* document was shared with the participants, allowing them to select the transportation mode cluster they wished to work on with their partners. This document also contained *Drive* links that invited participants to access their specific *Miro* boards. Each pair was asked to sit near their team members. Initially, there were 55 students, resulting in the formation of 27 teams, with one team consisting of three students. One late participant was added to a group of two, leading to four transportation mode clusters being covered by 27 teams (sustainable modes - 7 teams; METU-related modes - 7 teams; mass transportation - 6 teams; and car use - 7 teams).

At the beginning of the workshop, participants were directed to their respective *Miro* boards. An example of a car use mode template can be seen in Figure 6.2. The workshop template was divided into two rows: the first row contained the descriptive part of the session, and the second row provided space for participants to address related sources with their suggestions.

Figure 6.1. Brainstorming Workshop Setting and Environment Photos 1,2,3

6.4 Brainstorming Workshop Structure

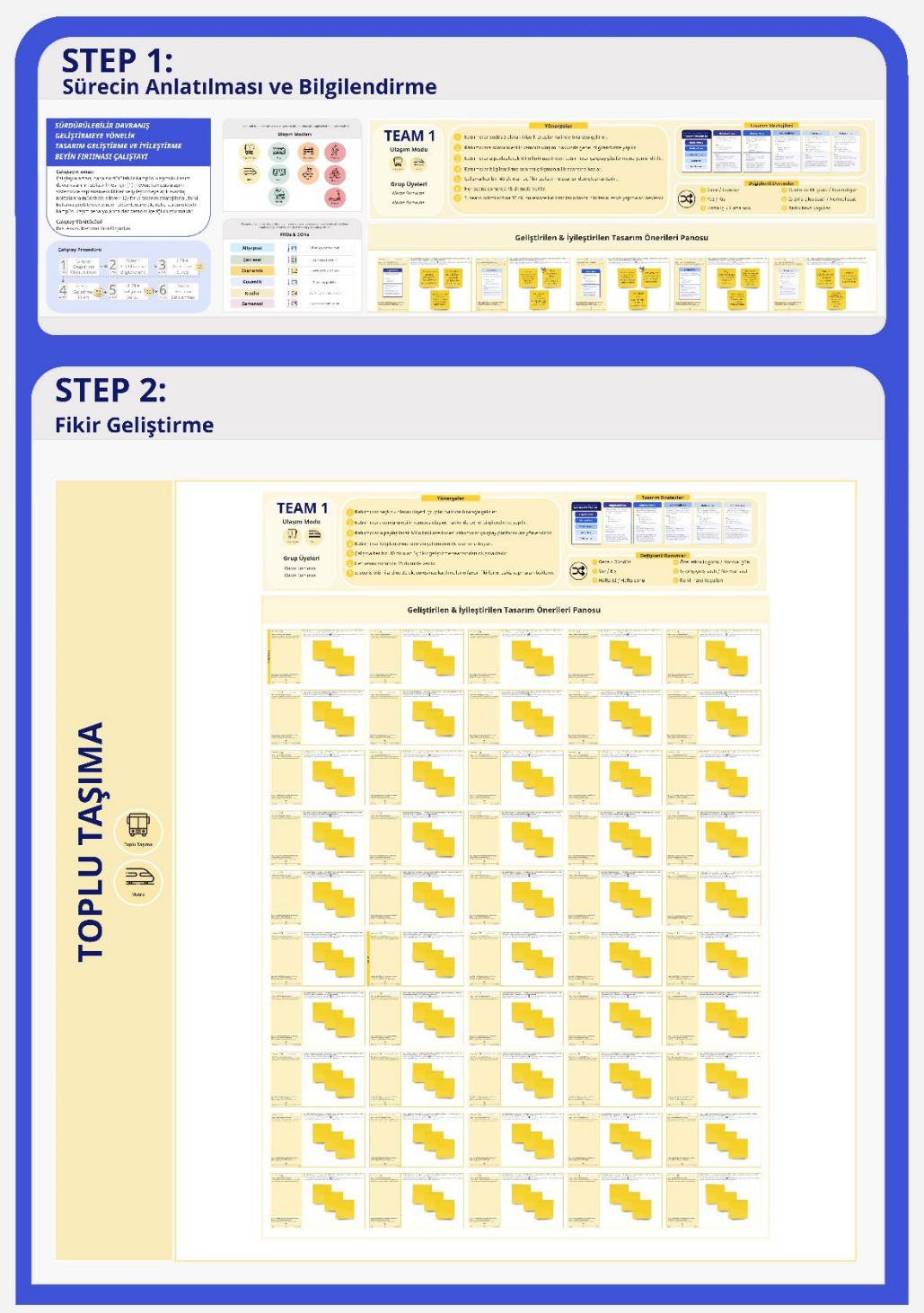


Figure 6.2. *Miro* board template for idea generation

In the descriptive part, the aim of the study is clearly stated.

Figure 6.3. The aim of the workshop

On the right side of the workshop aim, the transportation mode clusters are specified for each mode type, accompanied by visual icons. This visual representation helps participants quickly identify and focus on their designated transportation mode cluster, ensuring that each group works on relevant and specific issues.

The clusters include:

- **Sustainable Modes**: Icons representing bicycles, walking, and electric scooters.
- **METU-Related Modes**: Icons depicting campus shuttles, ring buses, and other university-specific hitchiking.
- **Mass Transportation**: Icons for buses, metro, and other public transit options.
- **Car Use**: Icons for private cars, and taxi.

These visual icons serve as quick references, guiding participants as they navigate their Miro boards and develop solutions for their assigned transportation modes. By organizing the clusters with clear visual aids, the workshop facilitates a more streamlined and effective brainstorming process, enabling participants to focus on generating actionable and innovative solutions tailored to each mode type.

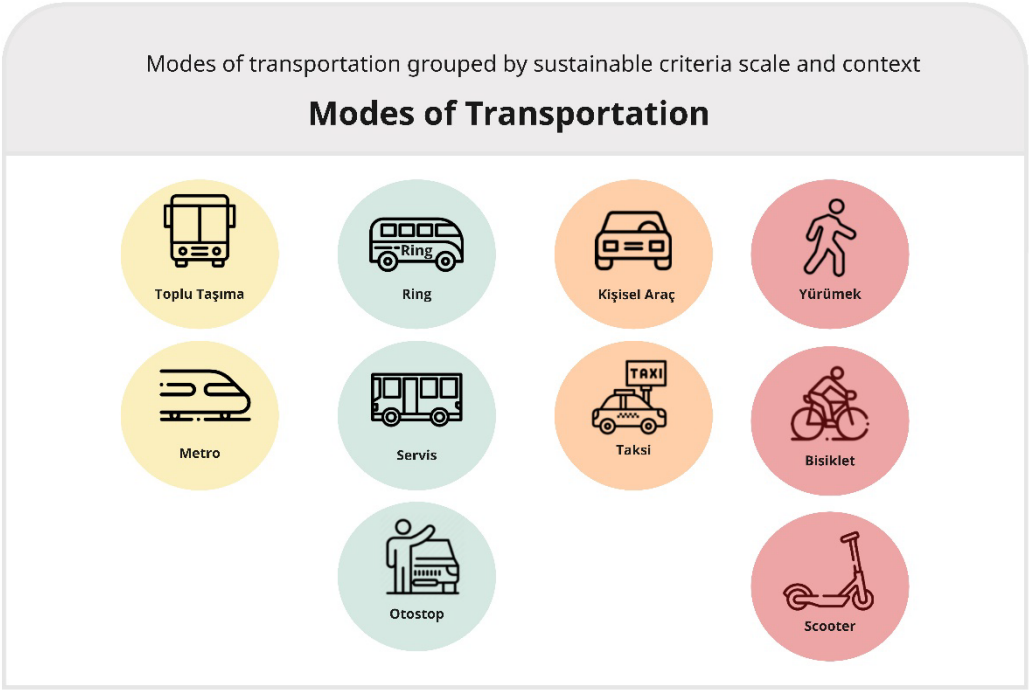


Figure 6.4. Transportation mode clusters

The descriptive part also includes the team number, team members, and detailed directions for the workshop. The session is planned into three brainstorming phases, each lasting 40 minutes, with two 15-minute breaks in between, making the total duration of the workshop 150 minutes.

- **Team Number and Members**: Each team is assigned a number and the names of team members are listed. This organization ensures clarity and allows facilitators to provide specific guidance to each team.

- **Workshop Directions**: Clear and concise directions are provided for each phase of the brainstorming session. Participants are briefed on the objectives of each phase, the expected outcomes, and the process they should follow.
- **Brainstorming Phases**:
    - **Phase-I** (40 minutes): Participants brainstorm on identifying and discussing the pain points and advantages of their assigned transportation mode.
    - **Break** (15 minutes): A short break to refresh and prepare for the next phase.
    - **Phase-II** (40 minutes): Teams generate possible solutions and suggestions for improving the identified pain points and enhancing the advantages.
    - **Break** (15 minutes): Another break to allow teams to rest and consolidate their thoughts.
    - **Phase-III** (40 minutes): Final phase where teams refine their solutions and prepare to present their ideas.

By structuring the workshop into these phases with designated breaks, participants can maintain high levels of focus and productivity. This setup encourages deep thinking and thorough discussion, ultimately leading to well-rounded and innovative solutions for sustainable campus transportation.

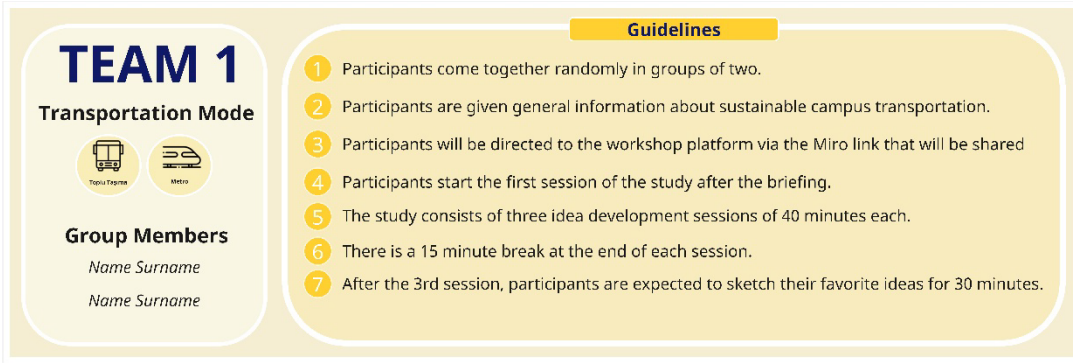


Figure 6.5. The workshop directions

The descriptive part also includes a detailed time plan spanning a total of four hours (240 minutes). This time plan ensures that the workshop runs smoothly and participants can effectively engage in each activity. The schedule is as follows:

- **Creating Pairs (15 minutes)**: Time is allocated for organizing participants into pairs and ensuring everyone is settled and ready to begin.
- **Briefing (30 minutes)**: Participants receive an overview of the workshop, including the aims of the study, the significance of sustainable transportation, and detailed instructions on the workshop process.
- **Brainstorming Phases (3 x 40 minutes; 2 breaks for 30 minutes and 1 break after)**
- **Sketching (30 minutes)**: Teams create sketches or visual representations of their proposed solutions. This visual component helps clarify and communicate their ideas effectively.

By adhering to this detailed time plan, the workshop ensures that each phase is given adequate attention, allowing participants to fully explore and develop their ideas. This structured approach fosters a productive environment conducive to generating innovative solutions for sustainable campus transportation.

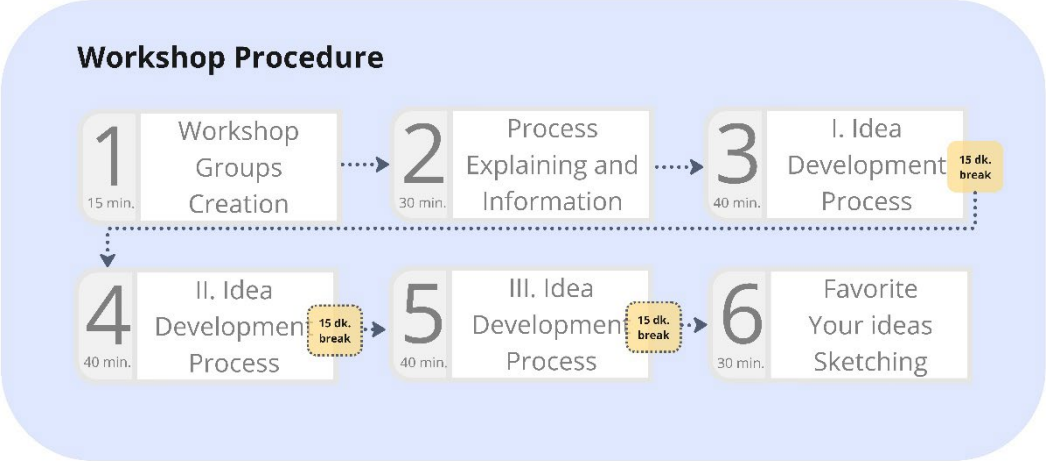


Figure 6.6. Detailed time plan of the workshop

In the descriptive part, there are also main themes under which sources are grouped, each color-coded for clarity. These themes are:

- **Infrastructural**: Addresses the physical and organizational structures needed for sustainable transportation.
- **Environmental**: Focuses on the impact of transportation on the natural environment.
- **Economical**: Covers the financial aspects, including cost efficiency and economic benefits.
- **Safety and Security**: Pertains to the security and safety of transportation methods.
- **Comfort**: Relates to the ease and convenience of transportation for users.
- **Temporal**: Deals with the time efficiency and punctuality of transportation modes.

These different sub-theme sources are further divided into two categories: pros and cons. Pros are marked with the letter 'P', and cons are marked with the letter 'C'. This categorization helps participants easily identify and focus on specific aspects of each transportation mode, facilitating more structured and effective brainstorming sessions.

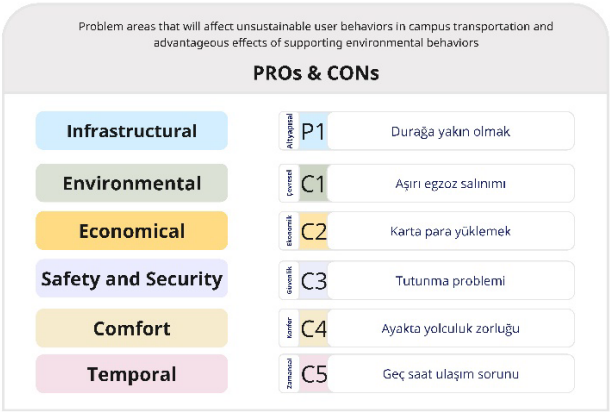


Figure 6.7. Sources according to their subthemes with examples

Design intervention strategy cards are located in the descriptive part along with conditional situations. These strategies are explained in detail and include specific examples related to transportation. The strategies are as follows:

1. **Informing**: This strategy involves providing users with necessary information to make informed decisions about their transportation choices. For example, real-time updates on bus schedules or information about the environmental impact of different modes of transport.
2. **Motivating**: This strategy aims to encourage users to adopt sustainable transportation behaviors through incentives and rewards. For instance, offering discounts or perks for using public transportation or cycling.
3. **Guiding**: This strategy focuses on directing users towards sustainable transportation options through signage, apps, and other navigation aids. An example could be wayfinding systems that highlight bike lanes or pedestrian paths.
4. **Determining**: This strategy involves creating policies or regulations that enforce sustainable transportation practices. For example, implementing car-free zones on campus or restricting parking spaces to encourage the use of public transport.
5. **Engaging**: This strategy seeks to involve users in the design and implementation of sustainable transportation solutions. For instance, organizing workshops or feedback sessions where students and staff can contribute ideas and solutions.

Conditional situations are also outlined, specifying how these strategies can be adapted to different contexts such as daytime versus nighttime, weekday versus weekend, and peak hours versus regular hours. This ensures that the interventions are flexible and can address various scenarios effectively.

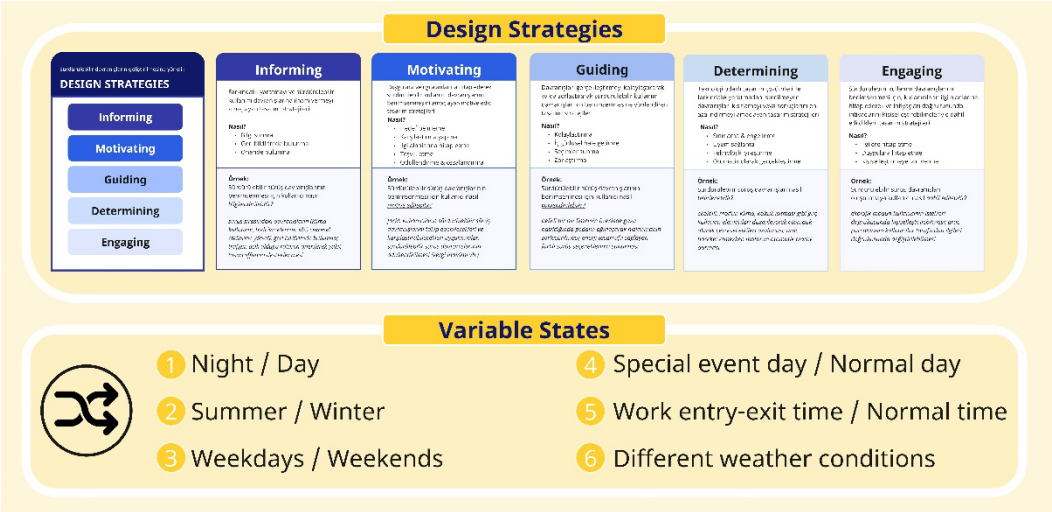


Figure 6.8. Design intervention strategy cards and conditional situations

Multiple suggestions for five randomly selected sources are provided in the descriptive part, each using the five different design intervention strategy cards. These examples are intended to guide participants on how to proceed through the brainstorming session. Here are the examples:

1. **Informing**:
    - **Source**: Lack of awareness about bike-sharing programs.
    - **Suggestion**: Develop a mobile app that provides information on the locations of bike-sharing stations, availability of bikes, and real-time updates on bike routes.
2. **Motivating**:
    - **Source**: Low participation in carpooling initiatives.
    - **Suggestion**: Implement a rewards program that offers incentives such as free parking passes, gift cards, or discounts at campus stores for students and staff who regularly participate in carpooling.

3. **Guiding**:
    - **Source**: Difficulty in navigating campus transport options.
    - **Suggestion**: Install clear and informative signage throughout the campus that directs students and staff to various transportation options like bus stops, bike lanes, and carpool pick-up points.
4. **Determining**:
    - **Source**: High use of personal vehicles leading to traffic congestion.
    - **Suggestion**: Enforce a policy that limits parking permits for personal vehicles and increases the cost of parking on campus.
5. **Engaging**:
    - **Source**: Limited student involvement in sustainable transportation planning.
    - **Suggestion**: Organize regular workshops and town hall meetings where students and staff can discuss transportation issues and propose solutions.

These examples illustrate how each design intervention strategy can be applied to address specific sources of transportation challenges. By providing these concrete examples, participants can better understand how to approach the brainstorming session and develop innovative solutions for improving the campus transportation system.

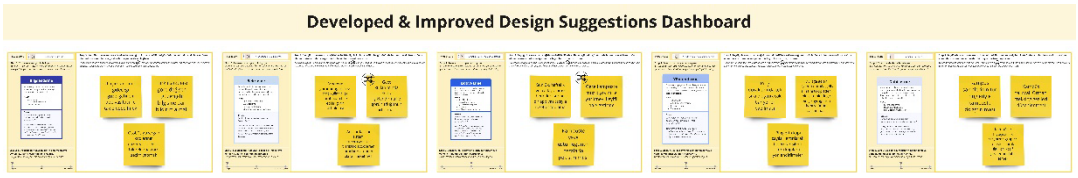


Figure 6.9. Developed and Improved Design Suggestions Board

Below, a typical cell for a specific source is illustrated. At the top left side of the cell, the source is mentioned. A blank space on the left side is provided for placing the selected strategy card or cards for the ideated suggestions. At the bottom left side of the cell, there is a scale where participants can slide user intentions among detailed user profiles if their suggestions are user-oriented. The right side space is designated for multiple ideation areas, accompanied by color-coded post-its and a shifter icon, which participants can use for conditional situations. This typical cell is multiplied 50 times for each source in the ideation part of the *Miro* board template.

By organizing the ideation process in this structured manner, participants can systematically address each source, apply relevant design intervention strategies, and consider user profiles and conditional scenarios. This setup ensures a comprehensive and detailed exploration of potential solutions for sustainable transportation on the METU Campus.

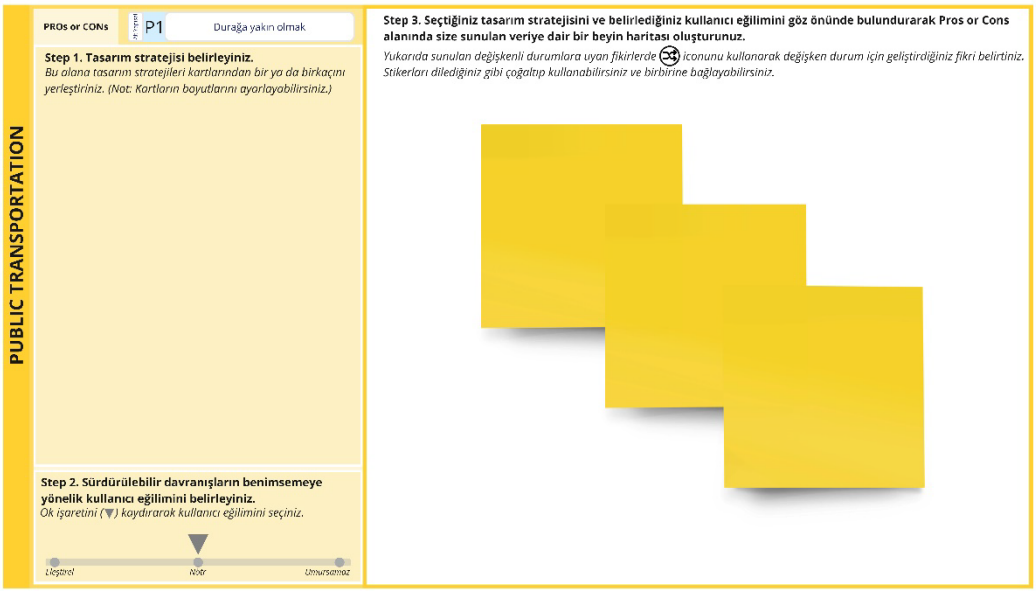


Figure 6.10. Typical cell space consisting for ideation multiple design suggestions

Participants approached the workshop session with seriousness, efficiently utilizing their time and generating multiple suggestions for each source provided (an average

of 3 solutions per source). They demonstrated professionalism in adhering to the schedule and were punctual during the breaks between phases. Each phase of the detailed time plan proceeded as expected, and the progress of the participants was monitored at regular intervals. The researcher and facilitating colleagues addressed all questions related to clarifying the sources, advancing the board, using design intervention strategy cards, and generating possible suggestions during the workshop process.

In the final 30 minutes, every team completed their boards by addressing all sources and began sketching their top 5 favorite ideas on blank papers, indicating the source code and team number on their sketches. After a collaborative four hours, the workshop concluded as scheduled.

After the workshop was completed, all participants were provided with an online form to evaluate the workshop and give feedback on specific criteria (see Appendix).

6.5 Analysis and Coding

After the workshop, the *Miro* boards of the participant pairs were revisited, and all the data on the boards were transferred to the *Airtable* platform for analysis, associating them with the pair group numbers. Each suggestion was grouped under a specific source code, with the group number indicated, and an example analysis table for each transportation mode cluster can be seen in the Appendix.

Once all the data from the participants was transferred for analysis, the total number of potential solution suggestions for the advantageous points and problematic areas of the METU transportation system was determined to be 2781. These suggestions were evaluated by the researcher based on their innovativeness, added value for sustainability, feasibility, and potential. Each transportation cluster was examined in relation to the six criteria identified in the previous stage: (1) comfort, (2) safety, (3) infrastructure, (4) time-related aspects, (5) environmental aspects, and (6) economic

aspects. The detailed discussion of these evaluations is presented under the next section, "Findings."

6.6 Findings of Study Stage-II

In this section, the transportation mode clusters created within the scope of the study [(1) More sustainable transport modes (walking, cycling, and scooters); (2) METU-related modes (METU ring shuttles, personnel shuttles, and hitchhiking); (3) Mass transportation (minibus, bus, and metro); and (4) Car use (individual car use and taxis)] and the concerns identified for each cluster [(1) infrastructural, (2) comfort, (3) temporal, (4) safety and security, (5) economical, and (6) environmental aspects] are discussed under separate headings. The improvement suggestions brought by the workshop participants for the advantageous points and the solution proposals for the pain points of each concern are analyzed and discussed.

6.6.1 Campus-related Transport Mediums

This section addresses the infrastructural, comfort-related, temporal, safety and security, economic, and environmental advantages and disadvantages of traveling using transportation modes associated with METU. The solutions and improvement suggestions provided by workshop participants for these points are analyzed, and the results are discussed under separate headings. Specifically, within the context of METU campus, these modes include campus ring buses, personnel shuttles, and hitchhiking/ride-sharing within the campus.

6.6.1.1 Infrastructural

When examining the existing ring buses within METU campus, several infrastructural disadvantages are highlighted: the routes are unclear for most users, the color coding of ring buses is not well understood, irregular service schedules, a

limited number of active ring buses, capacity issues, full buses not picking up passengers, the use of old-model vehicles, and the lack of active ring buses during the summer break.

The schedule, stop, and route information for ring buses is shared with users on the METU Transportation Operations Office website. Additionally, the real-time location of active buses within the campus can be tracked at *ring.metu.edu.tr*. METU campus has a ring system differentiated by seven color codes, each with distinct routes and schedules: yellow-red, light brown, turquoise, orange, navy blue, purple, and grey. Although maps for each ring are shared by the university, the variety and complexity of routes often present challenges for users in utilizing the system effectively based on their needs.

Workshop participants proposed several solutions for issues related to route ambiguity and color coding of shuttles: utilizing onboard screens for route tracking, implementing smart stops and interactive maps at stops for easy route tracking and information, making stop names more prominent, providing real-time feedback on the active status of rings based on user needs, and adding information signs about destinations alongside the color signs on the front windows of buses. Participants also suggested using different mapping methods to enhance color code comprehensibility, such as mapping stops with color coding according to the ring routes, coloring the buses for better visibility from a distance, and coloring the routes and paths.

For issues related to irregular shuttle schedules, suggestions included real-time tracking of ring status and minute-by-minute stop arrival times, knowing the exact time of the next service, organizing ring schedules to minimize potential delays during peak hours, providing onboard seating arrangement guidance to reduce boarding time, and implementing a rating system for drivers to ensure punctuality and care in service.

To address the issue of the limited number of ring buses and capacity problems, suggestions included increasing ring services by supplementing them with personnel

shuttles, adjusting the frequency of services according to peak hours or adding extra services during peak times, and increasing the standing passenger capacity by rearranging the seating layout. The most frequently proposed solution was encouraging and promoting alternative transportation methods like walking for short distances.

Lastly, regarding the absence of ring services during the summer months, participants emphasized the need for alternative transportation methods like bicycle and scooter sharing to meet transportation needs during summer and the renovation of old shuttle buses with technological upgrades or replacing them with more environmentally friendly electric models.

6.6.1.2 Comfort

The primary comfort-related advantages of ring buses include the convenience of circulating within the campus, the nostalgic feeling provided by old buses, and encountering acquaintances on the bus while going to classes. Improvement suggestions from workshop participants for these points included adding campus sightseeing shuttles, particularly for non-university users, to provide information about the campus. For encountering acquaintances, the idea of creating a social campus app was suggested. This app would allow users to share information about where their friends are, enabling them to use the same shuttle and act as travel buddies.

Comfort-related disadvantages of ring buses include long queues, cutting in line while boarding, difficulty boarding and alighting, narrow shuttles, excessive contact, personal space violation, crowding, odor issues, windows that do not open, lack of ventilation, and rude drivers. Suggestions for managing ring queues included redesigning stops, raising user awareness through guidelines, ground markings to organize queues, adding barriers to enforce lining up, and implementing a complaint mechanism for users who cut in line. Issues like excessive contact, personal space

violation, and crowding stem from the high usage of campus rings. Suggestions included increasing the frequency of ring buses, not exceeding a certain number of passengers, optimizing the onboard space layout to increase standing capacity, and promoting alternative transportation methods during peak hours.

For the issues of odor and lack of ventilation, continuous and active ventilation, especially during the summer months, was suggested. Additionally, adding open-top or convertible buses to the ring services during the summer was proposed. For rude drivers, suggestions included improving their comfort and the onboard spaces, implementing onboard camera systems, and introducing a rating system for drivers.

Regarding the comfort benefits of hitchhiking, the prominent points were a widespread culture of hitchhiking, a sense of mutual assistance and good feeling, and socialization. To enhance these benefits, the workshop participants mostly suggested creating a communication network via an app to systematically and efficiently organize hitchhiking, particularly for rides outside the campus. For the comfort drawbacks of hitchhiking, such as being at the mercy of the driver and weather conditions, suggestions included promoting hitchhiking awareness, especially among drivers, and making designated hitchhiking spots more defined and weather-protected.

6.6.1.3 Temporal

The only temporal disadvantage mentioned for ring buses is the inconsistency of service timing. Suggestions included placing information panels at stops to show the next ring arrival time, improving the real-time tracking system, and providing instant feedback on delayed rings.

For the temporal benefits of hitchhiking, the points mentioned were time-saving, door-to-door access, short-distance travel, and flexibility. The common suggestion for improving these benefits was making hitchhiking systematic through an app that

allows route sharing, reservation, and planned trips, particularly for morning and evening commutes.

The temporal disadvantages of hitchhiking included uncertainty, the need to wait, difficulty in time management, unpredictability, queues, and drivers not picking up hitchhikers. Solutions focused on making hitchhiking systematic through an app, prioritizing urgent trips, grouping queues by different routes, incentivizing drivers, and creating designated waiting areas with seating.

Personnel shuttles were only noted for their temporal advantages, such as direct transportation, single-vehicle travel, and regularity. Suggestions for improving these advantages included adjusting the number of shuttles based on neighborhood density, expanding shuttle routes, adding extra services at different times, implementing a reservation system, and ensuring that shuttles do not significantly impact campus traffic at the passenger drop-off and pick-up points. The most frequently mentioned issue by the workshop participants was that the personnel shuttles should also be used by students within their capacity or that student shuttles should be implemented in the same way as personnel shuttles.

6.6.1.4 Safety and Security

Safety and security disadvantages of ring buses included passengers being thrown around during the ride and careless driving by ring drivers. Suggestions included not exceeding a certain number of passengers, redesigning the onboard seating arrangement, and increasing the number of handrails. For careless driving, a system where students can monitor and rate drivers, and report any issues was suggested, along with onboard camera systems to monitor ring usage and campus traffic.

The most frequently mentioned security disadvantage of hitchhiking was harassment incidents, particularly involving non-university individuals. Workshop participants emphasized the importance of a system for recording and monitoring hitchhiking to

ensure mutual security, with mandatory registration of vehicle license plates. Thus, it is thought that such situations will be prevented as a discouraging factor.

6.6.1.5 Economical

As can be expected, campus rings and personnel shuttles provide services free of charge. At this point, they positively support campus transport in a sustainable manner and meet the transport needs of campus stakeholders to a significant extent. At this point, the most striking suggestion from the workshop participants is the introduction of free student shuttles, serving for intra-campus commuting, similar to the personnel shuttles. In terms of hitchhiking, it was stated that fuel sharing can be used in cases where hitchhiking will turn into regular and long-distance ride sharing with the help of a systematic system.

6.6.1.6 Environmental

Since most campus rings are old diesel models, their environmental impact is significant due to exhaust emissions. Workshop participants agreed on the need for technological upgrades or replacing ring buses with hybrid models. Regarding hitchhiking, the participants agreed that hitchhiking should be encouraged not to produce an extra carbon footprint and that individual vehicle users should be made more hitchhiking friendly in order to raise awareness on this issue. Promotions such as badges through the application that will provide motivation or discounts for sticker fees for individual vehicle users who hitchhike are among the suggestions made.

6.6.2 Public Transport

In this section, the advantages, and disadvantages of travelling by public transport in terms of infrastructural, comfort, safety, economic and environmental criteria are

discussed; the solutions and improvement suggestions of the workshop participants are analyzed, and the results are discussed under separate headings.

6.6.2.1 Infrastructural

For public transport, the most important advantage point that supports the preference of this mode is being close to the public transport stops. If the travelers are close to public transport stops, they can shape their travelling habits in a way to make their journeys by public transport. In terms of infrastructure, the service network of public transport and central location are the most significant issues in this regard. When the workshop data is analyzed, it is seen that the participants mainly suggested expanding the service network with improvements to be made in the public transport infrastructure while developing more sustainable suggestions on this issue. In cases where this is not possible, they suggested that the distance between the starting and ending point of the journey and the public transport stops should be covered by walking in the first place, or they suggested that this distance can be covered effectively by bicycle and scooter sharing methods in cases where this distance is too long. Another factor that is emphasized on this issue is the awareness of the public transport stops by users and the ability to track the information of the vehicles that will arrive at these stops instantly.

In terms of infrastructural problems related to public transport, route uncertainty specially for buses, loading money on the card in order to use public transport and technical problems such as technical malfunctions and flooding of the metro due to weather conditions are mentioned.

Suggestions regarding route uncertainty for buses include smart stops, in-vehicle information boards and instant route tracking via an app. All solutions are based on receiving feedback from travelers on where to go, what route to follow and how long it will take to travel. It is found important by the workshop participants that the users can be updated with the route information that changes due to infrastructural reasons

and can easily access the information about which vehicle they will use to get to their destinations.

It is considered valuable by the workshop participants that rather than increasing the number of kiosk points to load money on the cards required to use public transport, facilitating the payment method, and enabling payment methods that are easier and do not require extra effort through different platforms to make payments. Instead of constantly putting money on the card and keeping track of how much money is left, it would be easier to make monthly payments for continuous use, or to make payments via alternative mediums such as mobile phones and credit cards. Payment discounts and campaigns to encourage public transport according to the frequency of use are some of the suggestions developed in the workshop outputs.

According to the workshop outputs, in case of technical problems related to the breakdown of the subway, the users should be informed in advance if possible. If such a problem occurs at the time of travel, it should be ensured that their suffering is eliminated by alternative methods and the delays of the users during their travels should be kept to a minimum in such a case. For the risk of flooding of metro stations due to weather conditions, it is suggested that the stations should be reinforced with an infrastructure prepared for such situations and meteorological information should be provided to the users in advance for precautionary purposes.

6.6.2.2 Comfort

The most important feature that comes to the front in the comfort benefits of public transport is that compared to individual car use, public transport users do not have car responsibility and do not have parking problems. It can be very risky and dangerous to drive, especially in rainy and snowy weather when the weather is bad. In addition, due to being tired in the mornings and evenings, the time intervals with heavy traffic also carry this risk for individual car users. The stress of finding a parking space and the time lost finding a convenient parking space are among the

most important reasons for preferring public transport compared to individual car use. In addition, using the subway during peak traffic hours is considered to be a reason for preference in taking users to their destination more quickly by escaping the traffic of congested arteries.

The most problematic points of public transport are the difficulty of carrying things, the standing journey, lack of comfort, crowded environment, violation of personal space, inflexible nature, hygiene problem and stressful environment. Many of these issues arise in relation to each other. In the first place, when we look at the difficulty of carrying things, this is directly related to the crowdedness of public transport vehicles. According to the workshop data, the idea of creating storage cabins under the ceiling of the vehicle and under the seats in specialized areas such as intercity buses has gained a lot of importance. Difficulty in standing and comfort problems also come to the front as disadvantages that can be associated with the crowded environment, and the suggestions are stated as increasing the frequency of public transport schedules, especially during rush hours, increasing vehicle passenger capacities, not allowing more than a certain number of passengers in order to increase the comfort of travelers, and rearranging the vehicle interiors to increase efficiency. Another main disadvantage of public transport is the hygiene problem due to the crowd and the lack of maintenance and hygiene of public transport vehicles. At this point, the participants emphasize the necessity of frequent maintenance, cleaning and control of the vehicles and the need for adequate ventilation in the vehicles, especially in summertime. It is seen from the repeated statements that suggestions to reduce the crowd in the vehicle will bring a solution to the hygiene problem. Another important issue is the stressful environment, dissatisfied words, and arguments in public transport vehicles. In this regard, the participants find it useful to have emergency buttons in the vehicle, to provide a discouraging effect to prevent such situations with in-vehicle cameras, and to have penalty mechanisms for such situations. In case of conflicts with drivers, a penalty/reward system where drivers are evaluated by scoring them is suggested, while the most striking idea for all public transport users is to create an individual public transport record. In this way, it is

aimed to create a safe environment in which problematic people will be removed from the system, and at the same time, the sustainability of the system is ensured through discouragement. On the issue of the inflexible nature of public transport, instead of being limited to a certain time at night, it is suggested that flexible additional services be offered and that the service network be expanded. Finally, it is stated that a solution should be brought to the limited structure of the subway for internet access in terms of infrastructure; it is considered important for users to be online in the subway.

6.6.2.3 Temporal

There are only a few advantages mentioned in the time-related issues with public transport. For the subway, these advantages are the fact that the subway is not affected by traffic and carries passengers to the destination within a predictable time, its punctuality, and the high frequency of its journeys. In this regard, it has been suggested that the use of the subway can be promoted by sharing information with the users on how much time it will save compared to the use of individual car use, especially during peak hours and in areas with heavy traffic. On the other hand, many disadvantages of public transport in terms of time-related issues are revealed. The most significant issues are time uncertainty, time waste, the need to change more than one vehicle, peak hour transport problem, late hour transport problem, and in the case of METU campus, the problem of transport from A1 gate.

Suggestions made by the workshop participants regarding the uncertainty of the duration of the journey includes the ability to track the location of public transport vehicles via an app instantly, to receive feedback on the estimated time of arrival at the stop and reach the destination. Also, there is a necessity of receiving instant information on the extent to which the time is affected by factors such as traffic conditions, accidents, road construction, etc. during daytime. In order to minimize the time spent on public transport, workshop participants propose a better and broader public transport service network, as well as solutions to minimize the time

lost through faster boarding and unboarding at public transport stops. Similarly, for the necessity to change and transfer more than one vehicle, it is also suggested to improve the service network, while the idea of ensuring faster mobility among diverse transport vehicles when transferring is emphasized. In order to reduce the difficulties of traveling by public transport during peak hours, different suggestions are made. Some of these suggestions are to reduce the use of personal vehicles by encouraging ride sharing; increasing the frequency of public transport services during peak hours and incentive campaigns such as special discounts during these hours to encourage the use of public transport; and increasing the number of personnel shuttles. For late night transport problems, it is suggested that additional services should be offered or alternative sustainable transport modes such as bicycle and scooter sharing should be provided for late hours when public transport is not available. Finally, it is expected that the hitchhiking culture should be promoted and strengthened for the continuous transportation from the A1 gate to the campus and that the last-mile transportation solutions to be provided by the university should be made available at the gates.

6.6.2.4 Safety and Security

Regarding the safety concerns of public transport, the most important advantage of the metro is the low risk of having an accident. Workshop participants suggested that this condition should be emphasized, and subway should be encouraged in transportation.

The safety concerns and disadvantages of public transport on this issue are the risk of infection, the problem of holding on and sudden brakes, fast and careless drivers, the problem of harassment in public transport vehicles and the lack of guardrails in the subway. Against the risk of infection, the workshop participants suggest that the use of masks and disinfectants in public transport vehicles should be mandatory, the vehicles should be cleaned periodically, there should be proper and active ventilation in the vehicle, and the number of passengers should not exceed the capacity in order

to minimize the contact in public transport vehicles. In addition, a suggestion is also made to identify sick passengers in public transport vehicles and prevent them from being taken into the vehicle. It is suggested to increase and redesign the gripping elements for possible accidents and injuries that may occur during sudden brakes, while it is emphasized that overcapacity should be prevented in vehicles so that each passenger can hold on during the journey. To ensure a safe journey when using public transportation, it has been emphasized that there should be mechanisms for providing feedback on drivers' behavior. This includes reporting, scoring, and implementing reward or penalty systems for drivers who exhibit unsafe practices, such as speeding or driving carelessly, which may threaten passenger safety. In addition, it is suggested that recording the journeys of the drivers would be a discouragement for careless driving, and it would create a record of possible bad incidents. The suggestion that the use of autonomous vehicles would prevent such situations is also proposed by a group. Public transport vehicles are crowded places where personal space is violated from time to time. The most frequently mentioned solution by the workshop participants against possible harassment situations in the vehicle is the placement of in-vehicle emergency buttons and preventing such situations. In addition, monitoring the interior of the vehicles with cameras and punishments to be applied to passengers who attempt such situations are other suggestions. Finally, the lack of guardrails at metro stations and possible suicide attempts are identified as safety problems. In this regard, it was suggested to add guardrails and barriers to the metro stations and to implement a two-stage entrance system that opens only when the metro arrives at the station.

6.6.2.5 Economical

Public transport is considerably cheaper and more affordable than individual car use in economic terms. When economic considerations are taken into account, only the advantages of public transport are highlighted, and suggestions are made to use these advantages to encourage public transport. In particular, the comparatively low cost

of public transport and the ability to transfer between different modes of transport without paying extra fees are among the main economic factors that make public transport attractive. In order to encourage public transport in economic regard, the workshop participants suggest rewarding and promotions for those who use public transport regularly; making the gains obtained by using public transport visible and informing the passenger of this; campaigns such as extra privileges or discounts based on the frequency of use; and different fee plans at peak hours in order to reduce the traffic problem by encouraging public transport especially at peak hours.

6.6.2.6 Environmental

The environmental impact of public transport, especially the subway, is considerably less in terms of efficiency compared to individual car use in environmental aspects. For the promotion of public transport, workshop participants find it important to emphasize this difference and make it visible to users in order to be more conscious of the environment. In this way, it is considered that the awareness of users about environmental issues will increase, and an environmental consciousness will develop among users. It is considered important to emphasize the comparison of the environmental impact caused by individual car use and public transport use through campaigns, advertisements, etc. and to create public awareness. In addition, the suggestions that public transport vehicles should be electrified with technological improvements and be able to carry more people with less carbon emissions are also among the statements of workshop outputs.

6.6.3 More Sustainable Transport Modes

In this section, the advantages and disadvantages of travelling using more sustainable means of transport in terms of infrastructural, comfort, time-related, safety, economic and environmental criteria are discussed, the solutions and improvement suggestions of the workshop participants are analyzed and the results are discussed

under separate headings. More sustainable means of transport include walking, cycling and scooter use and are discussed under these three main headings.

6.6.3.1 Infrastructural

In relation to the disadvantage points related to the choice of more sustainable means of transport, the most critical points related to *walking* are: damaged roads, lack of pedestrian paths, secluded roads and poorly lit roads. When the workshop outputs are analyzed, the most fundamental solution suggestion developed by the participants for the damaged roads is to share the information about the damaged roads with the campus users through an application and to share with them the information that users should be careful when using these roads. In the short term, this suggestion is valid until the existing infrastructure is improved. In the longer term, it is suggested that the damaged roads should be renovated and the walking infrastructure reaching every point in the campus should be provided safely with high sidewalks along the main arteries and where it is missing, it should be improved to allow comfortable walking. In the expansion and improvement of the walking network, it was found important by the workshop outputs to examine the walking habits of the campus users and to make the routes that are frequently used instinctively easy to use.

Secluded and poorly lit paths were perceived by users as unsafe for walking, especially late at night, and forcing them to change their walking habits. The main solution suggested by the workshop participants on these issues is that every point in the walking network of the campus can be lighted during the dark hours with the energy to be stored in the morning hours with the help of solar energy. In addition, the continuity of lighting with motion sensitive sensors with the help of photocells was also expressed. Considering the energy efficiency of the campus in terms of lighting, it is among the suggestions to use the savings from unnecessary over-lighting at inadequate points. Some of the solution suggestions are to notify the points in need of lighting through an application and until a solution is found, these

routes should be travelled collectively in communication with users with similar transport motives.

Regarding the use of *bicycles* as a more sustainable mode within the campus, the lack of bicycle paths and infrastructure and insufficient bicycle parking issues emerge as disadvantageous points. Workshop participants emphasized the need to increase the extent of bicycle lanes and network to all parts of the campus. They suggested that this network can be expanded with separated roads to be built on the side of the vehicle roads and that the existing bicycle paths should be improved and made visible. Regarding the inadequacy of bicycle parking, they suggested that the number of bicycle parking spaces should be increased, the occupancy of these secure parking spaces should be monitored instantly, bicycles that have been abandoned in bicycle parks for a long time should be identified and brought back to campus use and as a result, bicycle parks should be used actively and efficiently.

The last means of more sustainable modes of transport are *scooters*. The disadvantages of scooters are that they are inefficient in meeting the needs of crowded environments such as the campus due to their one-person capacity, pavement occupation and limited sharing on the campus. In order to meet the deficiency of being inefficient, the issue of increasing their number comes to the fore. Scooter designs that safely allow two-person use were also mentioned as a solution. It was emphasized that scooters should use bicycle lanes and fines should be applied for those parked on the pavement. The use of shared scooters of private companies within the campus is not approved by the university rectorate. For this reason, it is forbidden to enter the campus with these scooters, and only individual scooters owned by users can be used on campus. The workshop participants agreed that if the university administration cannot allow this service provided by private companies on campus, it should support it with the scooter sharing infrastructure university will provide. This scooter sharing system provided by the university, which can be done with student ID, was considered very important by the workshop participants. It was found valuable that this service is supported by an application

and that each scooter on campus can be actively monitored and thus provides ease of use.

6.6.3.2 Comfort

When we consider *walking*, which is one of the more sustainable modes of transport, it is noticeable that this mode has many advantages. The most significant of these are; listening to music and podcasts, watching the surroundings, enjoying the view of the campus, health, sports, exercising, and the opportunity to socialize. In the suggestions for improvement made by the workshop participants regarding these advantage points, they first emphasized the need for safe listening to music with headphones while going from one place to another on the campus. It was found important to warn campus users who listen to music while walking in parallel with the campus traffic with visual signs at the points where they intersect with traffic. In addition, it was suggested to develop a platform where podcasts and music broadcasts prepared by METU stakeholders can be shared, and even common playlists can be shared for users travelling on foot on campus. In these playlists, users will be able to access the playlists they want according to the route distance and travelling time. In addition, in order to make walking around the campus more enjoyable, the suggestion of broadcasting music in the campus is among the suggestions for improvement.

In terms of walking around and enjoying the view of the campus, METU campus has a view that always fascinates users with its natural beauty and texture, and has viewpoints in certain places. Regarding the improvement of this advantage point, the workshop participants found it important to be able to instantly monitor the density information of these spots, especially when they want to spend time at these viewpoints. They also thought it would be useful to organize events at these spots and expeditions to introduce and teach the METU ecosystem, and to establish a platform where the moments recorded during these events could be shared.

Walking has numerous benefits for the human body in terms of health, sports and keeping the body fit. Workshop participants mentioned that this advantage of walking should be emphasized first and that it would be useful to support this with motivational visuals with the help of signboards to be placed on the campus.

It is known that walking is better for socializing with people you know and that it allows you to meet new people from time to time. In this regard, the participants found it valuable that users can find a walking buddy by adding their walking routes on a common platform. In addition, through this platform, a safer walking environment can be created for users in groups, especially at late hours.

The disadvantages of walking were identified as topography, slopes, being tiring, loss of effort, insensitive drivers, difficulty in carrying goods, sweating in hot weather, getting cold in cold weather and the psychology of not having a personal vehicle. Regarding the topography and slopes and in cases where walking is tiring, the workshop participants found it important to offer longer but less sloping routes to users as an alternative. In addition, another suggested solution is to make walking more enjoyable with a number of visual and auditory aids to forget the difficulty of walking.

One of the biggest problems faced by pedestrians while walking is insensitive drivers. Although there is pedestrian priority in the campus, this is violated from time to time, especially in rainy and snowy weather, and situations such as vehicles splashing water on pedestrians are serious comfort concerns. At this point, the workshop participants found it important to prevent this with improvements to be made in the infrastructure and the penalties and complaint mechanisms to be applied for insensitive drivers.

As walking is an activity that requires effort by nature, the obligation to carry items while walking brings extra effort loss and serious comfort concerns for users. At this point, storage lockers to be located in all faculties, in addition to this, in certain parts of the campus are the main solution to this issue.

In terms of sweating or getting cold while walking, the participants suggested water vending machines and disposable towel-like services along the walking paths, especially for hot weather, and indoor spots for shelter, especially for rainy and snowy weather.

Finally, it was found that those who have not yet bought their own personal vehicle, which can be associated with social status among campus users, feel bad at this point. Workshop participants emphasized that it should be highlighted that walking on campus is actually privileged compared to the use of personal vehicles and that it should be shared with the users that it is wrong to see this situation as a disadvantage by emphasizing the low carbon footprint produced as a more conscious individual while walking and making the respectful stance towards the environment visible.

When we look at the advantages of *cycling*, which is one of the more sustainable modes of transport, the elements of enjoyment, health, physical well-being, fitness and physical activity come to the fore. Considering that cycling makes you feel better and the economic aspect of owning a bicycle individually, the workshop participants found it important to offer a bicycle sharing service for its widespread use. In addition, it is thought that through a platform to be established, bicycle users can share their daily calorie calculation, and this will become a motivation by making it visible to other users.

The disadvantages of cycling are topography, slopes, fatigue, loss of effort, bad weather conditions and, as in walking, sweating, and getting cold. In terms of topography and slopes, the creation of alternative bicycle routes and resting spots for cyclists have been suggested. For weather conditions, maintenance and improvement of bicycle paths and instant warnings for bad weather conditions on the campus were preferred. Finally, as a solution to the problem of cyclists getting cold or sweating due to weather conditions, providing clothes lockers and changing rooms in bicycle parks was found valuable by the workshop participants.

While the advantages of *scooters*, one of the more sustainable modes of transport, are the sense of belonging for a certain period of time and the fun of use, the

disadvantages are the difficulty of carrying things. In the case of shared scooters, even using them enough for transport creates a sense of ownership in users, albeit for a short time. In order to further improve this, it was found important that scooters can also be personalized. As for the fun of scooter use, establishing a scooter committee and organizing group scooter activities to make it more enjoyable are among the suggestions. Regarding the difficulty of carrying goods, which is the disadvantageous point of scooter use, designing areas suitable for carrying goods for scooters, providing storage areas in scooter parking areas and also having backpack rental service are among the solution suggestions.

6.6.3.3 Temporal

As more sustainable modes of transport, walking, cycling, and scooters have many advantages in terms of time. Walking is highly advantageous in that it does not require waiting and is predictable. At this point, workshop participants found it useful for users to calculate the estimated time of walking routes through an application. In addition, this application will help them to save extra time by suggesting shorter routes when creating a destination. The other two modes of transport, bicycles, and scooters were also found to be fast modes of transport compared to alternative modes of transport and the fact that they do not require waiting was emphasized. At this point, for both modes, the workshop participants foresee that the time savings that users will achieve compared to other alternative modes should be made visible and this information should be shared with the users to create motivation for these modes.

6.6.3.4 Safety and Security

Some disadvantages of walking in more sustainable transport modes were identified in terms of safety. These are stray dogs on campus, careless drivers, pedestrian ignoring, pedestrian priority violation, risk of injury and slippery ground.

A large number of stray dogs, which are cared for by some student groups on the campus and whose number is increasing day by day, pose a danger to the residents of the campus. From time to time, it is known that dogs exhibit aggressive behavior towards users walking on the campus and undesirable situations are experienced. At this point, for the safety of the campus users, the workshop participants considered it important to mark the dog packs travelling in groups on the campus through mapping and to share this information with the users. Adequate lighting at every point of the campus, neutering the dogs on the campus and encouraging campus users to walk in groups of at least two on the campus are other solution suggestions. It was found useful to support the campus users with training by the campus animal lover groups on how to behave in unwanted situations where a pack of aggressive dogs is encountered.

The most important solution mentioned by all participants was to create a complaint mechanism for careless drivers and vehicles that violate pedestrian priority, since they are already registered in the campus license plate system, and to impose penal sanctions on these people.

Walking on the campus can sometimes cause the risk of injury or undesirable situations such as twisting a foot due to infrastructural reasons such as uneven ground. At this point, the workshop participants brought solutions for the separation, improvement, and regular maintenance of pedestrian paths to create a safe pedestrian network. Slippery ground is also a situation that makes walking difficult and poses a safety threat in snowy, icy, and wet weather. At this point, along with the previous solution suggestions, warning signs and markings for slippery surfaces and the closure of icy roads to pedestrian traffic were also suggested.

As with pedestrians, dogs are again a serious factor in safety concerns regarding cycling on campus. In addition, the fact that cycling is dangerous from time to time, the fear of theft or destruction of the bicycle, being ignored in traffic and slippery ground were considered as other factors.

For safe cycling on campus, solutions such as adding dog repellents to certain cycling routes of the campus, creating dog-free cycling routes, and adequately illuminating them, or integrating bicycle repellents on the bicycles offered by the bicycle sharing service come to the fore. Encouraging the use of helmets was considered important for possible bicycle accidents and resulting injuries.

Regarding the theft of bicycles parked on campus or the theft of bicycles by taking off some parts, workshop participants stated that bicycle parking areas with high security and monitored by cameras would be a discouragement. In addition, encouraging the installation of chips on bicycles is another suggestion.

As bicycle users often have to use car roads, they are very concerned about being ignored in traffic. Suggestions included the complete separation of bicycle lanes from vehicle roads, adequate lighting to ensure the visibility of cyclists at night, and the application of penal sanctions for careless and disrespectful drivers. It was also considered important to educate car drivers to pay more attention to cyclists, pedestrians and scooter users.

The safety disadvantages of the scooter, which is one of the more sustainable modes, are not being able to ride a scooter, the difficulty of travelling on the road and therefore the danger of vehicles, the danger of falling, and the lack of rear view due to the lack of back mirrors.

Scooters are relatively new to our lives and as a means of transport that everyone has not yet experienced, they can be challenging, especially for the first time of use. In order to ensure a safe ride by keeping the balance, the workshop participants found it important to provide initial training to the users and to facilitate the transition process with tutorials and simulations.

Again, as in the case of bicycles, the scooter should be routed on separated roads, and in the parts where it has to use the same road as the vehicle, the scooters should be sufficiently illuminated, especially for late hours. While encouraging the use of helmets for the danger of falling and possible accidents, it was stated that mirrors

should be attached to the scooters or mirrors should be placed at the junction points on the campus in order to see behind during use. The view that the blind spot sensor in vehicles can also be integrated into scooters in terms of detecting the vehicles behind and notifying the user is also among the outputs.

6.6.4 Individual Car Use

In this section, the advantages and disadvantages of travelling by private car in terms of infrastructural, comfort, time, safety, economic and environmental criteria are discussed, the solutions and improvement suggestions of the workshop participants are analyzed and the results are discussed under separate headings.

6.6.4.1 Infrastructural

The main infrastructural disadvantages of individual car use in the campus are parking space problem, vehicle stickers and sticker-related parking problem, vehicle sticker quota, on-campus vehicle traffic, speed bumps, traffic lights, road construction and accidents. Due to the insufficiency of the existing parking spaces in the campus in comparison to the number of vehicles entering the campus and the unbalanced distribution according to the departments, the parking space problem has been a serious issue especially in recent years. At this point, one of the most important solution suggestions of the workshop participants was to increase the number of parking spaces in line with the department capacity rates, and to solve this problem through multi-level car parks in order to prevent the damage to the existing campus environment. On the other hand, encouragement and widespread use of car sharing and hitchhiking were considered important in order to reduce on-campus vehicle congestion. In addition, the workshop participants found it valuable to detect and fine vehicles occupying campus parking spaces without stickers or inappropriate parking of vehicles with the wrong color vehicle stickers. Since long-term parking in parking spaces will increase the problem of not finding enough parking spaces in

practice, preventing parking for longer than necessary and even allowing parking for a limited and certain period of time in parking spaces when necessary and monitoring this is another proposed solution. Within the METU campus, certain parking areas are allocated to be used by the owners of certain stickers. At this point, parking spaces are categorized into 3 main groups as personnel, student and satellite. Depending on these groups, different types of stickers are created and the use of parking spaces is organized accordingly. In particular, the use of brown student stickers, which are called satellite, is restricted within the campus. On the other hand, yellow student stickers called as local are allowed to be used by students within a certain quota. At this point, for the parking problems that arise due to the vehicle stickers, the workshop participants found it important that the entry and exit of the parking spaces should be controlled with sensor doors that can be opened with vehicle stickers, or that the vehicles in the car parks should be checked regularly and frequently for their stickers and those who park inappropriately should be fined. In addition, increasing the visibility of parking spaces in a theme supported by the color of vehicle stickers was also one of the suggestions. The above mentioned issue of the quota of yellow student vehicle stickers is also one of the issues addressed for a solution. In this regard, it was found more important that the academic success of the students who will benefit from these privileged stickers should be the determinant rather than the price of this privileged sticker. Another solution is to design the vehicle stickers on the windscreen of the vehicle in a virtual and interactive way and to change the color of the virtual vehicle sticker according to the frequency of use and to turn it brown or to turn it into passive mode in case of prolonged non-use, thus gaining additional capacity for parking. With the increase in the number of daily vehicles entering the campus, serious traffic problems have arisen, especially in the peak hours. One of the main proposals in this regard is to reduce the number of vehicles entering the campus by encouraging the campus residents to use public transport. Some of the proposed solutions that will affect the current traffic density in the short term are the widening of the road especially at the departure points of the personnel services, increasing the number of ring services in on-campus

transport, increasing the number of controlled turnstiles in order to prevent congestion at the gates, and serious fines for drivers who park on the roadside, especially during peak hours, despite the parking restriction.

METU campus is a pedestrian friendly campus and in order to prevent possible unexpected accidents, it is designed with a large number of speed bumps to ensure that vehicles can drive slowly in the campus and pedestrian traffic flows smoothly. It can be characterized as a slow campus with these speed bumps and raised pedestrian walkways. However, from the perspective of vehicle users, these speed bumps do not seem to be the best solution for a slow campus. The participants of the workshop considered it important that the existing structure of the speed bumps should be designed in such a way that they do not cause damage to vehicles, and that their visibility, especially in the evening, should be increased with the necessary signs or even with glowing paint. Workshop participants agreed that a more appropriate solution would be to use electronic monitoring systems and speed cameras to control the roads within the campus instead of speed bumps, and to penalize speeding drivers with serious fines. Lastly, another suggestion was that vehicle roads should be constructed in different textures, such as walking paths, to prevent speeding.

Traffic lights can also be the cause of traffic congestion and even long queues. At this point, the fact that the METU crossroads will instantly direct the road use according to the density by smart traffic lights was found important. In the case of roadworks and accidents with material damage, the workshop users considered it significant to provide instant feedback to the campus residents of such situations and to be able to follow the traffic density instantly. The necessity to make road maintenance, watering and landscaping operations in the most quiet hours of the traffic is considered valuable in order not to affect the flow of traffic and to prevent possible accidents in terms of safety.

6.6.4.2 Comfort

When the comfort-based advantages of individual car use are discussed and the reasons why it is preferred are described, issues such as comfort, the opportunity to listen to podcasts or music in the vehicle, the ability to travel cool in summer and warm in winter, the habit of driving, the fact that driving allows carrying load, the personal space and privacy benefits of individual car use, the pleasure of driving, the possibility of extra activities and the benefit to other friends are highlighted.

In individual car use, there is certainly no risk of travelling standing, as in public transport, and there are many different features to make the user comfortable, depending on the vehicle model. Many car users tend to drive with the urge to get away from the crowded and uncomfortable environment, to protect their personal space, to be able to go wherever they want at any time and not to depend on anything else. It is also known that many personal car users are reluctant to hitchhike and car share in order not to compromise their comfort zone and privacy. At this point, the workshop participants support the creation of a reward mechanism for drivers in hitchhiking and car sharing, with the assumption that they can compromise their comfort, time, route and planning from the driver's perspective. Through a platform to be created, the ideas of encouraging drivers by scoring them and supporting them economically by splitting the fuel for ride sharing have been developed.

In terms of listening to music and podcasts, which is one of the comfort features in the vehicle, encouraging and guiding on-campus hitchhiking by reaching the drivers on the radio when entering the campus is one of the ways for individual car users to develop more sustainable transport habits.

For some users, driving may be a lifestyle that has become a habit rather than a necessity. At this point, workshop participants suggested that it is important to show the comparison of the economics of individual car use and using public transport in an app or on campus billboards. In addition, this feedback can be supported with about the damage caused by personal car use to the natural structure of the campus.

Other suggestions included encouraging car users to walk, especially for on-campus transport, and restricting vehicle access at certain points of the campus or completely closing some areas to vehicle access. Finally, it was concluded that it is essential to increase the efficiency of on-campus transport by encouraging car users to be a part of the hitchhiking and cooperation culture.

One of the advantages of individual car use is the comfort offered by car use in a more effortless way due to the excess of items to be used daily or the load to be carried. At this point, the workshop participants suggested that in cases where excessive loads are to be carried (such as moving to/from dormitories, carrying too many course materials), a mutual assistance platform should be created where other campus residents can communicate and share vehicles. In addition, the creation of special storage areas for students in faculties and departments was also presented as a solution to reduce the load to be carried.

Individual car owners sometimes prefer some gathering places or car parks within the campus for socializing. A4 gate car park and satellite car park are the places where people gather with their vehicles, while Mining or Petroleum Engineering car parks are the places where the vehicles on the campus are frequented for sunset. At such points, a kind of party atmosphere is created with different melodies coming from each vehicle. The participants of the workshop thought that it would be more valuable for the university to prepare those spots for such activities in a more organized way.

When considering the comfort-based disadvantages of individual car use, the traffic density and the stress faced by both traffic density and while finding a parking space and the lynching of those who park incorrectly in the university by other users, are considered as the disadvantages of individual car use. It has been suggested that individual car use can be discouraged by making visible the effect of the tiredness caused by driving to the campus in the morning and evening hours when there is heavy traffic and the stress experienced during the journey on the efficiency of the students during the day. In addition, workshop participants thought that it would be

possible to contact vehicle owners through vehicle stickers to identify drivers who park incorrectly, to score them on a common platform and to create sensitivity and awareness about driving behavior by leaving comments.

6.6.4.3 Temporal

Individual car use has many advantages, especially in terms of time. These advantages include time savings, long-distance travelling, door-to-door travel, flexibility in scheduling time for car users, no waiting time, the ability to make a decision to go somewhere immediately, and no need to get up early in the morning compared to travelling by public transport. Instead of improving these advantages, the workshop participants suggested that other modes of transport or other solutions could compete with these advantages and could reduce the use of the individual car. Some of the suggestions that can compete with the advantages of individual car use and make transportation efficient in terms of time are; increasing the frequency of ring services within the campus, encouraging ride sharing in order to reduce the fuel costs of daily individual car users coming to the campus especially from long distances and to make their transportation effective. Currently, there are *Facebook* car sharing platforms for *Batıkent* and *Eryaman*, which are relatively far from the campus. On this platform, drivers and passengers with similar travel times are matched by sharing their availability and share their journeys on a voluntary basis without any financial gain. Workshop participants consider it important to establish a more efficient and active platform where financial benefits can be left optional in a more systematic way. Another prominent suggestion was the establishment of a student neighborhood shuttle service that would bring and take students coming from distant places, especially in the morning and evening hours. Finally, since the dormitory capacity on campus is limited compared to the number of students, the accommodation of students residing in Ankara in the dormitories on METU campus poses a problem in dormitory applications. For this reason, another solution suggested by the workshop participants is to increase the dormitory facilities and

dormitory capacities and to allow students residing in Ankara to benefit from this right.

The time-related disadvantages of individual car use were identified as the congestion caused by identity checks at the gates and time losses as a result of rush hours at work entry and exit times. In order to prevent congestion at the gates, workshop participants consider it important to implement a drive-through system that monitors the drivers and occupants of the vehicles and to increase the turnstiles at the gates. Some of the suggestions made to reduce the congestion at rush hours are that the working hours of the *Teknokent* area on the METU campus should be rearranged in a way that would be synchronized with the start and end times of the university lecture hours. In this way, the density in the campus vehicle traffic will not peak between the same time stamps and will be decreased by being distributed over hours.

6.6.4.4 Economical

The economic disadvantages of individual car use were identified as the cost of stickers, extra costs and maintenance costs that arise due to car use, not being able to afford to buy a car within the financial means, and the increasing economic load of individual car use with the recent increases in fuel costs.

In the solutions developed by the workshop participants for these disadvantages, the most common solution suggestion was to share the costs due to the economic difficulty of owning a vehicle and the economic load caused using the personal vehicle for daily campus travels even if a vehicle is owned. In order to meet the economic load that individual car use will bring to individuals in every aspect, workshop participants consider it important for those travelling on similar routes to share their journeys through a more systematic platform. In this way, it is predicted that the number of vehicles entering the campus daily will decrease, the costs will be

shared by sharing the journeys, and a more sustainable and environmentally friendly approach will be adopted by using vehicle capacities more efficiently.

According to the workshop data on the use and pricing of stickers required for vehicles to enter the campus, it is expected that sticker fees should be raised to a discouraging level. In addition, it was emphasized that the priorities of the stickers should be reconsidered, and those in real need, those who are far away and who do not have alternative transportation should be prioritized. Finally, another frequently mentioned suggestion is that the annual stickers should be charged to vehicle users in monthly variable amounts by considering factors such as the number of entries to the campus, parking space usage and parking time via solutions such as a license plate recognition system, instead of a fixed fee.

For the solution of the economic difficulty of vehicle ownership, it has been concluded that this need will be reduced by increasing and diversifying alternative transportation methods to and from the campus. When transport needs are met, the use of personal vehicles by campus residents will no longer be a necessity. The participants of the workshop agreed that the university should enrich the transportation network with alternatives such as scooters and bicycles that can be rented on campus in the short term and tramway and electric vehicle services in the longer term. Thus, to the extent that campus transport meets the needs, there will be a decrease in the use of individual vehicles and alternative methods will become more important.

CHAPTER 7

A COMPREHENSIVE EXPERT REVIEW OF VARIABLES AND FACTORS

In the final phase of the study, referred to as Stage-III, the data obtained from the generative brainstorming sessions conducted with workshop participants in Stage-II was analyzed. These early prototypes (design interventions) of sustainable transportation scenarios were prepared for further evaluation and discussion by experts. The improvements suggested for the advantageous points and solutions proposed for the disadvantageous points in campus transportation were redefined as more inclusive variables and factors that influence and are influenced by each other.

In Stage-III, these variables and factors were evaluated through interviews with academic experts from various disciplines, who specialize in transportation sustainability and play a key role in shaping METU campus transportation strategies. The interviews aimed to assess the feasibility and sustainable added value of these variables and factors, while also examining the extent to which they influence and are influenced by one another.

The selected interview participants were specifically chosen to address the problem definition comprehensively. Fifteen questions were posed to these experts during the interviews, which were recorded and subsequently analyzed. This chapter details the limitations of the study, followed by a comparative analysis and presenting findings of the experts' similar and differing views on each variable and factor.

The analysis was conducted in two stages. Initially, the experts' responses to the same questions were compared, highlighting both commonalities and differences. This comparative analysis is presented with anonymized identifiers for each expert (P1, P2, P3). In the second stage, the responses were quantified as numerical values and further analyzed using a cross-impact matrix, which visualized and interpreted the relationships and influences between the variables and factors for each expert.

The values in the cross-impact matrix were summed and analyzed both collectively and individually for each expert. The comprehensive analysis revealed the interrelationships between all variables and factors impacting sustainable transportation on the METU campus. These relationships were visualized and interpreted, providing a deeper understanding of the interactions of the whole system nodes specific to the wicked problem which the study explores.

Additionally, the researcher's vision and positioning in addressing this wicked problem were briefly discussed, highlighting the importance of an inclusive and participatory approach. The study culminated in the development of alternative short, medium, and long-term sustainable transportation intervention areas for the METU campus, based on the matured prototypes that evolved through continuous stakeholder engagement and expert feedback. These interventions were designed to address user needs comprehensively, providing a valuable resource for developing sustainable transportation solutions on the METU campus.

7.1 Expert Reviewing Setup

The findings from the stage-II of the study were revisited, and the improvement suggestions for advantageous points and solutions for disadvantageous points proposed by workshop participants were elaborated. These suggestions were grouped under relevant headings and categorized into three main categories. The categories are: (1) administrative interventions within the scope of university management, (2) policy interventions within the domain of political will and related regulations, and (3) behavioral interventions that could be successful through the collective behavior changes and evolution of campus stakeholders.

The number of topics addressing administrative interventions is 78, with 177 suggestions generated by workshop participants. For policy-related interventions, 31 different points are addressed, with 67 suggestions ideated by participants. Lastly,

there are 24 topics concerning behavioral changes among campus stakeholders, with 56 intervention suggestions proposed by the participants.

Each suggestion was thoroughly analyzed to summarize the variables and factors that could directly or indirectly affect sustainable transportation at METU campus. These variables and factors are: (1) Improvement of ring buses, (2) Encouraging the spread of hitchhiking, (3) Expanding the use and network of personnel shuttles, (4) Improving walkability, (5) Improving cycling, (6) Providing bike and scooter-sharing infrastructure, (7) Taking measures for stray dogs, (8) Improving parking issues, (9) Reducing congestion at gates, (10) Promoting alternative modes, (11) Reducing the number of vehicles entering the campus daily, (12) Improving public transportation, (13) Solving late and peak hour transportation issues, and (14) Solving peak hour taxi access issues.

To thoroughly address these comprehensive and detailed variables and factors affecting campus transportation, interviews comprising 15 questions were designed. This interview aimed to gather in-depth insights from experts, focusing on how these suggestions could be implemented effectively, the potential challenges they might face, and their expected impact on the overall sustainability of the campus transportation system. This comprehensive approach ensures that the proposed solutions are both theoretically robust and practically feasible, thereby facilitating the development of a more sustainable transportation system on METU campus.

7.2 Selecting Participants: Experts

Initially, university faculty members with expertise in transportation sustainability and who have contributed publications on the topic were identified. Additionally, those who provide consultancy to the university administration and have played a significant role in shaping university transportation strategies were sought out. As a result of this research, three academicians were identified and contacted to participate in the interviews. These academics, who serve on traffic commissions in

the rectorate and have actively participated in the formulation of METU's transportation strategies, were selected for their comprehensive understanding and advisory roles.

Interviews were conducted with three academics—two from the Department of City and Regional Planning and one from the Department of Civil Engineering. This purposive sampling ensured that experts with diverse and relevant backgrounds could address the multifaceted nature of this wicked problem. Through their participation, the study aimed to evaluate and refine early prototypes of transportation interventions, allowing for maturation through expert insights and evaluations.

By involving these experts, the transportation scenarios were comprehensively examined, and the early prototypes were scrutinized and enhanced based on their specialized knowledge and practical experiences. This method not only validated the initial findings but also enriched the study with a depth of understanding crucial for developing sustainable transportation solution intervention areas for METU campus.

7.3 Interview Structure and Conduct

To develop more sustainable transportation intervention areas and supporting strategies for METU campus, the stage-I findings of the study were shared with the experts. These findings highlighted advantages and disadvantages of the frequently preferred transportation modes by campus users. Prior to the interviews, experts were sensitized to the topic by reviewing the data provided by the stakeholders, allowing them to gain a comprehensive understanding of issues at hand.

Consent forms, detailing what had been done so far in the study, its objectives, and the expectations from the experts during the interviews, were shared with the participating experts. Voluntary consent to participate in the study was obtained from all experts before proceeding with the interviews (see Appendix). During the interviews, experts were asked to share their valuable insights on the factors

influencing the identified transportation issues on the METU campus and how potential interventions might impact the overall transportation system. They were also queried about the feasibility of the proposed solutions in terms of implementation within the university context and the sustainable added value of these suggestions. Furthermore, experts were encouraged to provide information and comments on any past or current initiatives at the university related to transportation issues, how they have been addressed, and what the outcomes were. Lastly, the experts were invited to offer any additional insights or recommendations based on their expertise that might enhance the proposed interventions for sustainable transportation. The questions posed to the experts were as follows:

1. To what extent do you think it is possible to improve the systematic infrastructure of ring buses, which are the most crucial component of on-campus transportation at METU? How significant do you believe such an improvement would be for sustainable campus transportation?
2. How feasible do you think it is to encourage the spread of the hitchhiking culture and provide a safe and systematic hitchhiking infrastructure at METU? What impact do you think such an infrastructure would have on sustainable campus transportation?
3. To what extent do you think it is possible to reorganize and expand the network of METU personnel shuttles to be utilized by all METU stakeholders? What impact do you think the expansion of the personnel shuttle network would have on sustainable campus transportation?
4. How feasible do you think it is to improve pedestrian pathways, make the benefits of walking more visible, and mitigate its challenges at METU? What impact do you think such improvements promoting walking would have on sustainable campus transportation?
5. To what extent do you think it is possible to improve and expand bicycle lanes and provide secure bicycle parking at METU? What impact do you think these improvements to promote cycling would have on sustainable campus transportation?

6. How feasible do you think it is to establish a bicycle and scooter-sharing infrastructure to serve campus stakeholders at METU? What impact do you think the availability of bicycle and scooter-sharing options would have on sustainable campus transportation?
7. To what extent do you think it is possible to take measures for the stray dogs that occasionally pose a danger within the campus? What impact do you think such measures would have on sustainable campus transportation?
8. How feasible do you think it is to improve the systematic infrastructure of public transportation used for accessing and departing from the METU campus? What impact do you think improvements in public transportation would have on sustainable campus transportation?
9. To what extent do you think it is possible to solve the transportation issues during peak hours (start and end of the workday) and late hours at METU? What impact do you think solutions provided for these time periods would have on sustainable campus transportation?
10. How feasible do you think it is to address the on-campus parking issues arising from the increasing individual vehicle traffic? What impact do you think the resolution of parking issues would have on sustainable campus transportation?
11. To what extent do you think it is possible to reduce congestion at campus entry gates, especially during peak hours and special event days? What impact do you think reducing gate congestion would have on sustainable campus transportation?
12. How feasible do you think it is to solve the taxi access problem, especially during peak hours, at METU? What impact do you think resolving the taxi access issue would have on sustainable campus transportation?
13. To what extent do you think it is possible to make the cost-effectiveness of alternative transportation modes more visible, promote more environmentally friendly alternatives, and encourage users to adopt them at

METU? What impact do you think promoting alternative transportation modes would have on sustainable campus transportation?

14. How feasible do you think it is to reduce the number of vehicles entering and exiting the campus daily at METU? What impact do you think reducing campus vehicle traffic would have on sustainable campus transportation?
15. Apart from the mentioned topics, what other variables and factors do you think could improve campus transportation sustainability? Could you share their feasibility and potential sustainability benefits?

These interviews aimed to deepen the understanding of the experts' perspectives on sustainable transportation, incorporating their feedback to refine and improve the proposed intervention areas. By leveraging the knowledge and experience of these experts, the study sought to develop comprehensive and actionable strategies for a more sustainable transportation system on the METU campus.

The interviews were conducted face-to-face by visiting the identified academics in their offices. Each interview lasted between 1.5 to 2 hours and consisted of answering 15 questions. Before the interviews, the experts were given information about the doctoral study, a summary of the work done so far, and the workshop data to trigger their thoughts on the subject. Subsequently, the audio recordings taken during the interviews were transcribed for further analysis.

7.4 Limitations of the Study

The initial step in conducting expert interviews to evaluate the variables and factors influencing transportation on the METU campus involved identifying the appropriate individuals to interview. The focus was on those with decision-making authority concerning transportation strategies within the university administration. Consequently, priority was given to individuals with decision-making authority on transportation strategies within the university administration. Consequently, it was considered appropriate to reach out to the assistant secretary-general, given his

position in the rectorate's organizational chart, research areas, and psychology background related to behavior change. Following this, it was decided to interview the vice-rector responsible for transportation-related matters, who has a background in civil engineering. However, despite all efforts, attempts to meet with these individuals were unsuccessful. They politely indicated that they had no time to participate in the study and redirected the researcher to the heads of the Vehicle Operations Directorate and the Construction and Technical Affairs Directorate. Upon contacting these individuals, they stated that they were only responsible for implementing and supervising the decisions made regarding transportation, without any role in strategy development. This limitation restricted the study's ability to gather insights directly from those involved in the strategic planning of transportation policies at METU regarding campus transportation issues.

7.5 Analysis and Findings

Following the interviews with the experts, the responses from each expert were transcribed and compiled into separate documents. The analysis of this data was conducted in two stages.

In the first stage, the similar approaches and differing views provided by the experts on the same questions were organized and presented under related questions and overarching themes, with each expert specified. In the findings section, the participating experts are labeled as P1, P2, and P3, ensuring their personal information remains anonymous. Their detailed responses are compared and contrasted.

In the second stage of the analysis, the experts' responses regarding the variables and factors specific to METU campus transportation were numerically transformed by the researcher within a cross-impact matrix, assessing their interrelations. This comprehensive analysis will be discussed in detail in the section following the findings.

7.5.1 Findings

Following this section, the analyzed responses from the expert interviews will be presented. Each question will be addressed under comprehensive headings, comparing the views of the three different experts. The analysis will highlight both the similarities and differences in their perspectives, providing a detailed examination of each response.

Systematic Improvement and Sustainability Impact of METU Ring Buses

The systematic improvement of METU (Middle East Technical University) ring buses' infrastructure and the impact of this improvement on campus transportation sustainability were discussed with experts. The consensus was that increasing the number of buses and drivers, thereby increasing the frequency of trips, is essential. As the METU campus has expanded over time, with the construction of the west dormitories, the campus has become divided into two main areas of focus. The limited social activity areas, such as eating and drinking, in the west dormitory region necessitate students' access to the central area. The metro stations at the A1 or A2 gates result in campus access points being far from certain areas, particularly the engineering faculties, and similarly, the distance from the east dormitories to the preparatory building is quite significant. These factors highlight the critical role of METU ring buses in the campus transportation system and the importance of improving their systematic infrastructure.

The frequency of ring buses during peak hours ranges from 15-20 minutes depending on the type, while in the evening, the frequency drops to hourly intervals, concluding at midnight. Morning peak hour congestion at the gates is managed by 15-minute interval rings starting at 8:00 AM from the A1 gate with EGO buses, and 20-minute interval services from the A2 gate starting at 9:00 AM. However, the critical issue is that the capacity and frequency of these rings cannot meet the demand. During peak hours, a significant portion of ring bus usage is allocated to district services outside the campus, thus reducing the frequency within the campus. This is problematic as

peak hours are when the highest frequency is needed for campus access from the gates. A 15-minute interval, although seemingly short, can result in passenger loss and influence passenger behavior.

P1 warns that the efficient use of ring capacities can have both positive and negative impacts on sustainability. When ring buses are used for short-distance purposes, they detract from walking and alternative modes of transport, negatively affecting sustainability. Conversely, their use for long-distance purposes has a positive impact. Therefore, encouraging walking for short distances is crucial to ensure that ring buses are used by those who genuinely need them, preventing short-distance users from disadvantaging long-distance users. In addition, the low occupancy rates during evening hours and the extensive coverage of the ring route across the entire campus lead to inefficient use of resources. Moreover, the close proximity of ring stops and the approximately 30-40 stops in a single loop result in frequent stops and starts, extending the ring cycle time and reducing efficiency. Hence, P1 emphasizes the importance of supporting ring bus transportation with alternative modes and promoting walking for short distances to enhance efficiency.

P2 and P3 highlight the importance of free ring buses in encouraging accessibility and usage. P3, however, advocates for transitioning from rubber-tired buses to more environmentally friendly and higher-capacity sustainable solutions, such as rail systems.

In summary, the proposed solutions for improving the systematic infrastructure of ring buses initially focus on fully meeting the demand, which involves increasing the number of vehicles and drivers and, consequently, the frequency of services. Experts agree that solving this issue requires significant costs and state incentives or adjustments to METU's policies. Once the demand is fully met, further developments should focus on enhancing comfort (such as improving bus quality and renovating with new technologies) and user-friendliness (such as clear route information, real-time tracking, and smart stops), which are expected to greatly benefit the sustainability of campus transportation.

Evaluating the Sustainability and Viability of Hitchhiking Culture at METU Campus

According to the Turkish Language Association, the concept of hitchhiking (otostop yapmak) is defined as "a pedestrian stopping a passing car and getting a ride to their destination without paying" (TDK, 2020). At METU, a dominant car culture has, over time, led to a widespread and frequently utilized hitchhiking culture to meet transportation needs. Hitchhiking positively impacts environmental and economic sustainability by enhancing passenger efficiency and addressing transportation needs in individual car use. In this context, interviews with experts examined the potential impact of encouraging and institutionalizing the hitchhiking culture at METU on campus transportation sustainability.

Experts share similar views on hitchhiking. They believe hitchhiking emerged as a spontaneous supportive transportation method due to the inadequacy of existing transportation alternatives to meet immediate needs. The primary reason for hitchhiking is the university's inability to provide better alternatives. Furthermore, according to Traffic Law No. 5-2918, hitchhiking is legally prohibited. The law stipulates that even if someone picks up a friend, relative, neighbor, student hitchhiking, or a stranded person without obtaining a work permit/license from the relevant municipality, they will be considered in violation of the law. Violating this law can result in the vehicle being impounded and administrative fines.

Experts attribute this legal restriction to the safety concerns associated with hitchhiking. They argue that both the hitchhiker and the driver take risks, and the safety of both parties can never be guaranteed. P1 highlights that this practice, which is prevalent at METU, originated with good intentions and continues primarily because the METU campus operates as a closed transportation network accessible only to its stakeholders. Vehicles entering the campus either have stickers or the license plates of visitors are recorded.

P2 argues that the hitchhiking culture contradicts the principle of social sustainability. According to him/her, social sustainability means accessibility for

everyone. Hitchhiking does not fulfill this principle because there are gender-related differences in perceived safety. Female users or students and male students have significantly different perceptions of the reliability of this mode. Moreover, individuals with mobility constraints (such as vision, walking, or hearing impairments) are excluded from the system, thus failing to ensure accessibility for all.

Despite the anticipated negative outcomes of encouraging hitchhiking, experts agree that establishing a systematic infrastructure for car and ride-sharing could positively impact transportation sustainability. However, they emphasize that this practice would no longer be called hitchhiking. P1 notes that such systems are very new in our country and thus have legal gaps. Moreover, the university administration cannot solely bear the responsibility for managing the security risks and undesirable situations associated with hitchhiking. They suggest that private companies could manage this system, and only then would it be the university's duty to promote and expect the widespread adoption of such practices.

METU Shuttle Service Improvement and Its Impact on Sustainable Campus Transportation

METU administration provides shuttle services (semt servisleri) free of charge to academic and administrative staff, operating every weekday at 07:00 from residences to the METU campus and at 17:40 from the campus to residences, covering 33 different locations in the city. Considering last year's data, the student population is approximately 25,000, while dormitory capacity allows about 8,000 students to reside on campus, leaving the remaining population to commute daily from various parts of Ankara to the campus.

Increasing the capacity of these shuttle services to be usable by students and planning the service network to cover different parts of the city could directly affect and dramatically reduce the number of vehicles entering and exiting the campus daily, making it an important issue for sustainable campus transportation. As highlighted by P1 and P2, deciding whether to use private vehicles on campus is not solely an

on-campus issue. Instead, this decision is primarily related to transportation to the campus and the city's overall transportation policies, alternatives, and opportunities. For example, while metro access to/from the campus exists, the journey to regions like Eryaman or Batıkent is multimodal or requires a long duration due to the lack of direct transportation. Similarly, the Ayrancı minibus line emerged as a supportive solution due to the lack of public transportation.

Although directly supporting off-campus transportation for students with direct shuttles could significantly impact the quality of transportation and vehicle circulation on campus, it seems unlikely that METU administration can achieve this. Private universities offer such systems to students, but as experts similarly stated, the costs of existing staff shuttles are already very high due to increasing fuel prices. Hence, expanding this system and offering it free to students is neither feasible nor economically sustainable.

Despite this, experts believe that with state subsidies and planning in collaboration with the municipality, it could be possible. Experts agree on the potential of this proposal, stating that the shuttle system would create significant value for sustainable campus transportation. Only P2 emphasizes that if such infrastructure is planned with the municipality, it would be beneficial to determine the service network based on routes that do not compete with high-capacity transportation like the metro and according to student densities and demand. P2 also finds it important for the buses used in this infrastructure planned with the municipality to use dedicated lanes. Thus, while transforming multimodal trips to direct access to the campus, it would enable fast and comfortable journeys without being affected by peak hour traffic issues.

Enhancing Pedestrian Priority and Accessibility in METU Campus Transportation Planning

Since its establishment, the METU campus, which expanded based on the principle of pedestrian priority and the north-south-oriented alley, has grown over time, moving away from the main alley spine with the construction of dormitories in the east and west and the establishment of the Technopolis area. Consequently, the

principle of separating vehicle and pedestrian circulation in a complementary manner has weakened, with pedestrian paths in the east and west limited to very narrow sidewalks along vehicle roads.

P1 summarizes the disadvantages of narrow sidewalks in the METU campus as follows. According to him/her, while the alley was created with the intention of continuing the microclimate effect for shading and walking paths, the usability of sidewalks was not adequately considered in the landscape design. P1 points out that secondary sidewalks, designed to be approximately 1.5 meters wide, are more like tree paths. Because the sidewalks, planted with trees every few meters, narrow further as pedestrians pass by the trees with shy distance, making it impossible for two people to walk side by side. This requires constantly stepping on and off the sidewalk, making walking difficult. In support, P2 and P3 also note that sidewalks constructed after the main alley have not sufficiently separated from vehicle roads in the expanded campus, are narrow and impractical, and disconnected from the main alley. P2 suggests shared streets as a possible intervention, where pedestrians and vehicles can coexist, meaning that vehicle speed should be determined accordingly. He/she argues that a pedestrian-priority campus should demonstrate this through its design, making drivers feel the principle of pedestrian priority through self-explaining roads. P3 believes that campus expansion has prioritized vehicle-centric approaches over pedestrian needs and suggests that new pedestrian paths could be created based on frequently used pedestrian routes.

P1 and P3 also agree that during snowy and icy conditions, priority is given to clearing vehicle roads, while pedestrian paths are not adequately maintained. Additionally, fallen leaves on pedestrian paths can create slippery surfaces during rainy weather. P1 also criticizes the use of paving stones for sidewalks, arguing that usability should be prioritized over visual landscape.

To address the difficulties of walking, P1 suggests creating an app that provides information on the frequency of use of campus walking paths, the time required to cover certain distances, and allows real-time feedback on path issues, enabling

necessary adjustments and improvements based on user data. To encourage walking within the campus, P2 highlights awareness-raising campaigns as a key component of behavior change, suggesting various campaigns, such as student poster competitions on sustainability, short film contests, or health programs organized in collaboration with the medical center. P1 believes that the primary focus should be on infrastructural improvements to enhance walkability, followed by a system that rewards pedestrians based on the distances they walk, tracked through an app. However, He/she insists that ensuring safe pedestrian mobility should be the first priority. In this context, He/she emphasizes the importance of providing adequately lit, universal, healthy, well-maintained, and sufficiently capacious pedestrian paths.

Enhancing Bicycle and Scooter Sharing Infrastructure at METU: Challenges, Opportunities, and Sustainable Transportation Solutions

In the last quarter of 2021, a 6 km long bicycle path project planned in collaboration with the Ankara Metropolitan Municipality around the METU campus was completed. The bicycle path network extends between the university's main entrance gates A1 and A4; and between gates A2 and A7 and the western dormitories. The bicycle path is planned to be two-way and separate from the pedestrian path, intersecting with the vehicle road at only a few points.

Due to the large size of the METU campus and the widespread academic activity areas within the campus, the existing bicycle infrastructure does not provide access to every point. One of the main reasons for this is that the Alley, which forms the main axis of the METU campus, does not allow bicycle access due to its architectural structure and features, resulting in the existing bicycle network being disconnected from the Alley. Another reason is that a large part of the METU campus is registered as a forest area, and interventions in this area are prohibited by forest laws. To establish bicycle path infrastructure, it is necessary to inspect the ground, pour concrete, and construct the required infrastructure for lighting along the bicycle network.

The experts have varying opinions on expanding the scope of bicycle paths, improving the existing infrastructure, and establishing secure bicycle parks on the METU campus. P3 points out that using bicycles is a cultural practice and that there are countries where it is adopted as a collective habit. However, according to him/her, the culture of using bicycles for transportation does not yet exist in Ankara's urban structure and, by extension, on the METU campus. He/she cites the developing public transportation culture in Istanbul but notes that in Ankara, even multimodal transportation is not yet something that is willingly done or preferred.

P1, on the other hand, emphasizes the importance of evaluating the efficiency of the existing 6 km bicycle network. According to him/her, the use of the current bicycle paths and the demand for them are meaningful indicators for further expansion. If these paths are not used, they fall into disrepair, and their capacity is not well utilized. He/she highlights the importance of transitioning to shared systems if the current capacity and opportunities are not meeting the demand sufficiently.

P2 believes that having a campus where bicycles are used for transportation would positively impact METU's identity and contribute to a sustainable campus. While he/she thinks improving pedestrian conditions is more important, he/she believes that promoting a bicycle-friendly campus image would significantly influence user behavior. He/she does not want to overlook the possibility that not everyone can use or have access to bicycles. He/she asserts that the university administration's determination will be decisive and that a comprehensive and extensive bicycle network infrastructure can be established at reasonable costs in collaboration with the municipality.

The experts also provided different perspectives on establishing bicycle and scooter-sharing infrastructure on the METU campus and its impact on sustainable campus transportation. They generally focused on the potential benefits and feasibility of such a system.

The experts agree that bicycle and scooter-sharing infrastructure could positively impact campus transportation. These systems could make transportation within the

campus more sustainable and allow users to move faster and more efficiently. P1, P2, and P3 acknowledge that sharing systems could be theoretically effective.

P1 highlighted the inadequacy of the existing bicycle paths and emphasized the need to improve their safety. He/she suggested measures such as speed control and widening the bicycle paths. Additionally, he/she mentioned that scooters and bicycles should be integrated into pedestrian and vehicle areas in a suitable manner. P2 expressed concerns about the uncontrolled use of scooters and emphasized that they should be used with speed and safety measures. P3 pointed out cultural and practical challenges, noting that habits related to bicycle and scooter use in Turkey could affect the success of such systems.

Regarding the infrastructure for shared bicycle and scooter systems, the experts shared similar concerns. P3 expressed doubts about whether such systems could adequately meet the transportation needs of a large population. He questioned whether the solution would be too localized, whether it would meet the demand, and whether the investment would be worthwhile. Additionally, both P2 and P3 emphasized the need for serious monitoring and logistical mobility if the system were established. They noted that there are peak times during campus arrivals and departures, and commuter flow is not equally distributed throughout the day. Therefore, to compensate for crowded arrivals, rental bicycles or scooters would need to be continuously collected and transported back to the main hubs. Similarly, during peak departure times from the campus, the bicycles and scooters accumulated at the gates would need to be redistributed to the departments.

The experts also emphasized the need to consider cultural and practical challenges when implementing bicycle and scooter-sharing systems. P3 stated that users' habits towards public transportation and sharing systems in Turkey could affect the success of such projects. P1 stressed the importance of making the necessary infrastructure and regulations to ensure the safety of bicycle and scooter users.

Overall, all three experts agree that bicycle and scooter-sharing infrastructure could positively contribute to campus transportation. However, they emphasize that the

success of such systems depends on considering safety, infrastructure, logistical management, and user behavior. P1 highlighted the importance of infrastructure and safety measures, while P2 emphasized the importance of logistical management and preventing the uncontrolled use of scooters. P3 pointed out the cultural and practical challenges that could affect the success of such projects and advocated for more comprehensive transportation solutions.

Stray Dogs in the Campus: Challenges and Solutions for Sustainable Campus Transportation and Safety

Stray dogs within the campus have been identified as a significant issue affecting both sustainable campus transportation and overall safety. Experts agree that this problem needs to be addressed, though they offer different perspectives on potential solutions and their feasibility.

P1 highlights the serious dangers posed by stray dogs in public areas, emphasizing that this issue negatively impacts not only walkability but also the overall safety of the campus. This expert asserts that dogs should be controlled and that municipalities must take responsibility for this issue. He/she argues that current legal regulations are inadequate, as municipalities often collect stray dogs only to release them back into the community, which is not a sustainable solution. According to P1, stray dogs should not be present in public spaces, and it is essential to keep them under control.

P2 points out that stray dogs are particularly problematic in dormitory and residential areas, where they hinder people's ability to walk safely. He/she believes that controlling stray dogs would positively impact campus transportation. However, he/she emphasizes that this issue cannot be resolved solely through ODTÜ's efforts and that a national policy is required. This expert notes that dogs being abandoned in the campus from outside complicates control measures and adversely affects the campus ecosystem.

P3 suggests that stray dogs should be regularly collected and taken to shelters. Additionally, he/she stresses the importance of making pedestrian paths within the

campus more distinct and safe, suggesting that defining and securing specific pedestrian routes could be as effective as the collection of stray dogs. This expert believes that the design of pedestrian pathways within the campus plays a crucial role in mitigating the issue and that a planned approach could help reduce problems.

Overall, the experts' assessments highlight the negative impacts of stray dogs on campus transportation and propose various solutions. They recommend different approaches, such as the role of municipalities, legal regulations, and the organization of campus pedestrian pathways. Despite their differing solutions, they agree that addressing this issue requires comprehensive and sustainable policies.

Improving Public Transportation Infrastructure to and from ODTÜ Campus

Three experts agree that improving the public transportation infrastructure to and from the ODTÜ campus would significantly contribute to sustainable campus transportation. However, each expert emphasizes different critical points for these improvements.

P1 emphasizes that the public transportation system needs to be integrated with Ankara's general public transportation network, surpassing ODTÜ's boundaries. He/she suggests additional trips based on student demands and collaborative solutions with other universities. P1 proposes adding extra trips to match students' entry and exit times, noting that the municipality previously provided such services but no longer does. Additionally, P1 suggests creating a demand-responsive public transportation system among major universities along Eskişehir Road (ODTÜ, Bilkent, Hacettepe, Çankaya, Başkent) to alleviate the overcrowding on metro and bus services. This system could allow students to make reservations for specific times, enabling more efficient public transportation infrastructure managed by the municipality.

P2 advocates for improving public transportation infrastructure with solutions such as rail systems and dedicated bus lanes, similar to Istanbul's metrobüs. P2 also highlights the importance of enhancing minibus systems and integrating various

transportation modes to ensure efficient public transportation. Developing minibus systems that connect from peripheral points of the city to the campus and supporting high-demand areas with high-capacity public transportation vehicles are critical. Additionally, P2 stresses the need for high-quality, user-friendly public transportation services.

P3 points out the lack of comfort and management issues in the current public transportation system. Problems such as signalization issues and frequently malfunctioning escalators and elevators significantly affect users. The absence of a regular timetable and insufficient information prevents users from fully benefiting from the system. P3 emphasizes that providing public transportation is not enough; it must also be user-friendly and comfortable. Regular management of buses and metro systems, maintaining cleanliness, and well-planned boarding and unboarding points are crucial. P3 argues that the public transportation system needs serious management and operational consideration, noting that many people use public transportation out of necessity rather than preference due to comfort and management deficiencies.

In summary, all three experts agree that improving public transportation infrastructure to and from the ODTÜ campus would significantly contribute to sustainable campus transportation. However, each expert approaches the issue differently. P1 emphasizes the integration of the public transportation system with Ankara's network and proposes demand-responsive transportation systems and collaborative solutions with other universities. P2 advocates for improving the infrastructure with rail systems and dedicated bus lanes. P3 highlights the comfort and management deficiencies in the current system and stresses the need for user-friendly improvements. Collectively, their views suggest that comprehensive improvements in public transportation infrastructure are necessary for sustainable campus transportation.

Solutions for Campus Transportation Problems During Peak and Late Hours

Three experts agree that solving transportation problems during peak and late hours would significantly contribute to sustainable campus transportation. However, each expert addresses the issue from different perspectives.

P1 emphasizes the need to identify existing issues to solve transportation problems within the campus. The rush of preparatory students trying to reach classes during peak hours and the effort to clear the campus during lunch breaks create significant transportation problems. P1 notes that there is insufficient fleet capacity for motorized solutions and argues that those within walking distance should prefer walking. Additionally, P1 points out that ODTÜ was once an isolated campus, but now it is in the city's center, making integration with public transportation more crucial.

P2 advocates for increasing the frequency or capacity of existing public transportation lines during peak hours and adding new lines as necessary. Improving the metro line and introducing solutions such as new metro lines and metrobüs could facilitate access to the campus during peak hours. P2 also emphasizes the importance of improving public transportation services during late hours. The early closing and late opening of metro lines worsen this problem. Comparing Ankara to Istanbul, P2 notes that Ankara's public transportation services are more limited, especially on weekends, creating a significant deficiency. Providing better public transportation services to the university campus during late hours and weekends is essential for supporting activities such as student projects.

P3 suggests investigating the causes of peak hour congestion, noting that ODTÜ campus projects might have studied this issue. The ODTÜ College within the campus is primary causes of peak hour congestion. P3 highlights that Teknokent has solved this problem with its own services, but the transportation issue at ODTÜ College is more significant and needs resolution. P3 suggests solutions such as reducing the capacity of ODTÜ College or mandating the use of services for those above a certain age.

In summary, the experts agree that solving transportation problems during peak and late hours would significantly contribute to sustainable campus transportation. However, each expert offers different approaches. P1 highlights the transportation problems of preparatory students and the lack of fleet capacity for motorized solutions. P2 advocates for increasing the frequency and capacity of public transportation lines and improving services during late hours. P3 emphasizes investigating the causes of peak hour congestion and suggests solutions such as reducing the capacity of ODTÜ College or mandating service use. Collectively, their views suggest that comprehensive improvements in public transportation systems and managing peak and late hour congestion are essential.

Resolving Parking Issues Due to Increased Vehicle Density on ODTÜ Campus

P1, P2, and P3 offer different views on resolving parking issues due to increased vehicle density on the ODTÜ campus.

P1 highlights the insufficiency of existing parking capacity and the anticipated increase in vehicle ownership in the future. He/she notes that the rise in private vehicle ownership in Turkey will render current parking capacity inadequate. Due to Ankara's insufficient public transportation infrastructure, people prefer private vehicles, but the campus's limited parking capacity cannot meet this demand. P1 argues that private vehicle use should not be encouraged and that student vehicles should be restricted from entering the campus. Increasing parking capacity is neither possible nor sustainable, and public transportation should be promoted instead.

P2 contends that increasing parking capacity contradicts sustainable transportation goals. One of the main objectives of sustainable transportation policies is to discourage private vehicle use. Increasing parking capacity would undermine this goal by encouraging private vehicle use, conflicting with sustainable transportation policies. Private vehicle use should be challenging and costly, leading people to opt for alternative transportation methods. For example, P2 suggests that difficulty finding parking during graduation days encourages public transportation use,

arguing that making the current situation more challenging is more effective than increasing capacity.

P3 advocates for improving parking management through various measures. He/she suggests making certain parking areas paid and increasing sticker fees. P3 recommends increasing bicycle parking spaces and making parking management more systematic. For instance, allocating specific parking areas to particular groups and making these areas paid. Additionally, P3 proposes installing barriers at campus entrances and exits to control parking areas more effectively. P3 also suggests that regulations should be implemented regarding the use of parking spaces by ODTÜ College students and staff. Managing parking through fees and restrictions is essential for sustainable campus transportation.

Overall, the experts agree that resolving parking issues due to increased vehicle density on the ODTÜ campus is necessary, but each offers different approaches. P1 emphasizes that increasing parking capacity is not feasible and promotes public transportation. P2 argues that increasing parking capacity would counter sustainable transportation goals and advocates for measures that discourage private vehicle use. P3 recommends improving parking management, increasing bicycle parking spaces, and making certain areas paid. Collectively, these views suggest that comprehensive parking management and promoting public transportation are essential for sustainable campus transportation.

Reducing Congestion at Campus Entrance Gates

P1, P2, and P3 agree that reducing congestion at the ODTÜ campus entrance gates would contribute to sustainable campus transportation, but they offer different approaches.

P1 states that reducing congestion is challenging, especially for vehicle traffic. Turnstiles can be implemented for pedestrian traffic, but vehicle traffic is limited by existing roads and city connection points. Increasing private vehicle capacity would lead to more traffic congestion. Checks at the gates contribute to congestion, and the

lack of parking space worsens the issue. P1 highlights that irregular parking at gates, especially A1 and A4 gates, negatively impacts traffic flow, and municipalities and law enforcement fail to regulate roadside parking effectively.

P2 argues that reducing congestion at entrance gates can have positive effects but is primarily due to private vehicle use. Traffic congestion can push people toward alternative transportation methods, and solving traffic congestion is not always the right approach. The congestion experienced during event days can encourage public transportation use. P2 suggests that adding extra lanes at entrances might draw more vehicles, contradicting sustainable transportation goals. Traffic congestion can serve as a deterrent for private vehicle use, making it more effective to make the current situation challenging.

P3 believes that reducing congestion during peak hours and special event days is possible with various measures. He/she proposes monitoring vehicle entry and exit and tracking parking capacity. Tracking the number of vehicles entering and leaving parking areas can help manage congestion more effectively. Using occupancy indicators similar to those in airports and shopping centers can be applied to the campus. Limiting vehicle entry on specific days or events and monitoring parking occupancy rates is crucial. P3 also suggests measures such as prohibiting vehicle entry or implementing paid parking in certain areas during specific times.

In summary, the experts agree that reducing congestion at campus entrance gates would contribute to sustainable campus transportation. P1 highlights the limitations of existing roads and parking spaces and the challenges in managing vehicle traffic. P2 argues that traffic congestion can serve as a deterrent for private vehicle use and that adding lanes is not the solution. P3 emphasizes monitoring vehicle entry and exit, tracking parking capacity, and implementing specific measures during peak times and events. Collectively, these views suggest that comprehensive parking management, vehicle entry restrictions, and promoting alternative transportation methods are essential for sustainable campus transportation.

Solving the Issue of Taxi Access During Peak Hours on Campus

P1, P2, and P3 offer different approaches to solving the issue of taxi access during peak hours on campus.

P1 highlights that the existing taxi system and the number of taxi licenses are the root causes of the problem. Taxi licenses and operating rights are granted by municipalities, and the university cannot directly intervene. The number of taxis in Turkey is insufficient, and the elimination of alternatives like Uber has left the current taxi fleet inadequate for mobility needs. P1 suggests that metropolitan municipalities can establish vehicle-sharing systems to support public transportation integration, and campus vehicle-sharing systems can serve as taxi alternatives. However, legal guidelines and regulations need clarification before implementing such systems.

P2 argues that focusing on taxi stands at campus entrance gates would be more effective. Having large taxi stands at the gates would benefit users, especially those with mobility limitations. This approach would prevent the traffic congestion caused by taxis circulating within the campus. P2 emphasizes that taxi use is more sustainable than private vehicle use because it does not create parking demand. However, taxi incentives should not be uncontrolled, and taxis should serve by concentrating at gates without causing campus traffic.

P3 believes that solving the issue of taxi access during peak hours is possible with various measures. P3 points out that taxi licenses are fixed and regulated by municipalities, and establishing a university-owned taxi system involves legal and practical challenges. Instead, new taxi stands can be created around the campus, and the number of existing stands can be increased. For instance, facilitating access to the campus from nearby areas like Çukurambar and Bilkent can increase the number of taxis. P3 also suggests re-evaluating pedestrian pathways and ring systems within the campus, noting that the current systems are inadequate for the growing campus demand.

In summary, the experts agree that solving the issue of taxi access during peak hours would contribute to sustainable campus transportation, but each offers different approaches. P1 highlights the importance of the existing taxi system and vehicle-sharing systems, P2 suggests concentrating taxi stands at campus entrance gates, and P3 proposes creating new taxi stands and re-evaluating pedestrian pathways and ring systems. Collectively, these views suggest optimizing existing systems and supporting new regulations for improved campus taxi access.

Promoting Alternative Transportation Modes

P1, P2, and P3 offer different approaches to promoting alternative transportation modes and their impact on sustainable campus transportation.

P1 emphasizes that universities do not have the authority to provide transportation services like local governments, such as issuing fines or establishing companies for fee collection. While universities can conduct awareness activities, these efforts have limited impact. For example, organizing symposiums or symbolic no-car days can be done, but these initiatives face challenges. P1 argues that municipalities and local governments should be responsible for transportation policies.

P2 advocates that promoting alternative transportation modes can significantly impact sustainable campus transportation. However, this requires comprehensive and consistent policy packages. P2 divides these policies into "carrots and sticks," where carrots represent incentives and sticks represent penalties. Incentive policies include making bicycle use or walking more attractive and public transportation free. However, these incentives should be accompanied by policies discouraging car use. For instance, not addressing traffic congestion, limiting parking capacity, and implementing car-free campus policies are necessary measures. Increasing parking fees and introducing regulations that make car use difficult can discourage private vehicle use. Additionally, P2 emphasizes the importance of awareness campaigns to educate people about alternative transportation modes.

P3 believes that promoting alternative transportation modes is beneficial, but it should go beyond information dissemination. P3 suggests that reward and penalty systems can be more effective. For example, rewarding those who follow specific rules and penalizing those who do not can encourage alternative transportation use. Increasing the frequency and effectiveness of campus ring systems and information campaigns are also necessary. P3 highlights that as a public institution, the university's advertising and information campaigns are limited, but various incentive and deterrent measures can increase the use of alternative transportation modes.

In summary, the experts agree that promoting alternative transportation modes can contribute to sustainable campus transportation, but each offers different approaches. P1 highlights the limited authority of universities and the need for awareness activities, P2 emphasizes comprehensive and consistent policy packages, and P3 suggests reward and penalty systems as more effective measures. Collectively, these views suggest that promoting alternative transportation modes requires comprehensive, consistent, and incentive-deterrent policies.

Reducing Daily Vehicle Entries and Exits to Campus

P1, P2, and P3 offer different approaches to reducing the number of daily vehicle entries and exits to the campus and their impact on sustainable campus transportation.

P1 emphasizes the importance of categorizing vehicles entering and exiting the campus. Restricting administrative and academic staff who need to commute is difficult due to insufficient public transportation. However, for students, campus capacity is limited, and vehicle use can be restricted. P1 notes that students who wish to drive may face parking difficulties, but academic staff should be prioritized for parking to ensure the continuity of education. P1 argues that universities are not municipalities and cannot completely ban vehicle use but should prioritize appropriately. For example, if a professor is late, it disrupts education, so academic staff should have vehicle use priority, while students should prefer public transportation.

P2 argues that reducing the number of daily vehicle entries and exits can have positive effects and is achievable with a consistent policy package. Increasing alternative transportation modes and reducing car use require integrated and consistent policies. A single measure alone is insufficient. For example, building only a metro line will not reduce car use. Parking fees should be high, parking areas limited, and traffic congestion should make car use difficult. Simultaneously, public transportation, bicycle, and pedestrian facilities should be improved. P2 emphasizes that these measures should be applied as a consistent package to be effective. For instance, reducing parking capacity within the campus and designating car-free zones can discourage car use.

P3 advocates for monitoring and managing vehicle entries and exits. Recording and analyzing vehicle data can help manage demand. For example, determining the busiest times for vehicle entries and exits and adjusting parking fees and access rules accordingly can be effective. Limiting or completely banning vehicle entry during specific times and events can also be a solution. P3 emphasizes that monitoring systems can reduce vehicle congestion and improve campus traffic. Additionally, tracking vehicle movements with a pass system and optimizing this system can help. For example, restricting campus access to sticker holders during certain hours can reduce congestion. These measures can effectively reduce vehicle congestion within the campus.

In summary, the experts agree that reducing the number of daily vehicle entries and exits to the campus can contribute to sustainable campus transportation, but each offers different approaches. P1 emphasizes categorizing vehicles and prioritizing, P2 advocates for a consistent policy package, and P3 suggests data analysis and demand management. Collectively, these views suggest comprehensive, consistent, and data-driven management policies for reducing vehicle congestion within the campus.

Strategies and Recommendations for Making Campus Transportation More Sustainable

Experts offer various strategies and recommendations for making campus transportation more sustainable. Each expert approaches the issue from different perspectives and proposes different solutions. Here is a detailed evaluation:

P1's View:

P1 emphasizes the importance of defining the purpose of movement for sustainable transportation. Dividing transportation into on-campus and to-and-from campus categories, P1 highlights the importance of providing solutions tailored to people's needs. There is no single solution, and each mode has its limitations. Determining the purpose and frequency of movement and the number of people involved is crucial. Based on this data, appropriate infrastructure and services should be provided. P1 argues that public transportation should be managed dynamically to avoid inefficiencies due to underutilization.

As an example, P1 mentions a shuttle service at Northwestern University that provided safe and free transportation for students going off-campus at night. Students operated these shuttles, and similar services could be implemented in Turkey. However, differences in transportation laws in Turkey present challenges. P1 also supports the idea of vehicle-sharing systems like Uber, which were eliminated in Turkey, leaving the current taxi fleet inadequate for mobility needs.

P1 highlights the importance of increasing technology usage but emphasizes the need for a legal framework. Smart transportation services can provide environmentally friendly and sustainable transportation, but safety and regulation are essential. Therefore, legal regulations must be established.

P2's View:

P2 suggests that vehicle-sharing systems could play a significant role in campus transportation. These systems operate like club memberships, allowing users to rent vehicles for a certain period. Widely used in European cities, these systems can help

solve parking issues and improve transportation efficiency. P2 also emphasizes the need for inclusive access to these systems, ensuring that those without smartphones or internet access are not excluded.

P2 advocates for policies that make public transportation, cycling, and walking more attractive while implementing measures to discourage car use. Incentive policies such as making public transportation free and enhancing cycling infrastructure should be accompanied by deterrent policies like increasing parking fees and reducing parking spaces. P2 emphasizes the need for integrated and consistent policy packages to effectively promote alternative transportation modes.

P3's View:

P3 highlights the challenges of implementing bicycle lanes and other alternative transportation methods in Ankara due to its large size and topography. He/she notes the existing demand management issues and suggest prioritizing vehicle-free access to the campus and then promoting alternative transportation methods. P3 also proposes improving parking management and pedestrian pathways as cost-effective solutions for sustainable campus transportation.

P3 suggests that implementing organized and safe alternatives like ride-sharing could provide economic and environmentally friendly transportation options for students and staff. However, the feasibility of such systems needs careful evaluation.

To sum up, experts offer various strategies and recommendations for making campus transportation more sustainable. General recommendations include promoting public transportation and alternative transportation methods, improving parking management, enhancing pedestrian pathways, and implementing vehicle-sharing systems. These measures can contribute to more efficient, safe, and environmentally friendly campus transportation. However, successful implementation requires collaboration with local governments and the establishment of legal regulations.

7.6 Cross-Impact Analysis of Expert Reviews: Delphi Method

The Delphi method, established in the 1950s by the RAND Corporation, was designed to achieve a reliable consensus among experts. Dalkey and Helmer (1963) noted its objective to refine expert opinions into a collective judgment. Linstone and Turoff (1975) later highlighted the method's core features, emphasizing its role in structuring group communication to address complex issues effectively. This process involves providing feedback on individual contributions, assessing the group's collective judgment, allowing individuals to revise their opinions, and ensuring some level of anonymity for responses.

In the 1960s, Cross-Impact analysis was developed to address the limitations of Delphi surveys, which often failed to consider the interdependencies between different technologies. Gordon and Hayward (1968) proposed that the realization of one event could alter the probability of other events occurring. This concept introduced a way to account for the mutual influences between events.

Cross-Impact methods have become integral to scenario planning, offering structured processes to derive plausible future developments through expert judgments on systemic interactions (Weimer-Jehle, 2006). Unlike forecasts, scenario analyses handle the uncertainty of strategic decisions in complex situations by presenting a coherent view of possible future outcomes (Weimer-Jehle, 2006; Porter, 1985). According to Helmer (1981), Cross-Impact analysis as a framework for organizing expert judgments to create a conceptual model of how events influence each other, providing a multidisciplinary perspective on future developments.

In the *expert review phase* of this study, the responses provided by experts during the interviews were thoroughly examined. Each factor and variable questioned, along with their impacts on one another, were meticulously analyzed. These analyses were conducted separately for each expert, with their responses being transformed into numeric values ranging from 0 to 3 to quantify their perspectives. This numerical

range was used to indicate the degree of impact, with: (0) representing no effect, (1) low effect, (2) medium effect, and (3) high effect.

The comprehensive analysis involved creating a cross-impact matrix for each expert, detailing the relationships and influences between all variables and factors. Each row and column of the matrix represented different variables and factors, allowing for a detailed examination of their interrelationships and their influences on each other.

In the matrix, the primary objective of the study was defined in the first row, establishing its central position relative to other dimensions. Factors numbered 2-12 were positioned as internal factors affecting sustainable transportation within the METU campus, while factors numbered 13-15 were classified as external factors.

The matrix included cells with numeric values, where white cells indicated a *positive effect*, red cells indicated a *negative effect*, and green cells indicated *both positive and negative effects*. The matrix allowed for the summation of active influence values for each row and passive influenced values for each column, creating a scoring system for the factors.

Additionally, each expert's matrix (P1, P2, P3) was color-coded to prevent confusion during the analysis of their combined views. Figures 7.2, 7.3, and 7.4 illustrate the cross-impact matrices created for each expert, while Figure 7.5 presents the total combined matrix, highlighting cells with total scores of '0' and the highest scores of '9' and '8' for clarity.

By conducting this thorough analysis, the study aimed to provide a comprehensive understanding of the interrelations between various factors and variables influencing sustainable transportation at the METU campus, ultimately guiding the development of more effective strategies and solutions.

CROSS-IMPACT MATRIX - P1																
Factors and Variables Affecting More Sustainable Transportation for METU Campus		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AS
1	Developing more sustainable transportation on METU Campus		3	1	2	3	2	3	3	3	1	2	2	2	2	1	30
2	Improving the systematic infrastructure of ring buses	3		0	0	3	3	3	0	0	3	3	0	2	3	0	23
3	Encouraging the spread of hitchhiking culture	3	0		0	0	0	0	0	0	1	2	2	0	2	0	10
4	Expanding the use and network of personnel shuttles	1	3	1		0	0	0	0	2	3	2	3	0	2	0	17
5	Improving pedestrian paths	3	2	0	0		0	0	3	0	0	3	0	0	2	2	15
6	Improving bicycle paths and providing secure bicycle parking	1	0	0	0	2		3	0	0	1	2	1	0	0	0	10
7	Providing bicycle and scooter-sharing infrastructure within the campus	3	0	0	0	3	3		0	0	3	3	2	0	2	1	20
8	Taking measures for stray dogs within the campus	3	0	0	0	3	3	2		0	0	2	0	0	2	0	15
9	Improving parking issues	2	2	0	1	0	0	0	0		1	2	3	3	1	0	15
10	Reducing congestion at the gates	2	0	0	0	2	1	0	0	2		3	2	1	2	0	15
11	Making the affordability of alternative transportation modes visible and promoting them	1	2	0	0	2	2	2	0	1	2		1	3	2	0	18
12	Reducing the number of vehicles entering the campus daily	2	3	0	3	1	1	2	0	3	2	2		3	2	0	24
13	Improving the systematic infrastructure of public transportation vehicles (E)	3	2	2	0	0	0	0	0	0	3	3	2		3	0	18
14	Solving late hour and peak hour transportation issues (E)	1	2	0	2	3	2	2	0	0	3	3	1	2		0	21
15	Solving peak hour taxi access issues (E)	2	1	0	0	1	1	3	0	0	1	3	0	3	3		18
	PS	30	20	4	8	23	18	20	6	11	24	35	19	19	28	4	0

Figure 7.1. Cross-Impact Matrix of P1

Figure 7.2. Cross-Impact Matrix of P2

CROSS-IMPACT MATRIX - P2

	Factors and Variables Affecting More Sustainable Transportation for METU Campus	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AS
1	Developing more sustainable transportation on METU Campus		3	3	3	3	3	3	2	3	3	3	2	3	3	3	40
2	Improving the systematic infrastructure of ring buses	3		0	3	3	3	3	0	0	3	3	2	0	3	1	27
3	Encouraging the spread of hitchhiking culture	3	2		3	3	3	3	0	0	0	3	0	3	3	3	29
4	Expanding the use and network of personnel shuttles	3	3	0		0	0	0	0	2	2	3	3	2	3	2	23
5	Improving pedestrian paths	3	0	0	0		3	2	0	0	0	3	0	0	0	0	11
6	Improving bicycle paths and providing secure bicycle parking	3	0	0	0	3		3	0	0	0	3	0	0	0	0	12
7	Providing bicycle and scooter-sharing infrastructure within the campus	3	2	0	0	2	3		0	0	3	3	1	0	3	2	22
8	Taking measures for stray dogs within the campus	2	0	0	0	3	0	0		0	0	2	0	0	0	0	7
9	Improving parking issues	3	0	0	0	0	0	0	0		3	3	3	0	0	0	12
10	Reducing congestion at the gates	3	0	0	0	0	0	0	0	2		3	3	0	1	0	12
11	Making the affordability of alternative transportation modes visible and promoting them	3	3	0	3	3	3	3	0	3	3		2	3	2	1	32
12	Reducing the number of vehicles entering the campus daily	2	3	0	3	3	3	3	0	2	3	3		3	2	0	30
13	Improving the systematic infrastructure of public transportation vehicles (E)	3	0	0	0	0	0	0	0	0	3	3	3		3	0	15
14	Solving late hour and peak hour transportation issues (E)	3	3	0	3	0	0	0	0	0	3	3	2	3		3	23
15	Solving peak hour taxi access issues (E)	1	0	0	0	0	0	0	0	3	3	0	1	0	3		11
	PS	38	19	3	18	23	21	20	2	15	29	38	22	17	26	15	0

Figure 7.3. Cross-Impact Matrix of P3

CROSS-IMPACT MATRIX - P3																	
Factors and Variables Affecting More Sustainable Transportation for METU Campus		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AS
1	Developing more sustainable transportation on METU Campus		3	2	1	1	2	3	3	3	3	3	2	3	2	1	32
2	Improving the systematic infrastructure of ring buses	3		2	0	2	2	1	0	1	3	3	0	0	3	0	20
3	Encouraging the spread of hitchhiking culture	2	3		0	0	0	0	0	3	2	1	0	3	2	2	18
4	Expanding the use and network of personnel shuttles	1	2	0		0	0	0	0	0	2	2	2	3	3	1	16
5	Improving pedestrian paths	3	0	0	0		1	0	3	3	0	3	2	0	0	0	15
6	Improving bicycle paths and providing secure bicycle parking	1	0	0	0	1		3	0	0	0	2	0	0	0	0	7
7	Providing bicycle and scooter-sharing infrastructure within the campus	1	3	0	3	2	2		0	2	3	2	2	2	3	2	27
8	Taking measures for stray dogs within the campus	2	0	0	0	3	3	0		0	0	2	0	0	0	0	10
9	Improving parking issues	3	3	0	1	2	1	0	0		3	3	3	3	0	0	22
10	Reducing congestion at the gates	2	3	0	2	0	0	2	0	3		3	3	2	2	0	22
11	Making the affordability of alternative transportation modes visible and promoting them	2	2	0	0	1	1	0	0	0	1		1	0	1	0	9
12	Reducing the number of vehicles entering the campus daily	2	1	0	0	0	0	0	0	3	2	2		3	2	3	18
13	Improving the systematic infrastructure of public transportation vehicles (E)	3	2	2	0	0	0	1	0	0	3	3	2		2	2	20
14	Solving late hour and peak hour transportation issues (E)	2	2	0	2	0	0	0	0	0	3	0	3	0		2	14
15	Solving peak hour taxi access issues (E)	2	2	0	0	2	0	1	0	0	2	0	2	2	2		15
	PS	29	26	6	9	14	12	11	6	18	27	29	22	21	22	13	0

CROSS-IMPACT MATRIX - AVARAGE																		
Factors and Variables Affecting More Sustainable Transportation for METU Campus		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AS
1	Developing more sustainable transportation on METU Campus		9	6	6	7	7	9	8	9	7	8	6	8	7	5	102
2	Improving the systematic infrastructure of ring buses	9		2	3	8	8	7	0	1	9	9	2	2	9	1	70
3	Encouraging the spread of hitchhiking culture	8	5		3	3	3	3	0	3	3	6	2	6	7	5	57
4	Expanding the use and network of personnel shuttles	5	8	1		0	0	0	0	4	7	7	8	5	8	3	56
5	Improving pedestrian paths	9	2	0	0		4	2	6	3	0	9	2	0	2	2	41
6	Improving bicycle paths and providing secure bicycle parking	5	0	0	0	6		9	0	0	1	7	1	0	0	0	29
7	Providing bicycle and scooter-sharing infrastructure within the campus	7	5	0	3	7	8		0	2	9	8	5	2	8	5	69
8	Taking measures for stray dogs within the campus	7	0	0	0	9	6	2		0	0	6	0	0	2	0	32
9	Improving parking issues	8	5	0	2	2	1	0	0		7	8	9	6	1	0	49
10	Reducing congestion at the gates	7	3	0	2	2	1	2	0	7		9	8	3	5	0	49
11	Making the affordability of alternative transportation modes visible and promoting them	6	7	0	3	6	6	5	0	4	6		4	6	5	1	59
12	Reducing the number of vehicles entering the campus daily	6	7	0	6	4	4	5	0	8	7	7		9	6	3	72
13	Improving the systematic infrastructure of public transportation vehicles (E)	9	4	4	0	0	0	1	0	0	9	9	7		8	2	53
14	Solving late hour and peak hour transportation issues (E)	6	7	0	7	3	2	2	0	0	9	6	6	5		5	58
15	Solving peak hour taxi access issues (E)	5	3	0	0	3	1	4	0	3	6	3	3	5	8		44
	PS	97	65	13	35	60	51	51	14	44	80	102	63	57	76	32	0

Figure 7.4. Cross-Impact Matrix of Avarage

After examining the views of each participating expert through the cross-impact matrices, the results were mapped to identify the relationships and differences in their responses. The elements identified as *active, reactive, critical, buffering*, and *neutral* were visualized in this mapping. The characteristics of these elements in system solutions are summarized as follows:

- **Active Elements**: These have a strong influence on the rest of the system but are not much influenced by other factors. They can be used as starting points or levers for changes.
- **Reactive Elements**: These are influenced by many other variables but do not significantly influence the system. They often act as indicators of the system's state.
- **Critical Elements**: These have a strong influence on the system and are also highly influenced by it. They are highly mobile and can bring turbulence and unpredictable side effects.
- **Buffering Elements**: These have little influence and are minimally influenced by other elements, thereby stabilizing the system.
- **Neutral Elements**: These support the system's self-regulation.

In the mapping, *active* elements were positioned in the upper left region, *critical* elements in the upper right, *buffering* elements in the lower left, *reactive* elements in the lower right, and *neutral* elements in the center. The assigned color codes from the cross-impact matrix were maintained, and the factors and variables were mapped with their associated numbers.

In the conclusion chapter, a comprehensive relationship diagram of the total data was visualized. The network of factors and variables influencing sustainable transportation at the METU campus was thoroughly discussed, highlighting each expert's unique perspective. This detailed analysis provided a deeper understanding of the interrelationships and helped refine the sustainable transportation intervention areas for METU campus.

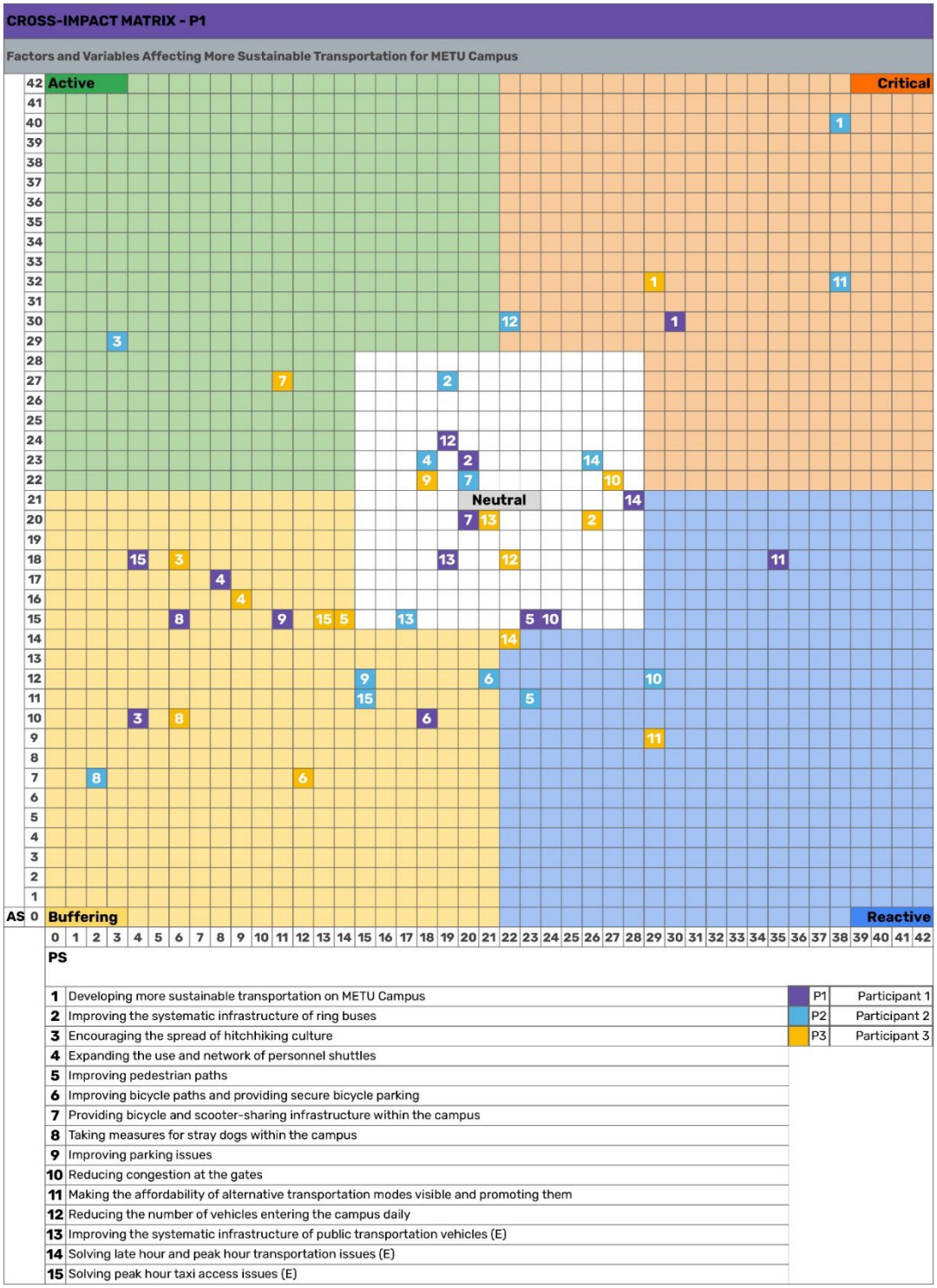


Figure 7.5. Cross-Impact Matrices Analysis

7.7 The Researcher’s Vision

In the transition design approach, the researcher's vision is crucial for achieving the ideal and desired scenarios in the complex and comprehensive process of creating sustainable transportation intervention areas for the METU campus, designated as a wicked problem. Transition Design emphasizes the importance of creating compelling visions of long-term sustainable and equitable futures. By utilizing foresight and visioning methods, these visions enable stakeholders to move beyond current conflicts and concentrate on a mutually desired future (Candy and Kornet, 2019; Candy and Lockton, 2019). The researcher utilizes this vision to guide the analysis and elaboration of the data obtained during the problem-solving and implementation stages. Each recorded phase is filtered through this vision to establish milestones for solving the wicked problem. However, the researcher's vision does not manipulate or alter the contributions offered by the stakeholders involved in the process. Instead, it listens to and incorporates the voices of each individual in this participatory process. Thus, the researcher's vision is rooted in a collective will, independent of the thoughts of a single person, and aims to establish ideal, self-sustaining interventions that are universally desired and inclusive.

In light of the aforementioned points, the researcher's vision aims to develop transportation solutions that align with sustainability principles, meet the needs of the campus community, minimize environmental impacts, are economically viable, and are easily affordable and socially inclusive. Therefore, throughout the research phases, each iterated intervention and solution development phase is addressed considering the intertwined environmental, economic, and social dimensions and their mutual impacts. Within the relationships of all these dimensions, the user is placed at the center, taking into account the experiences and pain points of all campus stakeholders, with a focus on their needs and desired ideal scenarios. The researcher's vision also highlights the integration of traditional cultural values with innovative and technological developments, as long as they benefit the users.

With an awareness of environmental responsibility, the green and unique nature and texture of the METU campus are accepted as the fundamental principles to be preserved. Any intervention or developed solution must align with this principle. Accordingly, strategies that support the efficient use of resources and the campus ecosystem are favored.

Economically, the focus is on long-term solutions that are achievable through the support of political will and comprehensive planning studies, rather than short-term changes that lose their impact. These solutions must be economically accessible to all stakeholders.

Socially, the vision is to revert the transportation patterns that have evolved towards individual car use back to a pedestrian-first approach, as originally intended. The primary goal is to provide solutions that prioritize the safety and well-being of all stakeholders, reflecting their voices in every decision made.

Lastly, in embracing innovative approaches, the vision includes integrating technological advancements into the proposed solutions, continuously monitoring and improving the solutions using data and information technologies, and designing interventions that leverage smart transportation systems to provide facilitative and rapid solutions to stakeholders' needs. This completes the designer's vision for campus transportation.

CHAPTER 8

CONCLUSION

This doctoral research investigates the existing transportation behaviors, challenges, and preferences of METU campus stakeholders. It involves students, faculty, staff, and administration in the design process to propose specific design interventions that address the needs of the entire community. With the aim of proposing transportation solution intervention areas for the development of sustainable campus mobility within the METU context, the study asks the following main research question:

- How can sustainable transportation for the METU campus be supported through the development of short, medium, and long-term intervention areas with the participation of campus stakeholders?

To answer this main question, several sub-questions are explored:

1. What are the current transportation patterns of METU campus stakeholders, and what challenges, experiences, and desires shape these patterns?
2. What are the stakeholders' perceptions of the existing transportation infrastructure, and what design interventions can promote more sustainable transportation behaviors?
3. How should the feasibility, potential, and sustainability value of the design interventions proposed by stakeholders for improving the transportation system be assessed and evaluated?
4. What are the inclusive variables and factors that affect each node of the campus transportation network, and how can the relationships between these factors be defined?
5. How can research findings and insights be translated into comprehensive strategies that improve transportation experiences and influence behavior towards sustainability?

The findings and insights gathered throughout this doctoral study have been thoroughly presented. This chapter aims to achieve the specific objectives of the study and address the research questions by discussing the key conclusions and contributions derived from the research. The following sections will detail how the research questions have been addressed, position the study within the existing literature to highlight its contributions to knowledge, and conclude with the study's limitations and opportunities for future research.

8.1 Revisiting Research Questions

8.1.1 Q1: What are the current transportation patterns of METU campus stakeholders, what challenges, experiences, and desires shape these patterns?

The transportation patterns of METU campus stakeholders are complex, shaped by a variety of factors including available infrastructure, personal preferences, and the accessibility of different transportation modes. These patterns involve a significant reliance on public transportation, private vehicles, and active transportation modes such as walking and cycling.

Public Transportation Utilization

A large number of METU campus stakeholders rely on public transportation for their daily commutes. The ring bus services provided within the campus and EGO and private buses with minibus services as paratransit are crucial, offering essential connectivity between different parts of the campus and the city. However, the frequency and reliability of these services remain significant concerns. Long wait times and overcrowded buses, particularly during peak hours, diminish the attractiveness of public transport options. Similarly, the challenge of reaching faculties from the A1 and A2 metro gates, by utilization of metro use, contributes to prolonged commuting times.

Private Vehicle Use

Many stakeholders use private vehicles, which contributes to substantial congestion and parking challenges. This reliance on personal cars is often due to the convenience they offer despite the associated environmental and economic costs. Limited parking spaces worsens these issues, leading to frustration among those who drive to the campus.

Active Transportation

Walking and cycling are also common, given the campus's extensive network of pedestrian pathways and cycling routes. However, the existing infrastructure supporting these modes requires further development to ensure safety and accessibility. Enhancing these facilities can promote more sustainable transportation options and reduce reliance on motorized vehicles.

Challenges, Experiences, and Desires

After completing the methodology Stage-I, a comprehensive and detailed analysis was presented in Chapter 5 (*see 5.3.5 Analysis and related outcome tables*). In those tables, challenges with the current infrastructure, user experiences with their transport mode choices, and their desires for possible improvements are categorized according to various transport mode alternatives around the METU campus. This categorization involves four types of transport modes: (1) Sustainable modes (walking, cycling, and scooters); (2) METU-related modes (METU ring shuttles, personnel vehicles, and hitchhiking); (3) Mass transportation (minibus, bus, and metro); and (4) Car use (individual car use and taxis). In line with this categorization, all criteria are classified under several themes: (1) comfort, (2) safety, (3) infrastructure, (4) time-related aspects, (5) environmental impact, and (6) economic factors of challenges, experiences, and desires. Finally, under these themes, each point is identified as either an advantageous aspect to be further improved or a disadvantageous aspect to be addressed in the next stage of the study.

8.1.2 Q2: What are the stakeholders' perceptions of the existing transportation infrastructure, and what design interventions can promote more sustainable transportation behaviors?

In the methodological plan Stage-II of the study, a total of 2781 potential solution suggestions for the improvement of advantageous points and problematic areas mentioned in the previous section were collected as design interventions during the *brainstorming sessions* (a short collection of these can be found in the Appendix). After gathering these design interventions, they were evaluated by the researcher based on their innovativeness, added value for sustainability, feasibility, and potential. Each transportation cluster was examined concerning the six criteria identified in the previous stage: (1) comfort, (2) safety, (3) infrastructure, (4) time-related aspects, (5) environmental aspects, and (6) economic aspects. The completed analysis and discussions on the findings of these design interventions, including stakeholders' perceptions of the existing transportation infrastructure and their proposals for promoting more sustainable transportation behaviors, are presented in detail in the findings of Stage-II *(see 6.6 Findings of Study Stage-II).*

8.1.3 Q3: How should the feasibility, potential, and sustainability value of the design interventions proposed by stakeholders for improving the transportation system be assessed and evaluated?

The feasibility, potential, and sustainability value of design interventions proposed by stakeholders can be assessed and evaluated through a multi-criteria analysis framework. This involves considering various dimensions such as technical feasibility, economic viability, social acceptability, and environmental impact. For this multi-criteria analysis, expert review was selected to assess the variables and factors related to the METU campus transportation network, which were gathered in the previous stage. To ensure a comprehensive review, the interdependencies of these variables and factors, as well as their influence on one another, were evaluated

by experts *(see 7.5.1 Findings).* These experts were specifically chosen for their academic background and expertise relevant to the scope of the study.

Technical Feasibility: Evaluating the technical aspects of proposed interventions, such as the infrastructure requirements, technological capabilities, and operational logistics, is crucial. This includes assessing the compatibility of new systems with existing infrastructure and identifying any potential technical challenges.

Economic Viability: Analyzing the cost-effectiveness of interventions is essential for ensuring their long-term sustainability. This involves estimation on calculating the initial investment costs, ongoing operational expenses, and potential economic benefits, such as reduced congestion and lower transportation costs for users.

Social Acceptability: Understanding the social implications of proposed interventions is critical. This includes assessing how the interventions will be perceived by different stakeholder groups, their potential to enhance social equity, and their ability to meet the diverse needs of the campus community.

Environmental Impact: Evaluating the environmental benefits of proposed interventions is key to promoting sustainability. This includes assessing the potential for reducing greenhouse gas emissions, improving air quality, and minimizing the overall ecological footprint of the transportation system.

Policy and Governance: Analyzing the regulatory and policy implications of proposed interventions is necessary for ensuring their alignment with broader urban and transportation policies. This involves identifying any potential legal barriers and ensuring that the interventions support the overall strategic goals of the university and the city.

Stakeholder Involvement: Engaging stakeholders in the evaluation process is essential for ensuring that their perspectives and insights are incorporated into the decision-making process. Throughout all stages of this study, the participation of campus stakeholders was crucial. Their involvement was integral to defining the problem statement, addressing design interventions, and conducting expert reviews

of those interventions. This inclusive approach ensured that the perspectives and insights of the campus community were consistently integrated into the research process of this doctoral study.

By systematically assessing the feasibility, potential, and sustainability value of design interventions through these criteria, METU can develop a comprehensive and effective transportation strategy that addresses the current and future needs of the campus community, promotes sustainable transportation behaviors, and contributes to the overall resilience and sustainability of the university's transportation system.

8.1.4 Q4: What are the inclusive variables and factors that affect each node of the campus transportation network, and how can the relationships between these factors be defined?

To develop a comprehensive and sustainable transportation network for the METU campus, it is crucial to identify and understand the inclusive variables and factors affecting each node of the transportation system. These variables and factors can be categorized into internal and external elements, each playing a significant role in shaping the overall transportation dynamics.

Internal Factors: Internal factors are those within the control of the university administration and directly related to the campus infrastructure and operations. These include the quality and efficiency of mass transportation services, the availability and management of parking spaces, the safety and accessibility of pedestrian and cycling paths, and the preferences and behaviors of the campus community. For instance, the infrastructure quality determines the ease with which stakeholders can move within the campus, while mass transportation efficiency within the campus affects their reliance on private vehicles. The safety measures in place for pedestrians and cyclists can significantly influence their choice of transportation modes, promoting or discouraging active transportation options.

External Factors: External factors encompass broader influences that affect the campus transportation network but are beyond the direct control of the university. These include urban transportation policies, economic conditions, technological advancements, and environmental regulations. Urban transportation policies, for example, can facilitate or prevent the integration of campus transportation with the city's public transit system. Economic conditions might impact the funding available for transportation infrastructure improvements, while technological advancements can introduce new sustainable transport options. Environmental regulations ensure that the transportation system aligns with broader sustainability goals, reducing the campus's carbon footprint.

Defining Relationships: Understanding the relationships between these factors involves comprehensive analysis and modeling. Cross-impact analysis is a useful tool for evaluating how each variable influences others, identifying critical leverage points within the system. System dynamics modeling can further enlighten the interplay between different variables, allowing for predictive analysis of proposed interventions and their outcomes. Stakeholder feedback is essential in this process, providing insights that ensure the accuracy and relevance of the identified relationships and interdependencies.

By systematically identifying and analyzing these inclusive variables and factors, the study can develop robust, context-sensitive strategies for enhancing the sustainability of the METU campus transportation network. This holistic approach ensures that both immediate needs and long-term sustainability goals are addressed, fostering a resilient and efficient transportation system that meets the diverse needs of the campus community.

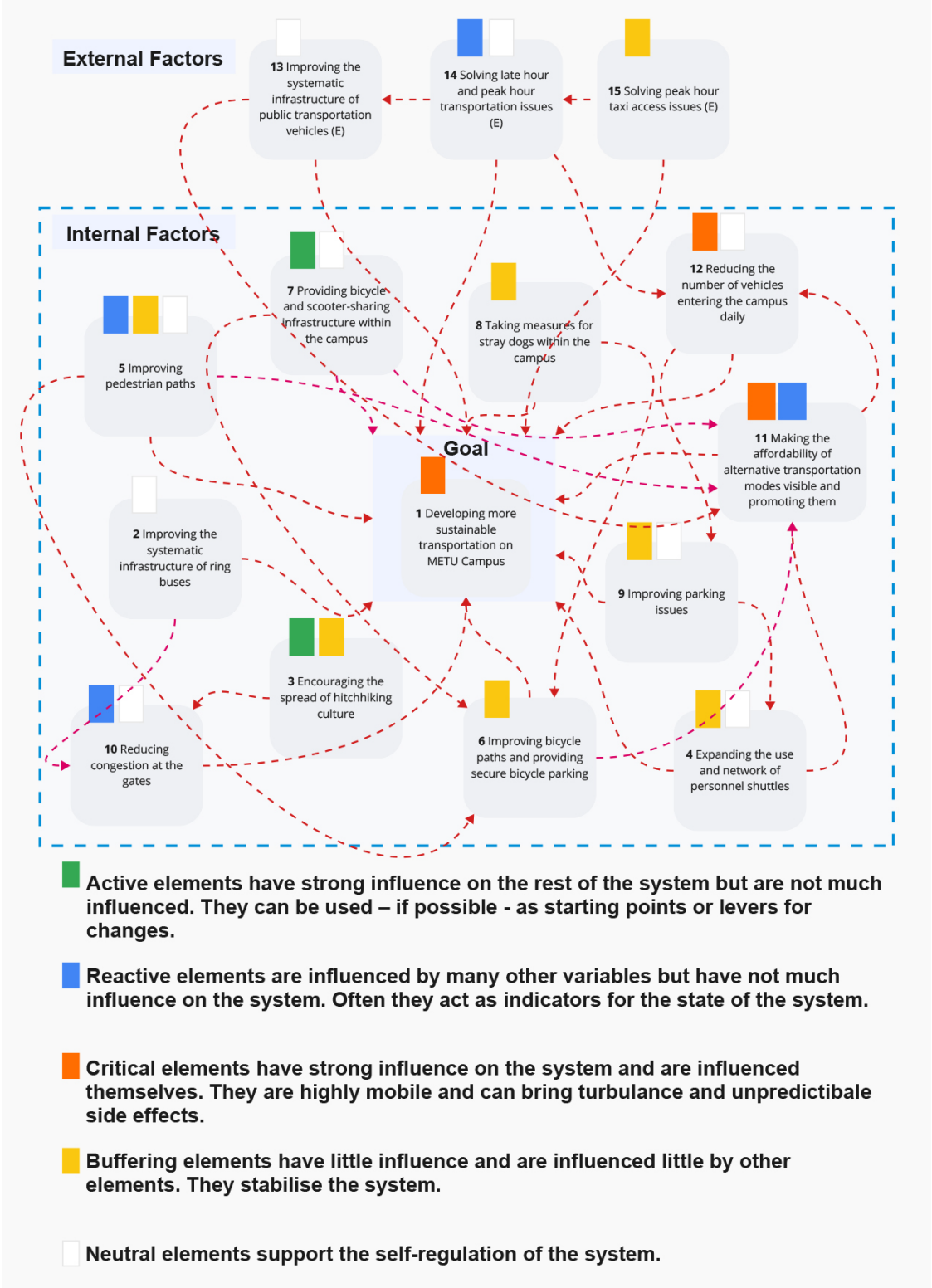


Figure 8.1. Relations Diagram of Cross-Impact Matrices Analysis

Discussions on Relations Diagram of Collected Data

Following in-depth interviews with experts, their responses regarding the sustainable development of METU campus transportation, the creation of guiding strategies, and the evaluation of relevant variables and factors were compiled and analyzed. Each expert's answer was examined in relation to the impact of other variables and factors, revealing those with critical and minimal effects on the system, as determined by cross-impact matrices incorporating the researcher’s insights.

Due to the focus on applicability and sustainability for the METU campus, experts' opinions often converged on certain topics, while diverging on others. Figure 8.1, derived from the analysis table in Figure 7.5, visualizes these findings, where each expert's opinion is color-coded.

In this visualization, active elements are marked in green, reactive elements in blue, critical elements in orange, buffering elements in yellow, and neutral elements with white icons. If a variable or factor is represented by a single icon, it indicates uniform expert opinions; if represented by two different colors, it reflects two varying perspectives among the three experts; and if labeled with three different colors, it shows diverging views.

Of the 15 variables and factors evaluated by the experts, 12 are categorized as internal, falling within the university's initiative and authority. The remaining three external factors involve elements influenced by higher-level decision-making at the city scale, beyond the university’s immediate control.

Considering all internal and external factors, all but one are directly related to developing more sustainable transportation at the METU campus. The consensus among experts was that promoting hitchhiking is not feasible due to legal issues, safety concerns, and social accessibility problems. However, when this suggestion shifts towards car-sharing, it shows significant potential, although the regulatory framework for ride-sharing in the country is still underdeveloped, as emphasized by all participants.

Further analysis of the table shows that the study's subject and objective are collectively deemed critically important. Other critical factors include making alternative transportation modes visible and encouraging their use, as well as reducing the number of daily vehicles entering the campus. These recommendations, along with reducing congestion at gates, improving pedestrian paths, and solving late and rush hour transportation issues, are seen as the most affected elements.

While the promotion of hitchhiking is not directly tied to the study's objective due to previously mentioned reasons, it, along with the provision of bicycle and scooter infrastructure on campus, has a significant impact on the entire system and is thus considered an active element.

Improving parking and bicycle infrastructure, expanding the coverage and network of personnel shuttles, taking measures for stray dogs on campus, and addressing peak hour taxi access issues are seen as necessary for the system's stability but are relatively less influenced by and have less impact on other variables.

Finally, the necessity of infrastructural improvements in public transportation as an external factor and the enhancement of the ring buses' infrastructure as the primary transportation model within the METU campus as an internal factor were highlighted. These were distinguished as crucial topics that, while separate from other issues, require significant attention to maintain the system's self-sufficiency.

In conclusion, these expert evaluations provide a comprehensive understanding of the variables and factors influencing sustainable transportation at METU. The insights gathered are critical for developing effective and implementable strategies to improve the campus's transportation system.

8.1.5 Q5: How can research findings and insights be translated into comprehensive strategies that improve transportation experiences and influence behavior towards sustainability?

Translating research findings and insights into comprehensive strategies to improve transportation experiences and influence behavior towards sustainability involves several steps. Initial steps to establish a foundation for transforming the METU Campus transportation network into a better and more sustainable future were based on data collected from stakeholders in a participatory manner. This data integration led to the creation of possible short, medium, and long-term intervention areas throughout this doctoral study.

Data Integration: The first step is integrating the insights gained from stakeholder engagement, current transportation patterns, and expert evaluations. This comprehensive data serves as the foundation for developing actionable strategies.

Development of Interventions: Using the integrated data, developing short, medium, and long-term interventions that outline various pathways to achieving sustainable transportation. These interventions should consider technical feasibility, economic viability, social acceptability, and environmental impact. Engaging stakeholders in development of interventions ensures that the proposed solutions are relevant and practical.

After these two initial steps, several additional steps are required to translate research findings and insights into comprehensive strategies for improving transportation experiences for the METU campus community and influencing their behaviors towards sustainability. These steps include:

Pilot Programs: Implementing pilot programs to test the feasibility and effectiveness of proposed interventions. These pilots provide valuable feedback and allow for adjustments before wider implementation. For example, a pilot bike-sharing program can help identify logistical challenges and user preferences.

Policy and Infrastructure Changes: Based on pilot program results, proposing necessary policy and infrastructure changes. This may include revising parking regulations, enhancing public transport schedules, and improving pedestrian and cycling infrastructure. Policies should be flexible to accommodate feedback and evolving needs.

Continuous Monitoring and Evaluation: Establishing a system for continuous monitoring and evaluation of implemented strategies. This ensures that the interventions remain effective and can be adjusted as needed. Regular feedback loops involving stakeholders are crucial for ongoing improvement.

Education and Awareness Campaigns: Launching education and awareness campaigns to promote sustainable transportation options. Informing the campus community about the benefits of sustainable practices and how they can contribute helps to foster a culture of sustainability.

Collaboration with Local Authorities: Collaborating with local government and transportation authorities to ensure that campus transportation strategies align with broader urban transportation policies. This collaboration can enhance the effectiveness of interventions and provide additional resources and support.

By following these steps, METU can effectively translate research findings into comprehensive strategies that improve transportation experiences and promote sustainable behaviors. This approach not only addresses current transportation challenges but also supports the long-term goal of creating a sustainable campus environment.

8.1.6 Main Question: How can sustainable transportation for METU campus be supported through the development of short, medium, and long-term intervention areas with the participation of campus stakeholders?

Addressing the challenge of developing sustainable transportation for METU (Middle East Technical University) requires a comprehensive and multi-phased approach that involves short, medium, and long-term intervention areas. These interventions were developed with active participation from campus stakeholders to ensure they are practical, widely accepted, and effective.

Short-Term Intervention Areas (0-2 years)

In the sustainable campus transportation interventions, the immediate issue requiring short-term solutions is the reduction of increasing individual vehicle use for campus travel. This involves moderating the number of daily vehicle entries and exits to the campus, solving congestion at campus gates, especially during rush hours, and addressing the inadequacy of parking spaces to enhance efficiency and prevent traffic congestion within the campus.

The increase in individual vehicle ownership, the growing number of METU graduates, the expanding Technopark area and the increasing number of AR-GE personnel, along with the traffic congestion caused by relatives of students at METU College during school hours, and the commuting needs of METU academic and administrative staff during peak hours, lead to occasional system blockages and a continuous influx of vehicles throughout the day. Additionally, the campus's green, protected, and appealing nature attracts recreational activities, especially in the evenings and weekends during summer, causing further congestion.

Merely taking measures to limit the number of vehicles entering the campus, without supporting strategies, would create accessibility problems for everyone and would not be sufficient to resolve mobility issues on an individual level, potentially worsening the situation.

Effective short-term strategies to address this issue include systematic improvements to the ring bus infrastructure, enhancements to the public transportation system that supports campus access, and new parking management strategies to optimize the use of existing parking spaces. These strategies were highlighted by the experts.

First, the discontinuation of personnel shuttle services, which previously facilitated the morning and evening commutes of about 5,000 METU staff due to cost-saving measures, is expected to add an extra burden to METU's internal traffic. Addressing this issue involves increasing the number of campus ring buses and forging new collaborations with the metropolitan municipality to provide additional support for internal campus transportation. Direct transportation solutions, rather than multi-modal journeys, and the reevaluation of the frequency and network coverage of high-capacity transportation solutions are critical.

Additionally, experts strongly recommended reprioritizing the use of existing parking spaces on campus and improving the campus vehicle sticker regulations. Developing a new parking management system for the utilization of current parking areas was emphasized as crucial. By integrating technological applications similar to the license plate recognition systems used at the gates, the new system would monitor and process data to prevent long-term, erroneous, incorrect, and inefficient uses of parking spaces.

Alongside these applications and strategies, promoting and making alternative modes of transport visible by campus management emerges as supportive strategies. In this regard, the scope of the recently expanded bicycle transport network can be further increased, and non-vehicle transport alternatives can be made more attractive through improvements in pedestrian pathways. Furthermore, infrastructure planning with private partnerships can be initiated for shared bicycle and scooter systems to be used within the campus and to access the campus from the gates. Given the cultural significance of using bicycles as a mode of transportation, awareness campaigns and incentive programs that educate stakeholders about the environmental impacts of their transportation choices and promote sustainable

practices are also essential in this initial phase. However, the most critical step in this area is addressing safety concerns and accessibility issues to ensure the successful adoption of these alternatives.

Finally, in the expert evaluations, the topic of promoting and expanding the hitchhiking culture, although not directly linked to the study's primary objectives, was identified as having critical importance for the transportation system. This practice could significantly impact the access issues at campus gates. The consensus among experts was that hitchhiking is prohibited in Turkey and, therefore, cannot be officially encouraged by the university. However, transforming this practice into a form of ride-sharing was considered highly significant by the experts.

Currently, Turkey does not have regulations for ride-sharing, but the recent *Martı TAG* initiative in Istanbul, involving approximately 200,000 vehicles, has started ride-sharing, and regulations for this initiative are being developed. It is anticipated that legal ride-sharing will soon be possible in Turkey. Therefore, in the near future, the hitchhiking culture on campus could evolve into a more systematic and secure ride-sharing infrastructure, which has been highlighted by campus stakeholders as a crucial solution for mobility issues in short-term intervention areas.

In conclusion, addressing immediate transportation issues on the METU campus requires a multi-faceted approach that combines systematic improvements to existing infrastructure, effective parking management, promotion of alternative transportation modes, and consideration of emerging ride-sharing solutions. These strategies, supported by stakeholder participation and awareness campaigns, aim to enhance campus mobility and sustainability in the short term.

Table 8.1 Short-Term Intervention Areas Keynotes

Short-Term Intervention Areas (0-2 years)		Proposed Solutions	Additional Considerations	Related Actors	Barriers	Limitations
Increasing individual vehicle use on campus Congestion at campus gates, especially during rush hours Inadequate parking spaces Technopark expansion, and school traffic	S1	Improving ring bus infrastructure and public transportation support		METU administration, public transport operators, local government	Resistance to change, budget constraints	Limited by existing road infrastructurechallenges
	S2	Implementing new parking management strategies using technology (e.g., license plate recognition)	Ensuring safety and accessibility of alternative transport modes	METU traffic control, parking management, transport technology providers	Initial implementation cost, technological hurdles	Technology adoption by all stakeholders
	S3	Increasing the number of campus ring buses	Promoting awareness and incentivizing sustainable practices	METU administration, bus service providers	Public acceptance, availability of buses	Dependence on availability of funds for increased bus services
	S4	Promoting alternative transport modes (e.g., bicycles, scooters)	Monitoring the effectiveness of the strategies through stakeholder feedback and data collection	Technopark, city transport planners, bike/scooter sharing companies	Safety concerns for cyclists, lack of existing infrastructure	Cultural shift required to embrace non-vehicle transport
	S5	Reevaluating parking space usage and vehicle sticker regulations		METU parking management, administration	Lack of clear regulation enforcement	Enforcement challenges for reallocated spaces
	S6	Encouraging ride-sharing as a safe, legal alternative to hitchhiking		METU administration, transport app developers, ride-sharing platforms	Legal barriers regarding ride-sharing regulations	Lack of clear regulation on ride-sharing in the country

Medium-Term Intervention Areas (3-5 years)

Medium-term intervention areas involve more substantial changes that require planning and initial investment but can lead to significant sustainability improvements. Developing integrated transport systems through public-private partnerships can establish better connectivity between campus transport and city-wide transportation networks, enhancing overall mobility and reducing environmental impact. Insights from the study indicate that one of the main factors influencing users' behavior and pushing them towards individual car usage is the lengthy, complicated, multi-modal, and exhausting nature of commuting from different parts of the city to the campus, especially from distant regions.

Considering these reasons, one of the primary solutions for reducing intra-campus vehicle congestion involves addressing commutes to the campus and producing collaborative solutions at the city transportation level. Significant importance is placed on developing specialized strategies for university and campus transportation through collaborations and planning between the city government and other high-density higher education institutions along Eskişehir Road, such as Bilkent University, TOBB University, Çankaya University, and Başkent University.

Through these strategies, unique mobility alternatives can be created for university transportation, reconfiguring the travel needs of universities separately from city transportation to provide faster and more comfortable options.

Infrastructure upgrades are also crucial in this phase. Expanding the network of pedestrian pathways and cycling routes, and developing infrastructure for electric vehicles, such as charging stations, will further support sustainable transportation. Replacing high vehicle density with electric vehicles will reduce emissions and noise pollution, while improving non-motorized transportation modes will directly influence more individuals to choose sustainable transportation options. Additionally, revising campus transport policies to support sustainable practices, such as implementing car-free zones and restricting vehicle access to certain areas, can significantly impact and gradually shape new sustainable transportation

behaviors. These measures will also play a critical role in positively influencing students' future transportation preferences.

Furthermore, the university administration's decisions and strategies will play a significant role in implementing teleworking policies and online classes, which can dramatically reduce transportation demand, as evidenced during the COVID-19 pandemic. The gradual adoption of hybrid and flexible work models within the university can be systematically planned. The online education model, utilized effectively during the pandemic, can be evaluated for implementation within appropriate departments and courses.

Additionally, the adoption of teleworking and hybrid working models can reduce the number of commutes required, thereby alleviating pressure on the transportation infrastructure. University policies could encourage flexible work hours and online meetings where feasible, further reducing peak time traffic. Implementing these strategies can lead to a significant decrease in daily transportation demand, contributing to a more sustainable campus environment.

Lastly, addressing peak congestion during rush hours, primarily caused by traffic to and from the Technopark area, the ODTÜ college, and the start and end times of academic sessions and staff working hours, is essential. By staggering these timings, traffic flow can be better managed throughout the day, preventing congestion and ensuring a smoother transportation system.

In summary, the medium-term strategies proposed in this study are designed to create a more sustainable and efficient campus transportation system by integrating infrastructure improvements, policy revisions, and collaborative efforts with city and regional stakeholders. These strategies are essential for fostering sustainable transportation behaviors and creating a more environmentally friendly and accessible campus environment.

Table 8.2 Mid-Term Intervention Areas Keynotes

Challenges		Proposed Solutions	Additional Considerations	Related Actors	Barriers	Limitations
Medium-Term Intervention Areas (3-5 years)						
Need for integrated transport systems with city-wide networks Infrastructure inadequacies (e.g., pedestrian pathways, cycling routes, electric vehicle support) Challenges with high vehicle density	**M1**	Developing integrated transport systems through public-private partnerships		Local government, public transport operators, METU administration	Bureaucratic red tape, differences in transport policies	Coordination issues across multiple jurisdictions
	M2	Expanding pedestrian pathways and cycling routes	Collaboration with city and regional stakeholders to align strategies	METU administration, city planning departments, cycling associations	High infrastructure costs, need for large-scale urban planning	Difficulties in repurposing urban spaces already dedicated to vehicular traffic
	M3	Implementing infrastructure for electric vehicles (e.g., charging stations)	Gradual adoption of hybrid work models and online education	METU administration, electric vehicle infrastructure providers	High setup and operational costs, lack of sufficient charging infrastructure	Uncertainty in the growth of electric vehicle adoption in the short term
	M4	Introducing car-free zones and restricting vehicle access in certain areas	Managing peak congestion by staggering timings of Technopark and academic activities	METU administration, city transport authorities	Public resistance, limited alternative transport modes for restricted areas	Backlash from the public and users used to convenient access by car
	M5	Encouraging teleworking, online classes, and flexible work hours to reduce transportation demand		METU administration, academic and administrative departments	Difficulty in maintaining consistent engagement and productivity in remote work	Implementation of online systems may face technical

Long-Term Intervention Areas (6-10 years)

Long-term intervention areas aim for transformative changes that can fundamentally shift the transportation dynamics on the METU campus. Planning for sustainable urban development, such as mass transit-oriented development, ensures that new campus expansions prioritize access to public transport and minimize car dependency.

Implementing innovative mobility solutions, like autonomous shuttle services and comprehensive mobility service solutions, can offer seamless, sustainable travel options and reduce the need for personal vehicles. Promoting a cultural shift towards sustainability through continuous engagement and education, and fostering long-term behavioral changes, are essential to ensure the sustainability initiatives are deeply implanted within the campus community.

Planning for sustainable urban development ensures that any future expansions of the campus are aligned with principles of mass transit-oriented development. This approach prioritizes accessibility to public transport, reducing the dependency on personal cars, and integrates land use with transportation planning. Such planning also involves creating mixed-use developments that combine residential, educational, and recreational facilities, which can significantly decrease the need for long commutes. In this regard, increasing the capacity of dormitories will significantly reduce the number of intra-campus commuters.

Innovative mobility solutions will play a crucial role in transforming transportation on the campus. Autonomous shuttle services which allocate a large number of commuters as a high capacity transport (e.g. a tram), for example, can provide efficient and reliable transportation within and around the campus, reducing the need for personal vehicles. Comprehensive mobility service solutions in the city scale, which integrate various forms of transport services into a single accessible platform, can offer seamless travel options and enhance user convenience. These solutions not only reduce the reliance on personal cars but also promote the use of sustainable transport modes such as public transit, cycling, and walking.

A significant cultural shift towards sustainability is essential for the success of long-term transportation strategies. Continuous engagement and education of the campus community can foster long-term behavioral changes. Programs that promote awareness about the environmental impacts of transportation choices and encourage the adoption of sustainable practices are vital. This cultural shift can be supported by implementing sustainability education in the curriculum, organizing workshops, and promoting campaigns that highlight the benefits of sustainable transportation.

By integrating these strategies, METU can achieve a sustainable and efficient transportation system that not only meets the current needs of the campus community but also supports future growth and environmental supervision and control. The combination of innovative mobility solutions, sustainable urban development, and a cultural shift towards sustainability will ensure that METU remains a leader in campus transportation sustainability for years to come.

Table 8.3 Long-Term Intervention Areas Keynotes

Long-Term Intervention Areas (6-10 years)						
Challenges		Proposed Solutions	Additional Considerations	Related Actors	Barriers	Limitations
Dependency on personal vehicles for campus access	L1	Planning for sustainable urban development focused on mass transit-oriented expansion	Integrating sustainability into the curriculum and campus culture Promoting mixed-use developments to reduce long commutes Ensuring that infrastructure upgrades keep pace with future campus expansions	METU administration, local government, urban planners	Resistance from drivers used to personal vehicles, funding required for long-term urban planning	Implementation of sustainable urban planning requires a significant cultural shift
	L2	Implementing autonomous shuttle services and comprehensive mobility service solutions		METU administration, autonomous vehicle technology providers, urban planners	High cost of autonomous shuttle services, potential public skepticism	Technology development, and public trust in autonomous solutions
Limited capacity of current infrastructure for future expansion	L3	Increasing dormitory capacity to reduce intra-campus commuting		METU administration, dormitory management, urban planners	High construction costs, need for student cooperation in using dorms	Planning and space constraints for further expansions
Need for a cultural shift towards sustainability	L4	Fostering a cultural shift towards sustainability through continuous engagement, education, and awareness campaigns		METU administration, sustainability experts, faculty and student bodies	Overcoming cultural resistance to changes in transportation habits	Slow adaptation of long-standing cultural attitudes toward vehicle use
	L5	Integrated mobility service solutions in the city scale		METU administration, local government, urban planners	Current forms of seperate transport services offering non-seamless travel options	Long commitment in planning, financial infrastructural cost

8.2 Contribution of the Dissertation

This dissertation makes several significant contributions to the field of sustainable transportation and urban planning, particularly within the context of university campuses.

The study offers *a comprehensive framework for developing and implementing sustainable transportation interventions* specifically tailored to the unique context of METU campus. By employing the *Transition Design approach*, the research integrates systemic thinking, stakeholder engagement, and long-term planning, creating a blueprint that other educational institutions can adapt to enhance their transportation systems. This holistic methodology ensures that the proposed solutions are not just theoretical but also practical and applicable in real-world contexts.

Through detailed surveys, interviews, and generative workshops, the research provides *empirical data on the transportation behaviors, experiences, and preferences of METU campus stakeholders*. These insights are essential for understanding the specific needs and challenges faced by students, faculty, and staff, which is crucial for designing interventions that are both effective and user-centered. The collected data significantly enriches the understanding of how transportation systems can be optimized to meet the diverse needs of the campus population.

The dissertation also identifies a range of *potential interventions aimed at promoting sustainable transportation behaviors* on campus. By assessing the feasibility, potential, and sustainability value of these interventions through expert analysis and cross-impact matrices, the study prioritizes those interventions with the highest potential for positive impact within the context of METU's unique environment. This systematic evaluation process ensures that only the most effective strategies are recommended for implementation.

The findings and recommendations of this dissertation have *significant practical implications for campus administrators and urban planners*. By emphasizing the

importance of integrated solutions that address both individual behavior and systemic infrastructure, the study provides actionable strategies that can be directly implemented to reduce carbon emissions, mitigate congestion, and promote active transportation modes. These recommendations offer a clear pathway for practical application, bridging the gap between theory and practice.

Moreover, the dissertation *contributes to the academic discourse* on sustainable transportation by filling gaps in the literature regarding the specific context of university campuses. It effectively bridges the theoretical and practical aspects of transportation planning, offering a comprehensive case study that can inform future research and practice in similar settings. This contribution is significant for advancing knowledge and guiding future research in the field.

The interdisciplinary approach of the study, which draws on urban planning, civil engineering, and industrial design, exemplifies how complex problems can be addressed through the integration of diverse perspectives. This approach not only enriches the analysis but also enhances the applicability of the findings across different contexts and disciplines, ensuring that the research addresses the problem from multiple angles and provides a more comprehensive solution.

In summary, this dissertation provides a comprehensive and practical contribution to the development of sustainable transportation systems within university campuses. Its innovative methodological approach, empirical findings, and actionable recommendations offer insights for both academic research and practical application, ultimately contributing to the broader goal of sustainability in urban environments.

8.3 Opportunities for Further Research

Building upon the findings of this study on sustainable transportation solution intervention areas for METU campus, several pathways for future research can be identified.

Conducting *longitudinal studies* would be particularly valuable, as they would allow researchers to assess the long-term impacts of the proposed transportation intervention areas. By observing these interventions over an extended period, researchers can determine how well the solutions adapt to evolving conditions, making it possible to refine and improve the strategies based on real-world outcomes. This longitudinal approach enhances the robustness and sustainability of transportation strategies.

Furthermore, conducting *comparative analyses* across different university campuses would provide insights into the transferability of the findings from METU to other contexts. Such research would highlight both commonalities and differences in transportation challenges and solutions, thereby broadening the applicability of the proposed interventions across various educational institutions.

The exploration of *technological innovations* is another promising research area. Emerging technologies, such as autonomous vehicles, smart transportation systems, and mobile apps for transportation management, offer new opportunities to enhance sustainable transportation solutions. These innovations could lead to significant improvements in efficiency and reductions in the environmental impact of campus transportation systems.

Additionally, further *behavioral studies* are needed to deepen the understanding of transportation choices among campus stakeholders. By investigating the psychological and social factors influencing the adoption of sustainable transportation modes, researchers can evaluate the effectiveness of various incentives and educational campaigns designed to promote sustainable behaviors.

Analyzing the impact of transportation policies at the local, regional, and national levels on university campuses is also critical. Future research in this area can provide insights into how external policies support or hinder the implementation of sustainable transportation initiatives, thereby highlighting the broader policy environment's role in shaping campus transportation systems.

Cross-disciplinary approaches can significantly enrich the research on sustainable transportation systems. Integrating insights from urban planning, environmental science, economics, and sociology can uncover new perspectives and innovative solutions that might be missed when using a single-discipline approach.

Moreover, developing and testing new *models of stakeholder engagement* could improve participatory processes in planning and implementing sustainable transportation solutions. By exploring different methods of involving students, faculty, staff, and local communities in decision-making, more inclusive and effective strategies can be developed.

Detailed environmental and economic impact studies of the proposed transportation intervention areas would provide a clearer picture of their benefits and trade-offs. Quantifying reductions in carbon emissions, energy savings, cost-effectiveness, and broader economic benefits would support evidence-based decision-making.

Finally, *research on the scalability and adaptability* of the proposed interventions is essential. Understanding how these interventions can be tailored to fit the specific needs of smaller or larger campuses with varying geographical and infrastructural characteristics, would validate their utility across diverse educational environments.

By pursuing these research opportunities, scholars and fellow researchers can build on the foundations laid by this doctoral study, contributing to a more comprehensive and distinctive understanding of sustainable transportation systems in university campuses and beyond.

8.4 Limitations of the Study

This study on developing sustainable transportation solution intervention areas for METU campus through stakeholder participation and the Transition Design approach faces several limitations.

First, the findings and recommendations are specific to the METU campus, which may limit their generalizability to other universities or urban settings. Each campus has unique characteristics, infrastructure, and stakeholder dynamics, meaning that the solutions developed for METU may not be directly applicable elsewhere. This site-specific nature of the study poses challenges in replicating or adapting the findings to different contexts with varying needs and conditions.

Additionally, while efforts were made to include a broad range of stakeholders, it is possible that some voices were underrepresented (mainly administrators and policy makers at the university) or excluded. Ensuring a truly representative sample is challenging, especially in a diverse community like a university campus. This could affect the comprehensiveness and inclusiveness of the interventions and recommendations. The diversity of perspectives is crucial for holistic solutions, and any gaps in stakeholder engagement might lead to oversight of important insights and needs.

Transportation systems are dynamic and influenced by numerous external factors, such as changes in urban planning policies, technological advancements, and economic fluctuations. These factors can significantly impact the feasibility and effectiveness of the proposed interventions over time. The study's intervention areas are based on current conditions and assumptions, which may change, thereby affecting the long-term applicability of the findings.

Even if well-designed interventions are developed, the implementation of sustainable transportation solutions can be restricted by practical constraints such as budget limitations, regulatory hurdles, and resistance to change. These challenges can delay or alter the intended outcomes of the proposed interventions. Financial and administrative barriers often pose significant obstacles to the realization of theoretically sound plans.

The Transition Design approach itself, while comprehensive, can be complex and resource-intensive. It requires continuous stakeholder engagement, iterative feedback loops, and a flexible approach to accommodate emerging insights and

changing circumstances. Managing this complexity effectively can be a limitation, as it demands sustained effort and coordination among various stakeholders.

Assessing the long-term impact of sustainable transportation solution intervention areas is inherently difficult within the timeframe of this study. Longitudinal studies would be required to fully understand the lasting effects of the implemented inteventions on the campus transportation system and the broader community. Without long-term data, it is challenging to measure the effectiveness and sustainability of the interventions accurately.

By acknowledging these limitations, future research can build on this study's findings, addressing these challenges to enhance the development and implementation of sustainable transportation systems in university campuses and beyond.

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APPENDICES

A. Traffic Department Duties at METU Campus

1. Warn drivers on our university campus who do not prioritize pedestrians, adhere to speed limits, or drive dangerously, and initiate necessary procedures in case of repeated offenses.
2. Take necessary safety measures in the event of traffic accidents on our university campus. Direct traffic flow with signs and signals.
3. Ensure the safe operation and proper parking of large vehicles such as tour buses and construction machinery arriving at our university campus.
4. During the control of university parking areas, leave a "Call Notice" for vehicles that are not parked in accordance with the vehicle sticker status.
5. Send warning emails to drivers who violate rules and parking regulations. After detecting three repeated violations, apply a temporary or permanent block with approval from the authority.
6. Warn drivers who park improperly outside of parking areas, on road routes, fire lanes, ambulance routes, parking lots, depot entrances, and disabled driver parking spaces on our university campus. In case of repetition, initiate necessary actions with approval from the authority.
7. Ensure traffic flow during official ceremonies and special events, take necessary precautions, and place signs and signals in appropriate places to ensure traffic safety.
8. Identify locations on our university campus where traffic signs and signals are needed or outdated, submit necessary requests, and ensure that new signs are installed.

B. Parking Permit Areas at METU Campus

Parking Permit Areas and Rules

Parking Permit Areas:

1. **Academic, Temporary Academic, and Administrative Parking Permits:** Vehicles with these permits may park in department parking lots, KKM and Cafeteria parking lots, general parking areas (such as the Bazaar Area, Large Sports Hall, and Tennis Courts), and satellite parking lots.
2. **Housing Parking Permit:** Vehicles with this permit may use department parking lots, KKM and Cafeteria parking lots, general parking areas (such as the Bazaar Area, Large Sports Hall, and Tennis Courts), and satellite parking lots.
3. **Student Yellow (Local) Parking Permit:** Vehicles with this permit may park in student-designated areas within department parking lots, as well as the Library, Cafeteria, KKM parking lots, general parking areas (such as the Bazaar Area, Large Sports Hall, and Tennis Courts), and satellite parking lots. Note that there are no designated student parking spots in the Central Engineering Building, Industrial Engineering Department, Chemistry Department, Physics Department, Mathematics Department, and Humanities Building parking lots.
4. **Student Brown (Satellite) Parking Permit:** Vehicles with this permit can park in the lot next to the Sports Center (across from MODSİMMER Practice Center), the satellite parking area on Yalıncak Road in the southern region of the Coastal Port Laboratory, the A-2 Metro Gate parking lot, and the designated dormitory parking lots. These vehicles may not use the Library, Cafeteria, KKM parking lots, or other student-designated department parking lots. However, they may use department parking lots after hours (from 18:00 to 07:00) and on weekends.

5. **Foundation Parking Permit:** Vehicles with this permit may park in areas designated for METU Development Foundation Publishing and Educational Services, EBİ, Mustafa Parlar Foundation, METU TÜBİTAK (UZAY, SAGE, MAM), Technopark, KOSGEB parking lots, student satellite parking lots, and KKM parking lots.
6. **Alumni Parking Permit:** Vehicles with this permit may park in student satellite parking lots and KKM parking lots.
7. **Technopark Parking Permit:** Vehicles with this permit may use parking spaces within the Technopark campus, student satellite parking areas, and KKM parking lots.
8. **Technopark A-7 Parking Permit:** Vehicles with this permit may use the Technopark Gate for entry and exit but are not authorized to park within the campus.
9. **College Parking Permit:** Vehicles with this permit may park in the College parking area, student satellite parking areas, and KKM parking lots.
10. **College A-7 Parking Permit:** Vehicles with this permit may use the A-7 Gate for entry and the A-2 Gate for exit but are not permitted to use other campus gates or parking areas.
11. **Guest Parking Permit:** Vehicles with this permit may use department parking lots, KKM and Cafeteria parking lots, general parking areas (such as the Bazaar Area, Large Sports Hall, and Tennis Courts), and satellite parking lots.
12. **Guest-2 (Student Parent) Parking Permit:** These vehicles do not have parking privileges but may use parking areas briefly to drop off students (students are not permitted to drive these vehicles).

13. **Guest-2 (Pool and Sports Club Members) Parking Permit:** Vehicles with this permit may park in the pool and sports facilities parking lots, provided they adhere to designated entry times.

14. **Guest-2 (Vendor) Parking Permit:** Vehicles with this permit may use department parking lots briefly to unload materials, provided they adhere to designated entry times.

15. **Weekend Course Participant Parking Permit:** Vehicles with this permit may enter during specified course days and hours and may park in the department parking areas, student satellite parking areas, and KKM parking lots associated with their course.

16. **Weekday Evening Course Participant Parking Permit:** Vehicles with this permit may enter during specified course days and hours and may park in the department parking areas, student satellite parking areas, and KKM parking lots associated with their course.

C. The Rules of Using ODTÜPass

ODTÜPass Guidelines:

1. ODTÜPass is exclusively available for use by our academic and administrative staff.
2. Relevant personnel must pre-register their visitors at https://odtupass.metu.edu.tr.
3. The system allows pre-registration of visitors only during weekdays between 06:00 and 17:30 for those who do not reside in campus housing. Visitor registration outside these hours is not permitted. Visitors must enter the campus within the specified time. For personnel residing on campus, including those in postgraduate guesthouses, there are no restrictions, and they can register visitors 24/7.
4. The system allows the creation of visitor pre-registration up to 5 (five) days in advance.
5. Visitors can enter the campus after their identity and registration are verified by the reception staff at the campus gates.
6. In the event of any legal or administrative issues arising from visitors, the person who created the pre-registration will be held responsible.
7. Sharing user information with others is prohibited. If detected, a block starting from 30 days or the cancellation of user access may be enforced with approval.
8. Personnel wishing to enter the campus on foot or by another vehicle must scan their METU ID cards at the gate card readers or with mobile card readers held by security personnel.
9. ODTÜPass may be temporarily restricted by the decision of the Rectorate when deemed necessary.

10. Personal data of our personnel and visitors are processed within the limits of the law (For more information, refer to the privacy notice at https://kvkk.metu.edu.tr/tr/system/files/aydinlatma_metinleri/aydinlatma_metni-kapi_gecis_sitemleri-kampus_giris-cikis.pdf).
11. ODTÜPass is managed by the Campus Technologies and Coordination Unit under the General Secretariat. Questions, opinions, and suggestions can be directed to

D. Parking Areas within METU Campus

PARK ALANI	PERSONEL		ÖĞRENCİ		UYDU		TOPLAM		TOPLAM PARK	ENGELLİ PARK YERİ	ALANI (M²)
	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER			
KKM	21		277	36			298	36	334	4	8746
TENİS KORTLARI (ÇARŞİ OTOPARKI)					41	13	41	13	54	1	2030
RESEPSİYON EVİ ESKİ LOJMANLAR	24	14					24	14	38		902
İŞ BANKASI ÖNÜ (RESEPSİYON EVİ ARASI)	35				35	2	70	2	72	3	685
ZİRAAT BANKASI ÖNÜ					16		16	0	16	1	289
BÜYÜK SPOR SALONU					38	17	38	17	55	2	1349
BÜYÜK SPOR SALONU GİRİŞ	15						15	0	15		533
İŞBANKASI ARAKASI					35	3	35	3	38	1	839
MİSAFİRHANE	39	3					39	3	42	1	1211
MİSAFİRHANE (36 NOLU LOJMAN)	5						5	0	5		
2.YURT ÖNÜ					16		16	0	16	1	220
2.YURT ARAKASI					18	6	18	6	24		433
2.YURT YANI (LOJMAN GİRİŞİ)	8	2					8	2	10		259
SAĞLIK MERKEZİ					55	2	55	2	57	2	1515
4. YURT YANI						17	0	17	17		515
3. YURT YANI						8	0	8	8		132
1. YURT YANI (DÖNER KAVŞAK)						25	0	25	25		876
1. YURT ÖNÜ YOL ÜZERİ						16	0	16	16		335
HAVUZ	30					29	30	29	59	1	1716
HALI SAHA VE YOL ÜZERİ	10					100	10	100	110		2010
BARAKA SPOR SALANU VE YOL ÜZERİ	5					24	5	24	29		686
6. YURT YOLÜZERİ						14	0	14	14		391
EBİ 2 KONUK EVİ VE YOL ÜZERİ					24	8	24	8	32	2	990
8. YURT ÖNÜ VE YOL ÜZERİ	4					18	4	18	22		769
8.YURT LOJMAN OTOPARKI	10					4	10	4	14		409
9. YURT LOJMAN YANI YOL ÜZERİ					9	10	9	10	19		398

PARK ALANI	PERSONEL		ÖĞRENCİ		UYDU		TOPLAM		TOPLAM PARK	ENGELLİ PARK YERİ	ALANI (M²)
	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER			
EBİ 1 KONUK EVİ 2					22		22	0	22	1	548
HIZIROĞLU KONUKEVİ					14	4	14	4	18	1	751
OSMAN YAZICI PARK ALANI					26		26	0	26	1	941
KIZ KONUK EVİ 1					18		18	0	18	1	342
39 NOLU LOJMAN(SUN SHİNE ARAKASI)	15	8					15	8	23	1	567
KÜTÜPHANE			119	2			119	2	121	1	3168
REKTÖRLÜK	57	10					57	10	67	2	1808
REKTÖRLÜK EGO DURAĞI	17	6					17	6	23		834
SOSYAL BİNA	12	8					12	8	20		484
KAFETERYA			50	3			50	3	53	1	1467
MM BİNASI ÖN KISIM	35	5					35	5	40	1	913
MM BİNASI ARKA KISIM	32	7					32	7	39		771
BİLGİSAYAR MÜH	29	6					29	6	35	1	778
BİLGİ İŞLEM DAİRE BAŞKANLIĞI	22		12	11			34	11	45	1	1063
İNŞAAT MÜH LAB GİRİŞİ		8					0	8	8		295
İNŞAAT MÜH. K1 BİNASI GİRİŞ			34	18			34	18	52	1	1105
İNŞAAT MÜH. K1 BİNASI YAN	50	10					50	10	60		1022
HİDROMEKENİK LAP YAN			50				50	0	50		1720
HİDROMEKENİK LAP ARKA	12	2					12	2	14		300
KİMYA MÜH E BLOK KANTİN YANI	9	2					9	2	11		301
KIYI LİMAN SU KAYNAKLARI	13		12				25	0	25		1067
YALINCAK UYDU (CAMİ) PARK ALANI					63	48	63	48	111		2522
ÇEVRE MÜH.	17		36	16			53	16	69	1	1643
KİMYA MÜH D BLOK	10		22	10			32	10	42		1092
KİMYA MÜH. YÜKSEL PROJE	11	11					11	11	22	1	765
METALURJİ MÜH.	65		56	10			121	10	131	3	3015

PARK ALANI	PERSONEL		ÖĞRENCİ		UYDU		TOPLAM		TOPLAM PARK	ENGELLİ PARK YERİ	ALANI (M²)
	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER			
JEOLOJİ MÜH	27		35	9			62	9	71	1	1807
MADEN MÜH.	36	1					36	1	37	1	509
MADEN MÜH. (TOPRAKLIK ALAN)				30			0	30	30		907
PETROL MÜH ÖN	15						15	0	15	1	427
GIDA MÜHENDİSLİĞİ	17	3	25				42	3	45	1	1425
HAVACILIK MÜH	22		9				31	0	31		782
HAVACILIK MÜH TOPRAKLIK ALAN				10			0	10	10		225
HAVACILIK MÜH HANGAR YANI	20						20	0	20		510
RÜZGEM						67	0	67	67	1	1302
MAKİNA MÜH B BLOK	38			18			38	18	56	1	1042
MAKİNA MÜH A BLOK	21	7					21	7	28	1	627
MAKİNA MÜH D-E-F BLOK	19		21	14			40	14	54	2	1173
MAKİNA MÜH G BLOK	14	6	34				48	6	54		330
TÜBİTAK-SAGE	12			4			12	4	16		310
MAKİNA MÜH D BLOK ÇEVRE YOLU ÜZERİ	8						8	0	8		354
MEKEZİ LAP ve TÜRK DİLİ	36		27	3			63	3	66	2	1096
ELEKTRİK ve ELEKTRONİK MÜH	52	5					52	5	57	1	1158
AYASLI	17						17	0	17		417
ENDÜSTRİ MÜH.	45						45	0	45	1	996
BİOMATEN	9	2					9	2	11	1	205
İSTATİSTİK B.	20						20	0	20	1	492
KİMYA B.	20						20	0	20	1	637
FİZİK B.	47	2					47	2	49	1	1114
FİZİK (GÜNAM)	34	2					34	2	36	1	764
FİZİK (ARKASI ADT)	9	2					9	2	11		199
MATEMATİK B.	30	8					30	8	38	2	768

PARK ALANI	PERSONEL		ÖĞRENCİ		UYDU		TOPLAM		TOPLAM PARK	ENGELLİ PARK YERİ	ALANI (M²)
	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER			
BEŞERİ B. KANTİN YANI	10	5					10	5	15		290
BEŞERİ B. KREŞYANI	29						29	0	29		523
MİMARLIK FAK. EK BİNA	32						32	0	32		1025
BİYOLOJİ MÜH.	39		22				61	0	61	1	1464
MİMARLIK FAK. ÖN	34	3					34	3	37	1	784
MİMARLIK FAKÜLTESİ DEKANLIK	17						17	0	17		467
MİMARLIK FAKÜLTESİ ÖĞRENCİ			23	21			23	21	44		1186
İİBF A BLOK ÖĞRENCİ (MİMARLIK)			62	22			62	22	84		2257
İİBF A BLOK ALT	29		13	22			42	22	64		988
İİBF A BLOK ÖN	11						11	0	11	2	300
İİBF B BLOK PARK ALANI	74		79				153	0	153	1	3754
MATBUM	21						21	0	21		542
KGPO BİLGİ DÖKÜMÜ(TEKNOKENT)	16						16	0	16		250
YDYO A BLOK	58	5					58	5	63	2	1481
YDYO D-F-G BLOK	50		37	22			87	22	109	2	1578
EĞİTİM FAK.	35						35	0	35		1078
EĞİTİM FAK. EK	65								0		780
MYO VE BÖTE	55	10					55	10	65	2	1307
MODSİM					37		37	0	37	2	884
GÜNAM					17		17	0	17		291
ARŞATIRMA MERKEZİ							0	0	0		2500
UYGULAMALI MATEMATİK					32		32	0	32		743
BİLTİR					32		32	0	32		943
ÇARPIŞMA LAB.					32		32	0	32		830
ENFORMATİK	44		11				55	0	55	2	1140
TÜBİTAK	199						199	0	199	4	2880

PARK ALANI	PERSONEL		ÖĞRENCİ		UYDU		TOPLAM		TOPLAM PARK	ENGELLİ PARK YERİ	ALANI (M²)
	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER			
TEKNOKENT UYDU PARK ALANI					140		140	0	140	2	3851
ODTÜKENT SPOR SALONU					63		63	0	63		963
KONUK EVİ 1- LİSANÜSTÜ					86		86	0	86	2	2595
KONUK EVİ 2					24		24	0	24		467
KONUK EVİ 3					16		16	0	16		431
KONUK EVİ 4					22		22	0	22		342
İSA DEMİRAY YURDU					40		40	0	40		929
FAİKA DEMİRAY YURDU KARŞISI					37		37	0	37		1032
FAİKA DEMİRAY YURDU 19. YURT					18	7	18	7	25		580
REFİKA AKSOY					16		16	0	16		275
BİLİM MÜZESİ	9						9	0	9		205
YAPI İŞLERİ TEKNİK DAİRE BAŞKANLIĞI	25	4					25	4	29		640
ISI MERKEZİ	15						15	0	15		331
YAPI BAKIM MÜDÜRLÜĞÜ VE YANI	15	7					15	7	22		376
ELEKTRİK İŞLETME MÜDÜRLÜĞÜ	39	1					39	1	40		491
SİVİL SAVUNMA VE MATBAA	6						6	0	6		134
TAŞIT İŞLETME MÜDÜRLÜĞÜ (OTOBÜS)	40	16					40	16	56		2539
TAŞIT İŞLETME MÜDÜRLÜĞÜ (ARAÇ)	54	12					54	12	66		742
GENEL ATÖLYELER MÜDÜRLÜĞÜ	20						20	0	20		240
TASARIM FABRİKASI	13	3					13	3	16		345
EVRAK ARŞİV					10	5	10	5	15		422
TELEFON İŞLETME MÜDÜRLÜĞÜ	19						19	0	19		484
AĞAÇLANDIRMA MÜDÜRLÜĞÜ	15	15					15	15	30		200
KOLEJ LİSE					95	18	95	18	113	2	2180
KOLEJ SERVİS OTOPARKI		80	8				8	80	88		2279
KOLEJ İLKOKUL	28	2	36		94	50	158	52	210	2	4499

PARK ALANI	PERSONEL		ÖĞRENCİ		UYDU		TOPLAM		TOPLAM PARK	ENGELLİ PARK YERİ	ALANI (M²)
	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER	PARK	DİĞER			
A1 KAPISI	11	2					11	2	13	1	274
A4 KAPISI					74		74	0	74		1707
A4 KAPISI BARAKA (KARAKOL)					8	5	8	5	13		204
A2 METRO (UYDU PARK ALANI)					507		507	0	507		13372
ODTÜKENT ŞOK					15		15	0	15		292
ODTÜKENT SOSYAL TESİSLER MD.	7						7	0	7		114
ODTÜKENT 1911 (142) A-B BLOKE	67						67	0	67		1521
ODTÜKENT 1101-1121	50						50	0	50		737
ODTÜKENT 1201-1217	29						29	0	29		365
ODTÜKENT 1301-1318	19						19	0	19		276
ODTÜKENT 1401-1415	20						20	0	20		287
ODTÜKENT 1501-1511	23						23	0	23		360
ODTÜKENT 16011-1629 (ÖN VE ÇEVRE PARK)	65						65	0	65		845
ODTÜKENT 1701-1706	8						8	0	8		179
ODTÜKENT 1707-1712 ÇEVRE YOL	11						11	0	11		145
ODTÜKENT 17013-1722	21						21	0	21		531
ODTÜKENT 1801-1807	8						8	0	8		179
ODTÜKENT 1901-1906	82						82	0	82		1148
							0	0	0		
							0	0	0		
							0	0	0		
							0	0	0		
TOPLAM	2717	305	1110	281	1845	520	5607	1106	6713	85	157469
	3022		1391		2365		6713				

E. Regulations Governing Parking Usage at METU Campus

Parking Usage Rules:

1. Vehicles are required to park in areas that correspond with their vehicle pass status.
2. Parking in spaces designated for disabled drivers by other drivers is prohibited. If a violation is detected, the vehicle pass may be canceled temporarily or permanently with official approval.
3. Vehicles found parking outside designated parking areas, on sidewalks, road edges, or in areas that do not match their vehicle pass status will have their vehicle passes canceled temporarily, and permanently upon repeated offenses, with official approval.
4. Students with a Satellite (Brown) vehicle pass must park only in the designated areas near the Sports Center (opposite MODSİMMER Application Center), Coastal Port Laboratory South area parking lot, Yalıncak Road satellite parking lot, A-2 metro gate parking lot, and the allocated spaces in the Dormitory area. Vehicles with a Local (Yellow) vehicle pass may also use these satellite (Brown) parking areas.
5. Drivers who park incorrectly will have a notification left on their vehicle, and an email will be sent regarding the issue. If the driver is found to have parked incorrectly three times, their vehicle pass may be canceled temporarily or permanently with official approval.
6. It is forbidden to park in areas with a no-parking sign, on the road, in front of garbage containers, at warehouse entrances, on fire and ambulance routes, on grassy areas, at shuttle stops, at minibus stops, and in the middle areas of parking lots.
7. Parking on the roadside of service routes (East-West Dormitory area and College area) is prohibited.

F. Stage-I: Interview Questions in Turkish

1a. Kampüse geliş ve kampüsten gidişlerinizde günlük uygulamanızda ..... araçları kullandığınızı belirtmişsiniz. Bunlar genel tercihlerinizi yansıtıyor mu?

1b. Tercihlerinizi belirleyen zorunlu etmenler var mı? Nelerdir?

1c. Kişisel tercihlerinizin sebepleri nelerdir?

2a. Kampüsiçi yaptığınız ulaşımlarda günlük uygulamanızda ..... araçları kullandığınızı belirtmişsiniz. Bunlar genel tercihlerinizi yansıtıyor mu?

2b. Tercihlerinizi belirleyen zorunlu etmenler var mı? Nelerdir?

2c. Kişisel tercihlerinizin sebepleri nelerdir?

3. Kampüs ulaşımında ulaşım tercihleriniz (pandemi süreci harici düşünüldüğünde) her zaman aynı mıydı? Tercihlerinizi değiştirdiyseniz (pandemi haricinde) bunun sebepleri nelerdir?
4. Kampüs ulaşımında pandemi öncesinde karşılaştığınız problemler nelerdir? Şimdi neler?
5. Sizce ulaşım tercihlerinizin kişisel anlamda ne gibi getiri ve götürüleri var?
6. Tercihlerinizin çevreye etkilerini nasıl değerlendiriyorsunuz?
7. Sizce daha çevreci ulaşım seçenekleri neler olabilirdi?
8. Daha çevreci bir ulaşım tercihi benimsemek adına kişisel önceliklerinizden vaz geçer miydiniz?
9. Sizden kampüs ulaşımınızda daha çevreci bir ulaşım tercihi benimsemenin 5 farklı sıfatla tanımını istesem, bunlar neler olurdu? Daha çevreci bir ulaşım tercihi benimsemek benim için ..... gibi.
10. Sizin için kampüs ulaşımının olmazsa olmazları nelerdir?
11. Hangi kriterler ulaşım tercihlerinizin oluşmasında önemli rol oynar?
12. En ideal kampüs yolculuğunuzun tanımını yapabilir misiniz?

G. Analysis of Pilot Study Follow-up Intervies (Short Version)

Question		Participant answer	Parcipant answer summary	Coding
3. Kampüs ulaşımında pandemi öncesinde karşılaştığınız problemler nelerdir? Şimdi neler?	P1	Trafik problemi (Genelde peak zamanlar harici ulaşım yapmaya özen gösteriyorum. Pandemi de trafik azaldı diyebiliriz. Kaza, yol çalışması gibi sebeplerle beklenmedik zaman dilimlerinde oluşan yoğunluklar.	Trafik	B: 1 TRAFFIC
	P2	Kampüsün içine özellikle teknokent bölgesine ulaşan çok az toplu taşıma aracı var. Ringler çok seyrek ve kalabalık. Çok fazla aktarma yapmak gerekiyor. Zaman ayarlamak çok zordu. Sticker tipinin her kapıya uygun olmaması ve istediğin kapıdan girememek.	Toplu taşıma altyapısı, zaman yönetimi, kampüs organizasyonel sıkıntıları	2 TRANSPORTATION INFRUSTRACTURE 3 TIME MANAGEMENT 4 CAMPUS RESTRICTIONS
	P3	Yoğun ve kalabalıktı eskiden. Artık araçlar fazla kişi almıyor ve gecikmeler yaşanıyor, evden daha erken çıkmak gerekiyor.	Kalabalık, zamansal problemler	5 CROWD 3 TIME MANAGEMENT
	P4	Otobüslerin yoğunluğu pandemi öncesi. Okul içerisinde çok fazla kişisel otomobil olması, okul kapısında hayli yoğunluk yaratıyordu. Bazen dersten yarım saat önce okulda olsanız bile, okula gelip park yeri bulup derse girmek yarım saatten fazla sürebiliyordu. Pandemi sonrasında hibrit şekilde olsa bile HES kontrolü ve ateş kontrolü öğrenci sayısı fazlalığı sebebiyle pek bir fark göstermedi.	Kalabalık, okul içi trafik, park sorunu, pandemiye bağlı kapılarda yaşanan yoğunluk	5 CROWD 6 PARKING ISSUES
	P5	Trafik sıkışması öncesi problem. Pandemi de bir haffifleme oldu. Şehir hastanesinin kavşağı pandemi de hayli yoğunlaştı. Dokuz tane kolu var onun. Bu kavşak çok kritik. Trafik sıkışıklığının azalması ama o kavşakta artan bir yoğunluk diyebiliriz. 10:00-16:00 olması da farkettirdi.	Trafik	1 TRAFFIC
	P6	Kampüse gelirken dönüşte problemimiz oluyor. Ne ringler ne dolmuşlar hiç teknokente özelleşmiş değil. Ring de kampüsü dolanıp a4e gidiyor, bu da bir problem.	Toplu taşıma altyapısı eksikliği, zamansal problemler	2 TRANSPORTATION INFRUSTRACTURE 7 TIME
	P7	Problem gibi deil de şöyle bir etkisi oldu normalde dönüşlerde daha fazla taksiyle dönüyordum. Şimdi pandemide taksileri daha riskli buluyorum. Havalar soğuyunca pencere felan da kapalı oluyor. Dolmuşta ama herkes maskeli ama bulaş riski daha az gibi sanki.	Taksi kullanımında bulaş riski korkusu	8 PANDEMI

Question		Participant answer	Parcipant answer summary	Coding
4. Sizce ulaşım tercihlerinizin kişisel anlamda ne gibi getiri ve götürüleri var?	P1	Getiri; zaman, esneklik, rahat bir yolculuk-konfor, soğuk havalarda üşümeme, sıcak havayı tolere edebilmesi, istediğin kadar yük taşıyabilme Götürü; ekonomik (benzin, bakım ve temizlik masrafları), park yeri sıkıntısı	Zaman, esneklik, konfor, kişisel iyi oluş, yük taşıyabilme / ekonomik, park yeri	A: 1 TIME 2 FLEXIBILITY 3 COMFORT 4 WELL-BEING 5 EXTRA LOAD D: 6 COST 7 PARKING ISSUES
	P2	Zamanı ayarlayabilme esnekliği. Götürüsü ise maddi anlamda ve eşimle aracımızı paylaşmada güzergah çizme ve zamanlama yapma zorluğu.	Zaman organizayonu esnekliği / ekonomik	A: 1 TIME D: 6 COST
	P3	Efor anlamında daha rahat gidebilmek adına fazlaca yürümem gerekiyor (metro için). Getirisi ise daha rahat ve hızlı ulaşım yapabilmek.	Rahatlık ve hızlı ulaşım / efor	A: 3 COMFORT 4 SPEED D: EFFORT
	P4	Kendi programıma uyabiliyorum. Kendi zamanıma uyarak çok rahat şekilde okula gidebiliyorum ama benzine fazla maddi kayıp var. Daha hızlı gidebiliyorum.	Zaman organizayonu esnekliği, hız / ekonomik	A: 1 TIME 4 SPEED D: 6 COST
	P5	Getirisi zaman kazanmak, daha konforlu gitmek ve eşya taşımaya yardımcı olması. Yedek eldiven yedek palto, şapka vs. Götürüsü inanılmaz benzin yiyor araba. Kışı çok çetin ve yollar açılmıyor özellikle ara yollar. O yüzden dört çeker tercih ettik ama otomatik araç inanılmaz maliyetli.	Zaman kazanmak, konfor, eşya taşıyabilmek / ekonomik	A: 1 TIME 3 COMFORT 5 EXTRA LOAD D: 6 COST
	P6	Konfordan ziyade zaman bakımından daha avantajlı otomobil. 15-20 dakkada gidebiliyorum ama bu toplu taşımayla 1 saati buluyor. Fiyat olarak dolmuşla gidip gelsem 4te 1ine giderdim şuanki durumdan.	Konfor, zaman / ekonomik	A: 3 COMFORT 1 TIME D: 6 COST
	P7	Getiri olarak benim için sabah yürüyüşü keyifli bir an. Hareket ediyor olmak sağlık açısından iyi bir şey. Kafa rahatlığı var. Taksiye çok binmek istemiyorum aslında ama negatif birşey gelmiyor aklıma. Seçeneğim olması güzel birşey, o anki ruh halime göre seçiyor olabilmek.	Keyif almak, sağlık için hareket ediyor olmak, kafa rahatlığı, seçenek özgürlüğü	A: 8 PLEASURE 4 WELL-BEING 9 HEALTH 10 FLEXIBILITY OF HAVING MULTIPLE OPTIONS

Question		Participant answer	Parcipant answer summary	Coding
5. Tercihlerinizin çevreye etkilerini nasıl değerlendiriyorsunuz?	P1	Karbon salınmımız fazlaca tabi. Elektrikli araç uygunluğu yaygınlaşırsa ve altyapısı kurgulanırsa daha çevreci bir tutum benimseyebilirim.	Farkında ve daha çevreci alternatifleri benimseyebilir	AWARE
	P2	Keşke toplu taşıma kullanabilsek ve karbon ayak izimizi azaltabilsek. Üzücü olduğunu düşünüyorum.	Farkında ve suçluluk duyuyor	AWARE / FEEL GUILTY
	P3	Otobüs ve dolmuşun emisyonarının zararlı olduğunu biliyorum ama ne yapılabileceğini bilmiyorum. Eskişehirde yaşadığım zamanlarda tramway kullanırdım, hem merkezi şekilde dolaşıyordu ve tercih sebebiydi.	Farkında ama ne yapabileceğini bilmiyor	AWARE / NOT KNOWING WHAT TO DO
	P4	Zorunda kalmasam kişisel otomobili kullanmazdım. Hem trafik hem hava kirliliği açısında metro bana daha sürdürülebilir geliyor.	Zorunda kalmadıkça kullanmak istemiyor	AWARE / THINK OBLIGED TO USE
	P5	Çevreye etkisi olduğunun farkındayım. Sadece suçluluk duyuyorum o kadar.	Farkında ve suçluluk duyuyor	AWARE / FEEL GUILTY
	P6	Normalde araba çok yakıyor, aslında tercih etmek istemiyorum ama işte mecburiyetten.	Zorunda kalmadıkça kullanmak istemiyor	AWARE / THINK OBLIGED TO USE
	P7	Olumlu. Bi taksi çok çevreci değil muhtemelen. Hergün gittiğim günlerde haftada 3 kere 3-4 kmlik bir yol gidiyorum. Dolayısıyla taksiye bindiğimde kötü hissetmiyorum çünkü normalde diğer alternatifleri öncelik aldığım için.	Olabildiğince çevreci bir tutum benimsediğini düşünüyor	ACT SUSTAINABLE AS POSSIBLE /SENSITIVE

Question		Participant answer	Parcipant answer summary	Coding
6. Sizce daha çevreci ulaşım seçenekleri neler olabilirdi?	P1	Kişisel aracın faydalarından mahrum kalmamak adına elektrikli araç iyi bir alternatif olabilirdi. Mevcut altyapı ve şarj istasyonları da beraberinde kurgulanmalı tabi.	Elektrikli araç	ELECTRIC VEHICLE
	P2	Keşke fosil yakıtları bırakabilsek. Bisikletle ulaşım yapanlara çok özeniyorum ama bir o kadar da güvenlik açısından geriliyorum. Toplu taşıma çok kalabalık ve her yeri dolandığı için yolculuk süreleri uzuyor, bu optimize edilebilir.	Bisikletli ulaşım	BICYCLE
	P3	Sürdürülebilir yakıtlarla ve kaynaklarla çalışan araçlar olabilirdi. Kişisel araç kullanımına karşın toplu taşımanın daha yaygın bir şekilde kullanılması olabilirdi ama pandemi döneminde ne kadar mümkündür tabi.	Sürdürülebilir yakıtlarla çalışan araçlar ve toplu taşıma	SUSTAINABLE RECOURCED VEHICLES / MASS TRANSPORTATION
	P4	Metro ulaşımı çok mantıklı olabilirdi ama ulaşımı çok rahat değil. Çok üniversiteli şehirlerde yalnızca öğrenci taşımasına yönelik bir ulaşım türü olabilirdi. Yani sabah ders saatinde gelse akşam ders çıkışı geri götürse şeklinde.	Metro	METRO
	P5	Carpooling yapmak. Bizim komşular zaman zaman yapıyordu. 20-21 haneden bazılarının çocukları aynı kurslara gidiyorlardı, her hafta birisi götürüyordu. Ama toplu taşımada bir öneri bulmakta zorlanıyorum. Belki çok çeşitli yokuşlu dar yollara girebilecek benzinle çalışmayan bir hop-on hop-off bir ring yapabilecek toplu taşıma araçları olabilirdi. Çok konforlu olmaları gerekmiyor, büyük adada başlattılar böyle bir şey.	Araç paylaşım ve otostop	CAR POOLING / HITCHHIKING
	P6	Daha çevreci, elektirikli scooter denedim bir keresinde o çevreci olabilirdi. Otobüs demek istemiyorum onlarda çok çevreci değil. Çok dolu olmayışı otobüsleri de verimlilik anlamında çok çevreci yapmıyor diye düşünüyorum.	Elektrikli skuter	ELECTRIC SCOOTER
	P7	Şeyi sorguluyorum bazen, taksiye binmek yerine scooter kullanmak. Bu civarda çok kullanılıyor ama genelde gençler kullanıyor, benim yaşındakileri pek görmedim ama o da tartışılır tabi elektrik bataryaları felan ne kadar sürdürülebilir. Bu arada burada bisiklet yolu felan yok, bu yüzden yayaların arasından ya da yoldan gitmen gerekiyor. Dolayısıyla müzik dinleyemezsin sürekli konsantre olman gerekli. Çok da ucuz olmadığını biliyorum bu arada.	Elektrikli skuter	ELECTRIC SCOOTER

H. Stage-I: Pilot Study of Second Phase - Answers

<table>
<tr><td rowspan="6">P1</td><td colspan="2">Step -1: Sebepler</td></tr>
<tr><td colspan="2">• toplu taşımanın hijyenik olmaması
• yol tutması
• evimden okula tek vesait ile yolculuk edememek
• araçla 10 dkda, toplu taşımayla kırk dakikada okula gidiyor olmak
• alışkanlık
• kişisel alan
• ulaşım esnekliği, okuldan çıkıp rahatça bir yerlere gidebilmek
• malzemeleri rahat taşımak
• kişisel eşyalarımı koyuyorum, sandalye, şemsiye, mat, örtü vb.
• konforlu olması</td></tr>
<tr><td colspan="2">Step -2: Problemler</td></tr>
<tr><td colspan="2">• park yeri bulma sorunu
• benzinin maliyetli olması
• otostop çekenleri almak zorunda hissetmem ama arabaya kimseyi almak istememem
• kasislere hızlı girip zıplamak
• kaza ve arıza riski
• özel araç kullandığım için geç kalmama beklentisi
• rush hourlarda trafik</td></tr>
<tr><td>Step -3a: Getiriler</td><td>Step -3b: Götürüler</td></tr>
<tr><td>• konfor sağlıyor
• pratik
• hijyenik
• kışın sıcak yazık soğuk</td><td>• çevresel etkileri fazla
• pahalı
• uykusuz kaldığım günlerde tehlikeli
• hava koşulları tehlike yaratabiliyor</td></tr>
</table>

<table>
<tr><td rowspan="6">P2</td><td colspan="2">Step -1: Sebepler</td></tr>
<tr><td colspan="2">• rahatıma düşkünüm
• mevsim geçişlerimde yedek kıyafetleri arabamda tutabiliyorum
• arabam ekonomik
• en hızlı ulaşım şekli
• otostopçu alabiliyorum
• isteğime göre kimseyle muhatap olmak zorunda değilim
• gıdada aracımla içebiliyoruz
• işyerime en yakın şekilde ulaşabiliyorum
• arabamın arkasında sandalye taşıyabiliyorum
• gün içerisinde farklı seyahetler yapmama olanak sağlıyor
• çok eşyam varsa aracımda tutabiliyorum
• iş çıkışı özgürlük imkanı verebiliyor</td></tr>
<tr><td colspan="2">Step -2: Problemler</td></tr>
<tr><td colspan="2">• arada kaza yapmak
• trafikte kavga edebiliyorum
• güzel arabaları görünce kıskanmak
• alkol almışsam arabayı bırakmak zorunda kalıyorum
• arka koltuğu genelde kullanmıyorum
• arabam kirlenebiliyor
• bazı teyzeler araba kullanmasın
• çarşıda ve stadyumda park yeri
• arabada soğutucu yok
• benzin parası
• karlı havalarda kar küremek çok zor</td></tr>
<tr><td>Step -3a: Getiriler</td><td>Step -3b: Götürüler</td></tr>
<tr><td>• kişisel alan
• sıcak
• hızlı
• konforlu
• pratik</td><td>• arabamın motoru küçük
• sosyalleşme imkanı az
• cam suyunu unutuyorum
• araba kullanmak yorucu
• kaza ihtimali</td></tr>
</table>

<table>
<tr><td rowspan="6">P3</td><td colspan="2">Step -1: Sebepler</td></tr>
<tr><td colspan="2">• keyif beyefendisiyim
• cunku var
• kendi ozel aracimda muzik dinlemeyi seviyorum
• kapidan kapiya erisime olanak veriyor
• arkadaslarimi bindirebiliyorum
• soğukta üşümüyorum
• bagajimda acil gunlerde kullanilabilecek her turlu esya hazirda bulunuyor
• kimseye eyvallahim yok
• araba benim icin 2. bir ev gibi
• istedigim saatte cikabiliyorum
• canim isterse gaza basabiliyorum, keyfime bagli</td></tr>
<tr><td colspan="2">Step -2: Problemler</td></tr>
<tr><td colspan="2">• trafik
• kaza riski
• yakıt
• ariza riski
• uykum gelince uyuyamıyorum
• alkollüyken kullanamıyorum
• makas atanlar ürkütuyor
• bakım</td></tr>
<tr><td>Step -3a: Getiriler</td><td>Step -3b: Götürüler</td></tr>
<tr><td>• konfor
• taşınacak yük
• lüks
• pratiklik
• hız
• mahremiyet</td><td>• kendinden ve başkalarının hayatından sorumlu olmak
• para para para
• hava koşullarına uyum sağlama zorluğu
• park yeri
• trafik cezası
• 4 kişilik ama genelde tek koltuk dolu :(</td></tr>
</table>

I. *Ethics Committee* Confirmation

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY

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Sayı: 28620816 /

20 Mayıs 2021

Konu : Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi : İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Gülay HASDOĞAN

Danışmanlığını yaptığınız Mehmet Erdi Özgürlük'ün "ODTÜ Kampüsü için Sürdürülebilir Ulaşımın Davranış Değişikliğiyle Geliştirilmesi"başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **174-ODTU-2021** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Dr.Öğretim Üyesi
İAEK Başkan Vekili

J. Invitation Call Poster Design

K. P4 – *Miro* Board Example

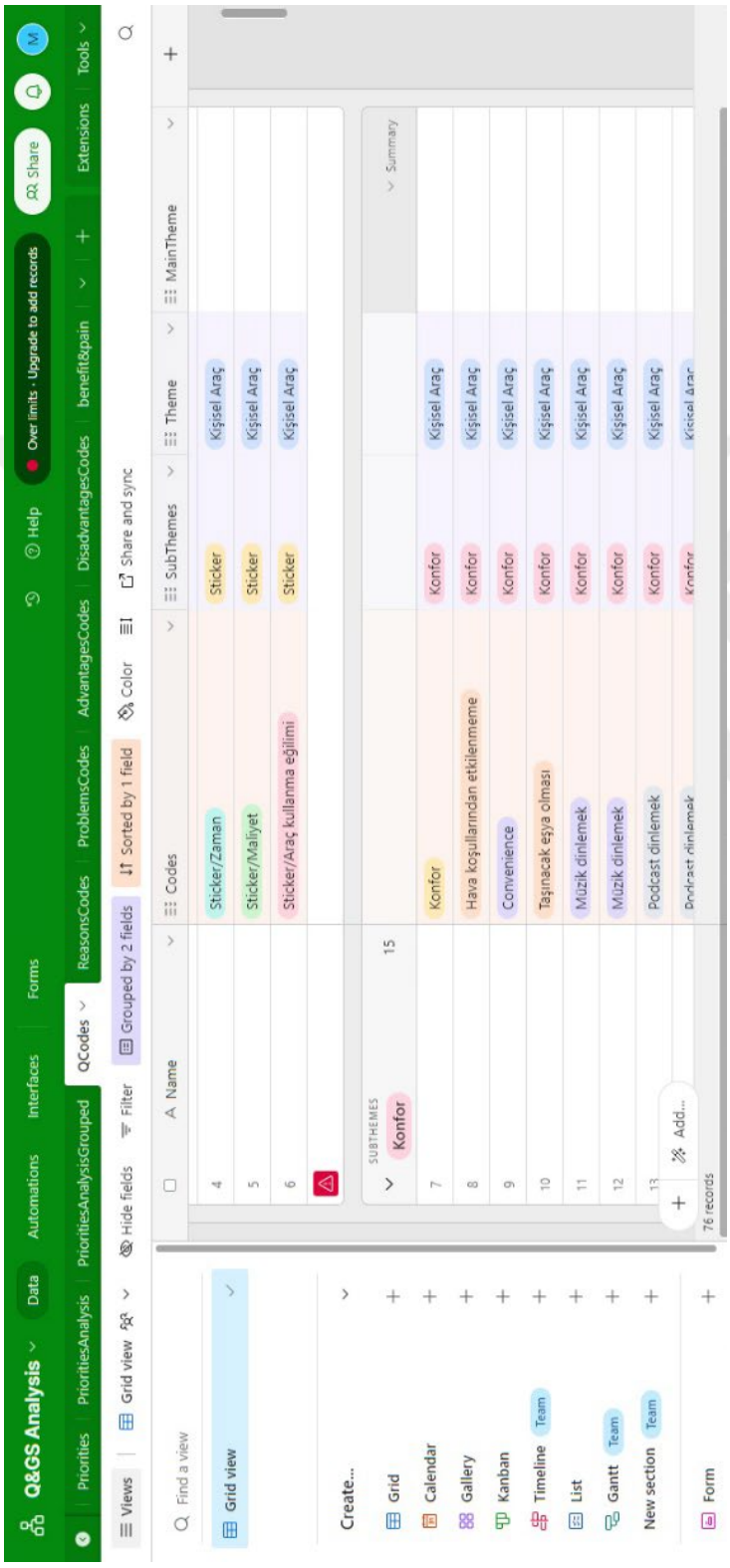
L. P1 Coding – Individual Car User

1. Sizden, kampüse yolculuk yaptığınız tipik bir günün hikayesini rica edebilir miyim? - Yolculuğunuza saat kaçta, nereden başladınız? - Yolculuğunuzda hangi ulaşım türü/türlerini kullandınız? - Yolculuğunuz ne kadar sürdü? - Yolculuk esnasında aklınıza gelen, sizi rahatsız eden şeyler ya da size keyif veren şeyler nelerdi?	Özel araç, öğle arası araç paylaşım, yürümek (P)
	Sticker tipine göre değişkenlik gösteren ulaşım zamanı (sarı-kahverengi) +
	Direkt ulaşım +
	Rahat +
	Müzik +
	Keyifli +
	Hava koşullarından bağımsız +
	Trafik (peak hour) -
	Park yeri -
- Yapmış olduğunuz yolculuklar her zaman böyle miydi yoksa zaman içinde değişti mi? Tercihlerinizi değiştirdiyseniz bunun sebepleri nelerdir?	Ehliyet sonrası
	ME-A1-metro-ring-Batıkent
	Araç paylaşım (arkadaş)
	Facebook Batıkent-ODTÜ araç paylaşım grubu
	A1e: ring, KKM otostop, dolmuş
	Yolculuk: 1.5 saat
2. Tercihlerinizin çevreye etkilerini nasıl değerlendiriyorsunuz?	çevresel anlamda mantıklı değil (farkında)
	lüks değil ihtiyaç
	15 dk vs 1.5 saat
	İkincil planda
	Rahat uyanmak vs stresli uyanmak
	Mesafe çok uzun
	Tek vesait yok (servis vb)
	Zorunluluk
3. Sizce daha çevreci ulaşım seçenekleri neler olabilirdi?	Toplu taşım araçları
	Öğrenci servisleri
4. Daha çevreci bir ulaşım tercihi benimsemek adına kişisel önceliklerinizden vaz geçer miydiniz?	Vazgeçmezdim (mesafeden kaynaklı)
	Alışkanlık

5. Sizden kampüs ulaşımınızda daha çevreci bir ulaşım tercihi benimsemenin 5 farklı sıfatla tanımını istesem, bunlar neler olurdu? (Daha çevreci bir ulaşım tercihi benimsemek benim için ..... gibi).	Konforsuz -
	Zaman kaybı -
	Dakiklik -
	Sosyal aktivite zamana elvermeyen -
	Kısıtlayıcı -
	Kişisel alan – mahremiyet -

Nedenler	Uzak mesafe		Kişisel alan
	Aktarmalı yolculuk (ulaşım altyapısı)		A1den-A1e ulaşım sorunu
	Ders saatlerinin erken oluşu		Taşınacak yükün olması
	Konfor		Saat esnekliği
	Araba kullanma keyfi		Alışkanlık
	İstenilen zamanda gelme esnekliği		Hava koşulları
	Ders sonrası aktivielere katılabilme		Kampüs dışı gidilecek uzak mesafe
	Öğle yemeği kampüs dışına çıkma imkanı		Kimseyle muhattap olmama
	Hız		Kalabalık toplu taşıma
Problemler	Trafik		Ortak kullanılan aracın uygunluğu
	Kaza korkusu/stresi (nadiren)		Park yeri sorunu
	Uykusuzluk		Stciker kaynaklı park cezası
	Dikkatli olma gerekliliği		Trafikte diğerleriyle yaşanan gerilim
	Araç bakım masrafları		Yakıt masrafı
Getirileri	Özgürlük		Sosyal aktivitelere katılabilme esnekliği
	Konfor		Kişisel alan
	Sosyal hayat		Acil işlerde rahat ulaşım
	Derslere zamanında girebilme/yetişebilme		Hava koşullarına uyum
	Geç saatlere kadar kampüste kalabilme		
Götürüleri	Ekonomik yük		Altyapı sorunlarından araç yıpranımı
	Araç kullanırkenki yorgunluk		Araç toplam kmsini artırmak
	Trafik stresi		Park yeri
	Ortak kullanım aracını meşgul etmek		
Olmazsa olmazlar değer sırası	1. Konfor	4. Hız	7. Taşınacak yük
	2. Esneklik	5. Hava koşulları	8. Eğlence
	3. Zaman	6. Sosyal hayata elveriş	9. Dakiklik

M. *Airtable* Analysis of Stage-I (A Snapshot View)



N. Brainstorming Workshop Consent Form

SÜRDÜRÜLEBİLİR DAVRANIŞ GELİŞTİRMEYE YÖNELİK TASARIM GELİŞTİRME VE İYİLEŞTİRME BEYİN FIRTINASI ÇALIŞTAYI:

KATILIMCI İZİN FORMU

Çalıştay Yürütücüsü: Araş. Gör. M. Erdi Özgürlük, ODTÜ Mimarlık Fakültesi, Endüstriyel Tasarım Bölümü

Akademik Danışman: Prof. Dr. Gülay Hasdoğan, ODTÜ Mimarlık Fakültesi, Endüstriyel Tasarım Bölümü

12 Aralık 2022, Pazartesi 13:30 – 17:30

İletişim:

Bu çalıştay, sürdürülebilir davranış değişikliği için kullanıcı eğilimlerinin potansiyelini irdeleyen ve Prof. Dr. Gülay Hasdoğan danışmanlığında Mehmet Erdi Özgürlük tarafından Orta Doğu Teknik Üniversitesi Endüstriyel Tasarım Bölümü'nde yürütülmekte olan doktora çalışması kapsamında gerçekleştirilmektedir. Çalıştayın amacı, ODTÜ Kampüs ulaşımının geliştirilmesi için, sürdürülebilir davranış geliştirmeyi destekleyecek tasarım alanlarının keşfedilmesidir.

Bir seri fikir geliştirme ve değerlendirme aşamalarından oluşan çalıştay yaklaşık olarak dört saat sürecek şekilde kurgulanmıştır. İzininiz ve haberiniz dahilinde çalıştay sonrası sizlerle birebir görüşmeler yapılarak ses kaydı alınacaktır. Çalıştay sırasında elde edilecek veriler yalnızca bilimsel amaçlarla, tasarım süreçlerinde, tez aşamalarında, bilimsel yayınlarda ve sunuşlarda kullanılacaktır. Katılımcıların kimlik bilgileri saklı tutulacaktır.

Bu formu imzalayarak yürütülecek çalıştay konusunda size verilen bilgiyi anladığınızı, çalıştay çıktılarının, görsellerinin ve yaptığınız yorumların tez çalışmalarında ve diğer yayınlarda kullanılmasını onayladığınızı belirtmiş oluyorsunuz. Çalıştaya katılım gönüllük esasına dayanır. Çalıştayın başlangıcında veya herhangi bir aşamasında açıklama yapılmasını isteyebilirsiniz. İstediğiniz zaman gerekçe belirtmeksizin katılımı sonlandırmayı talep edebilirsiniz. Çalışmaya katkıda bulunduğunuz için teşekkür ederiz.

Katılımcının Adı / Soyadı

.....

Tarih: 12.12. 2022

Çalışmaya katılmayı

☐ Kabul ediyorum

☐ Kabul etmiyorum

O. Brainstorming Workshop Feedback Form

Sürdürülebilir Davranışları Geliştirmeye Yönelik Tasarım Geliştirme ve İyileştirme Beyin Fırtınası Çalıştayı Değerlendirme Formu

Aşağıda size yöneltilen soruları 1 ve 5 arası ölçek üzerinden değerlendiriniz (1: çok az; 2: az; 3: orta; 4: fazla; 5: çok fazla)

1. Çalıştay öncesi yapılan sürdürülebilirlik ve ilgili tasarım geliştirmeye yönelik bilgilendirme ne derece açıklayıcıydı?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

2. Çalıştay sürecinin anlatılması ve bilgilendirme bölümü ne derece anlaşılırdı?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

3. Geliştirilen ve iyileştirilen tasarım önerileri panosunda size verilen örnekler size ne derece yardımcı oldu?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

4. Tasarım strateji kartlarını, üzerindeki açıklama ve örneklerle ne derece anlaşılır buldunuz?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

5. Çözüm ve iyileştirme getirdiğiniz kaynakları ne derece anlaşılır buldunuz?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

6. Çalıştay yönergeleri, neyi nasıl yapacağınıza dair ne derece size yardımcı oldu?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

7. Değişkenli durumları çözümlerinizde ne sıklıkta kullandınız?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

8. Sürdürülebilir davranışları benimsemeye yönelik kullanıcı eğilimi ölçeğini ne sıklıkta kullandınız?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

9. Çalıştay için ayrılan süre ne derece yeterliydi?

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10. Çalıştayın online ortamda Miro üzerinden olması ve size sunulan çalıştay şablonu ne derece uygundu?

    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Çalıştayın tamamı (anlaşılırlık, pratiklik, keyif alma, verimlilik, size getirisi vb.) ne derece yeterliydi?

    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

12. Çalıştaya dair gördüğünüz eksiklikler, zorlandığınız veya geliştirmeye açık noktalar, varsa önerileriniz nelerdir? (Kısaca belirtiniz)

P. Stage-II: *Airtable* Analysis (A Brief Outlook)

Grid view

#	Mod	Benefit	Pain	Ulaşım modu	Tags	Notes	Tags 2
Ulaşım modu:							
Tags: A.							
1	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Toplu taşıma istasyonlarının ve tesislerinin insanların yaşadığı, çalıştığı ve okula gittiği yerlere yakın yerlere yerleştirildiğini bilmeyen kullanıcılara yönelik bir app sağlanabilir.	T2
2	P1	Durağa yakın olmak		Toplu t...	Altyapısal	İnsanların istasyona araçla gitme yerine yürüyerek karbon emisyonunu azaltmaya yardımcı olabilir.	T2
3	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Durakların yakınlıkları ve dolulukları maps uygulamasından takip edilebilsin	T3
4	P1	Durağa yakın olmak		Toplu t...	Altyapısal	durak planlarının şehir yoğunluğuna göre dağılımının yapılması. Durakların dağılımının (neredeyse) eşitlenmesi	T3
5	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Taştların duraklar arasında nerede olduğu ne kadar mesafe kaldığı (km üzerinden) paylaşılabilsin.	T3
6	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Kullanıcı durağa yakın olduğunda az da olsa yürüyerek günlük egzersiz ihtiyacını karşılamış olur.	T4
7	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Toplu taşıma appinde adım sayısını görürse motive olabilir.	T4
8	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Durağa olan mesafesine göre kullanıcının o mesafeyi yürüdüğünde yakacağı kaloriyi app hesaplayıp kullanıcıya sunabilir.	T4
9	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Durakların dış tasarımı özelleştirilebilir ve ilerde bir durak olduğunu önceden anlayabiliriz belki.	T5

#	Mod	Benefit	Pain	Ulaşım modu	Tags	Notes	Tags 2
10	P1	Durağa yakın olmak		Toplu t...	Altyapısal	EGOcepte gibi toplu taşımayla alakalı app'lere yakınımızdaki durakları görmek için bir özellik eklenebilir.	T5
11	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Durakların konumlarını ve yol tariflerini de görebiliriz.	T5
12	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Uzaklığı fazla olan ulaşım araçları için kullanıcıların rahatça, engellere takılmadan bisiklet vb. araçlarla ulaşabileceği yolların yapılması	T6
13	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Bisikletten toplu taşımaya aktarma yapma indirimi	T6
14	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Gece koşullarında korunaklı ve iyi aydınlatmalı olması düşünülmeli	T6
15	P1	Durağa yakın olmak		Toplu t...	Altyapısal	Ders giriş çıkış saatlerinde toplu taşıma araçları okulun içinde daha farklı bölümlere daha yakın duraklarda duracak şekilde bir güzergah izleyebilir.	T7
16	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Duraklarda güzergah hakkında bilgi bulunması (örneğin: Arcadium Avm)	T2
17	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Aracın güvergahını app'le takip etmek	T2
18	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Araç içerisinde bir ekrana harita konulması vasıtasıyla güzargahı takip edebilme	T2
19	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Gideceğin yerin location'unu yazdığında kullanıcıya farklı araç alternatifleri gösteren bir uygulama	T2
20	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Metroların rotaları ve o an hangi noktada bulundukları metro içindeki bir dijital ekrandan gösterilebilir.	T3
21	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	ara ve ekspres güzergahlar ile yolculara belirlenmiş imkanlar sunma	T3
22	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Duraklar üzerinden geçen otobüslerin geçtikleri güzergahlarla birlikte duraktaki bir ekran sayesinde izlenebilmesi.	T3

#	Mod	Benefit	Pain	Ulaşım modu	Tags	Notes	Tags 2
23	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Araçlarda güzergaha dair bilgilendirici pano vs. olabilir	T4
24	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Bir noktadan diğer noktaya gitmek isteyen kullanıcı için alternatif güzergah seçenekleri appte gösterilebilir. Bu güzergahlarda tahmini süre veya ücrete göre sıralama yapılabilir.	T4
25	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Her duraktan önce görsel ve işitsel olarak geri bildirim olmalı.	T4
26	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Gelecek durak ile ilgili bilgiler verilebilir. Hangi durakta ne var bilgisi verilebilir.	T5
27	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Şoför koltuğunun arkasında afiş asılan yere bir harita asılarak duraklar harita üzerinde işaretlenebilir.	T5
28	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Aynı şey toplu taşıma app'ine de eklenebilir.	T5
29	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Toplu eğlencelerin olduğu Kızılay Taksim gibi kalabalık yerlerde trafik durumundan dolayı toplu taşıma araçların önceden bildirmeden güzergah değişikliğinde bulunmaları	T6
30	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Eski zamanlarda yaşanan olaylara göre olası güzergah oluşturulup özel günlerden önce kullanıcılarla paylaşılması	T6
31	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Özellikle tek bir servis sağlayıcısının olduğu (köy kasaba otobüsleri) toplu taşımalarda, o otobüsün direkt vesait yerine dolanan bir araç olması ve yolcunun bunu bindikten sonra öğrenmesi bir sorundur.	T6
32	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Virajlı ve uzun yollarda oluşan mide bulantıları :(	T6
33	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Daha kısa ya da dolambaçlı olmayan güzergahların oluşturulması	T6

#	Mod	Benefit	Pain	Ulaşım modu	Tags	Notes	Tags 2
34	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Otobüs şöförüne güzergah sürekli sorularak tehlikeli durumlar oluşma riski, çevre rahatsızlığı.	T6
35	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Otobüslerin güzergahını, kalkacağı saatini tutarlı gösteren bir uygulamanın olması	T7
36	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	Dolmuşlardaki takip sistemi sayesinde nerede olduğunu görebiliriz	T7
37	C1		Güzergah belirsizliği	Toplu t...	Altyapısal	100.yılda pazarın olduğu günlerde güzergah değişikliğinin bildirim ile haber vermesi	T7
38	C2		Karta para yüklemek	Toplu t...	Altyapısal	Kullanıcıların fiziksel bir yeri ziyaret etmek zorunda kalmadan kartlarına kolayca ve hızlı bir şekilde para yüklemesine olanak tanıyan çevrimiçi ve mobil ödeme seçenekleri sunma	T2
39	C2		Karta para yüklemek	Toplu t...	Altyapısal	Toplu taşıma acenteleri, elektronik ödeme yöntemlerini kullanarak ulaşım kartlarına para yükleyen kullanıcılara özel promosyonlar ve fırsatlar sunmak için bankalar ve diğer finansal kuruluşlarla da çalışabilir. Bu, elektronik ödeme seçeneklerini kullanmayı seçen kullanıcılara daha düşük ücretler, daha yüksek ödüller veya diğer avantajlar sunmayı içerebilir.	T2
40	C2		Karta para yüklemek	Toplu t...	Altyapısal	Öğrenci, öğretmen vb. gruplandırmalarla indirim uygulanması	T2
41	C2		Karta para yüklemek	Toplu t...	Altyapısal	İstasyonların dışında farklı alanlarda da yükleme bankolarının bulunması (kampüs, avm, hastane vb.)	T2
42	C2		Karta para yüklemek	Toplu t...	Altyapısal	Biniş sayısına göre biniş hakkı kazanılması (10 binişe 2 biniş gibi)	T2
43	C2		Karta para yüklemek	Toplu t...	Altyapısal	Renk ve ara yüz içinde kişisel tercihler ile deneyim, kullanıcı için keyiflendirilebilir.	T3

#	Mod	Benefit	Pain	Ulaşım modu	Tags	Notes	Tags 2
44	C2		Karta para yüklemek	Toplu t...	Altyapısal	Banka kartları vb. kartlar ile yapılan toplu taşıma ödemelerinin daha yaygın ve erişilebilir olması. Kullanıcıların kendi seçimine göre ödeme yöntemini seçebilmesi	T3
45	C2		Karta para yüklemek	Toplu t...	Altyapısal	Kullanıcılara kendi kartlarının dış görünüşünü seçme olanağının verilmesi.	T3
46	C2		Karta para yüklemek	Toplu t...	Altyapısal	Özel araç kullanımındansa toplu taşımaya yönlendirmek için ulaşımın yoğum olduğu zaman dilimleri (örn. iş giriş çıkış saatleri) ile daha seyrek olduğu zaman dilimlerinin (örn. gece saatleri) arasında ücret farkı olabilir.	T4
47	C2		Karta para yüklemek	Toplu t...	Altyapısal	Farklı sosyo ekonomik statüye sahip kullanıcı grupları için alternatif ücret tarifeleri sunulabilir (şu anki abonman gibi)	T4
48	C2		Karta para yüklemek	Toplu t...	Altyapısal	Para yüklerken kullanıcıya daha fazla geri bildirim sağlanması (kaç binişlik ücreti kaldığı vs.)	T4
49	C2		Karta para yüklemek	Toplu t...	Altyapısal	Daha kolay yöntemlerle para yükleme (temassız ödeme)	T4
50	C2		Karta para yüklemek	Toplu t...	Altyapısal	Karta para yüklemek için online sistemlerden yararlanılabilir. Motive etmek için puan toplama sistemleri kurulabilir.	T5
51	C2		Karta para yüklemek	Toplu t...	Altyapısal	Karta para yüklenen online sistemler (app) kişiselleştiri-lebilir. Örneğin eklenen kartlara isim verilebilir, renk atanabilir.	T5
52	C2		Karta para yüklemek	Toplu t...	Altyapısal	Örneğin İzmir'de gittiğin kadar öde sistemi mevcut. Bu sistem ile birlikte ilk başta sizden tüm durak parası çekiliyor, sonrasında vardığınız yerde kartınızı bir daha kioska okuttuğunuzda para iadesi oluyor.	T5
53	C2		Karta para yüklemek	Toplu t...	Altyapısal	Sürekli olarak karta para yükleme gerekliliği, kart unutulduğunda tek kullanımlık kart alma zorunluluğu	T6

Q. Expert Interviews Consent Form

UZMANLARLA GÖRÜŞME:

KATILIMCI İZİN FORMU

Araştırmacı: Araş. Gör. M. Erdi Özgürlük, ODTÜ Mimarlık Fakültesi, Endüstriyel Tasarım Bölümü

Akademik Danışman: Prof. Dr. Gülay Hasdoğan, ODTÜ Mimarlık Fakültesi, Endüstriyel Tasarım Bölümü

14 Mart 2024, Perşembe 15:30 – 17:00

İletişim:

ODTÜ kampüsü için davranış değişikliğiyle daha sürdürülebilir ulaşım senaryolarının geliştirilmesi ve destekleyici stratejiler ortaya çıkarmak amacıyla, ODTÜ kampüsü özelinde kullanıcıların sıklıkla tercih ettiği ulaşım modlarına dair avantaj ve dezavantaj noktaları kullanıcılarla yapılan mülakatlarla saptanmış olup; ilgili ulaşım moduna göre kategorize edilip, listelenmiştir.

Kullanıcıların daha sürdürülebilir ulaşım alışkanlıkları benimsemesinde etki edecek bu avantaj ve dezavantaj noktaları, ODTÜ kampüsünde sürdürülebilir ulaşıma doğrudan ya da dolaylı etki edebilecek daha kapsayıcı değişkenler ve faktörler halinde özetlenmiştir. Sizden beklenen, yapılacak mülakatta size yöneltilecek olan sorulardaki bu değişken ve faktörlerin nelerden etkilendiği; konuya yapılacak olası müdahalenin neleri etkileyeceği; önerinin uygulanabilirliği; ve önerinin sürdürülebilirlik artı değerine yönelik değerli görüşlerinizi paylaşmanızdır. Konuyla ilgili olarak üniversite bünyesinde geçmişte uygulamaya alınmış; hali hazırda yürütülmekte olan; veya uygulanması planlanan bir çalışma var ise konu kapsamında değerlendirmeniz, bilgi ve yorumlarınızı paylaşmanız ise çok kıymetli olacaktır.

Sizinle yapılacak olan mülakatın yaklaşık bir saat sürmesi öngörülmektedir. İzininiz ve haberiniz dahilinde mülakat esnasında ses kaydı alınacaktır. Mülakatta elde edilecek veriler yalnızca bilimsel amaçlarla, tasarım süreçlerinde, tez aşamalarında, bilimsel yayınlarda ve sunuşlarda kullanılacaktır. Katılımcıların kimlik bilgileri saklı tutulacaktır.

Bu formu imzalayarak yapılacak mülakat konusunda size verilen bilgiyi anladığınızı, mülakat çıktılarının ve yaptığınız yorumların tez çalışmalarında ve diğer yayınlarda kullanılmasını onayladığınızı belirtmiş oluyorsunuz. Mülakata katılım gönüllük esasına dayanır. Mülakatın başlangıcında veya herhangi bir aşamasında açıklama yapılmasını isteyebilirsiniz. İstediğiniz zaman gerekçe belirtmeksizin katılımı sonlandırmayı talep edebilirsiniz. Çalışmaya katkıda bulunduğunuz için teşekkür ederiz.

Katılımcının Adı / Soyadı

Tarih: 14.03.2024

Çalışmaya katılmayı

☐ Kabul ediyorum

☐ Kabul etmiyorum

R. Expert Interview Questions in Turkish

[ODTÜ KAMPÜSÜ İÇİN DAVRANIŞ DEĞİŞİKLİĞİYLE DAHA SÜRDÜRÜLEBİLİR ULAŞIM SENARYOLARININ GELİŞTİRİLMESİ]

Mehmet Erdi Özgürlük

UZMANLARLA GÖRÜŞME SORULARI

ODTÜ kampüsü için davranış değişikliğiyle daha sürdürülebilir ulaşım senaryolarının geliştirilmesi ve destekleyici stratejiler ortaya çıkarmak adına, ODTÜ kampüsü özelinde kullanıcıların sıklıkla tercih ettiği ulaşım modlarına dair avantaj ve dezavantaj noktaları kullanıcılarla yapılan mülakatlarla saptanmış olup; ilgili ulaşım moduna göre şu şekilde kategorize edilip, listelenmiştir.

Kullanıcıların daha sürdürülebilir ulaşım alışkanlıkları benimsemesinde etki edecek bu avantaj ve dezavantaj noktaları, ODTÜ kampüsünde sürdürülebilir ulaşıma direkt ya da dolaylı etki edebilecek daha kapsayıcı değişkenler ve faktörler halinde özetlenmiştir. Sizden beklenen, yapılacak mülakatta size yöneltilecek olan sorulardaki bu değişken ve faktörlerin nelerden etkilendiği; konuya yapılacak olası müdahalenin neleri etkileyeceği; önerinin uygulanabilirliği; ve önerinin sürdürülebilirlik artı değerine yönelik değerli görüşlerinizi paylaşmanızdır. Konuyla ilgili olarak üniversite bünyesinde geçmişte uygulamaya alınmış; hali hazırda yürütülmekte olan; veya uygulanması planlanan bir çalışma var ise konu kapsamında değerlendirmeniz, bilgi ve yorumlarınızı paylaşmanız ise çok kıymetli olacaktır.

1. ODTÜ'de kampüsiçi ulaşımının en önemli bileşeni olan ring servislerinin sistematik altyapısını iyileştirmek sizce ne derece mümkün? Böyle bir iyileştirmenin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
2. ODTÜ'de sıklıkla başvurulan bir ulaşım modeli olarak otostop kültürünün yaygınlaşmasını teşvik etmek, güvenli ve sistematik bir otostop altyapısı sağlamak sizce ne derece mümkün? Böyle bir altyapının oluşturulmasının sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
3. ODTÜ personel servislerinin kullanımını, tüm ODTÜ paydaşlarının yararlanabileceği şekilde düzenlemek ve servis ağını genişletmek sizce ne derece mümkün? ODTÜ personel servislerinin kapsamı ve servis ağının genişletilmesine yönelik önerinin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
4. ODTÜ kampüsünde yaya yollarını geliştirmek, yürümenin olumlu yanlarını görünür kılmak ve zorluklarını iyileştirmek sizce ne derece mümkün? Kampüsiçi ulaşımında yürümeyi teşvik edecek bu iyileştirmelerin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?

5. ODTÜ kampüsünde bisiklet yollarını geliştirmek, kapsamını genişletmek ve güvenli bisiklet parkları sağlamak sizce ne derece mümkün? Kampüsiçi ulaşımında bisiklet kullanmayı teşvik edecek bu iyileştirmelerin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
6. Kampüs içerisinde, kampüs paydaşlarına hizmet verecek kiralık/süreli kullanılmak üzere bisiklet ve scooter paylaşım altyapısı sağlamak sizce ne derece mümkün? Kampüsiçi ulaşımında bisiklet ve scooter paylaşım altyapısı alternatifinin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
7. Kampüs içerisinde zaman zaman tehlike yarattığı bilinen başıboş köpekler için önlem almak sizce ne derece mümkün? Alınabilecek önlemlerin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
8. ODTÜ kampüsüne ve kampüsten ulaşımda faydalanılan toplu taşıma araçlarının sistematik altyapısını iyileştirmek sizce ne derece mümkün? Kampüs ulaşımının ana bileşenlerinden olan toplu taşımada yapılacak iyileştirmelerin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
9. Zirve saati (iş başlangıç-iş çıkış) ve geç saat ulaşım sorununu çözmek sizce ne derece mümkün? Bu zaman dilimlerinde ulaşım için sunulacak çözümlerin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
10. Günden güne artan bireysel araç yoğunluğuna bağlı kampüsiçi park yeri sorununun iyileştirilmesi sizce ne derece mümkün? Kampüs içerisinde park yeri sorununun iyileştirilmesinin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
11. Özellikle zirve saatleri ve özel etkinlik günlerinde kampüs giriş kapılarındaki yoğunluğu azaltmak sizce ne derece mümkün? Kapılarda yaşanan yoğunluğun azaltılabilmesinin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
12. Kampüs içerisinde özellikle zirve saatlerinde taksiye erişim problemini çözmek sizce ne derece mümkün? Taksiye erişim probleminin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
13. Alternatif ulaşım modlarının ekonomik oluşunu görünür kılmak, daha çevreci alternatif ulaşım modlarını teşvik etmek ve kullanıcıları bunlara yönlendirmek sizce ne derece mümkün? Alternatif ulaşım modlarının teşvikinin sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
14. Kampüse günlük giriş-çıkış yapan araç sayısını azaltmak sizce ne derece mümkün? Kampüsteki araç yoğunluğunun azalmasının sürdürülebilir anlamda kampüs ulaşımına ne derece etki edeceğini düşünüyorsunuz?
15. Bahsedilen konulardan farklı olarak sizin aklınıza gelen, kampüs ulaşımının daha sürdürülebilir anlamda iyileştirilmesine dair değişkenler ve faktörler sizce neler olabilir, bunların uygulanabilirliğini ve sürdürülebilirlik getirisini paylaşabilir misiniz?

Katılımınız için ve değerleri görüşlerinizi paylaştığınız için çok teşekkür ederim!

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Özgürlük, Mehmet Erdi

EDUCATION

Degree	Institution	Year of Graduation
MS	METU Industrial Design	2016
BS	METU Industrial Design	2010
High School	Elmadağ High School, Ankara	2005

WORK EXPERIENCE

Year	Institution	Enrollment
2012-Present	METU Dept. of Industrial Design	Research Assistant

FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

Book Chapter

Özgürlük, M.E., Paksoy, I.Y. (2022). Dynamic Ride Sharing as an Alternative Transportation Mode for Commuting Among METU Campus and Eryaman. In: Duarte, E., Rosa, C. (eds) Developments in Design Research and Practice. Senses 2019. Springer Series in Design and Innovation , vol 17. Springer, Cham. https://doi.org/10.1007/978-3-030-86596-2_35