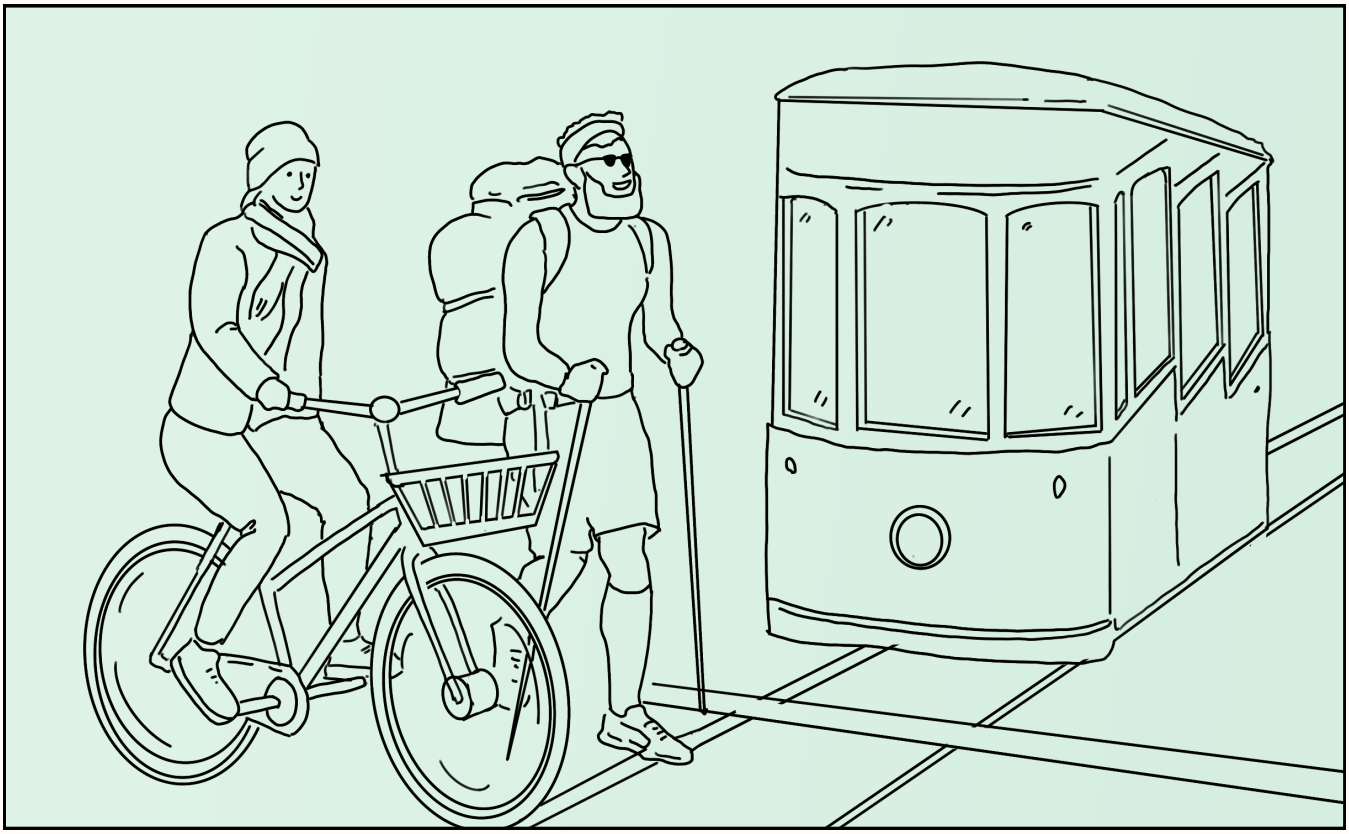
Designing for sufficiency in tourism mobility:

From understanding sufficient behaviors to facilitating future practices



Master Thesis

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Letter to the readers

Dear readers:

This thesis marks the culmination of my academic journey, and it would not have been possible without the invaluable support and guidance of several individuals.

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To my family and all my friends, thank you for your emotional support and constant encouragement throughout this journey. Your belief in me provided the strength I needed during challenging times.

Lastly, I hope this thesis offers valuable insights, and I wish all readers an enjoyable and enriching experience as they explore my work.

Best regards,

Ruihong Geng 耿瑞宏

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Abstract

Achieving a sustainable future necessitates a fundamental transition in both consumption and production patterns, as outlined in Sustainable Development Goal (SDG) 12. The urgency to adapt consumption patterns has grown due to criticisms surrounding the limitations of traditional approaches aimed at decoupling economic growth from energy use. In response, the concept of "sufficiency," which emphasizes reducing raw material and energy consumption while maintaining quality of life, has emerged as a pivotal component in sustainability discussions.

Within the tourism mobility sector, sufficiency holds particular promise for sustainability, as it encourages behaviors such as shorter travel distances and increased reliance on public transportation. This is especially crucial given that the transport industry significantly contributes to greenhouse gas emissions, with tourism mobility representing a key area for improvement.

This thesis investigates sufficiency and sufficient behaviors within tourism mobility, ultimately leading to the development of a design toolkit aimed at facilitating future projects. The research identifies three types of sufficient tourism mobility—absolute reductions, modal shifts, and sharing practices—alongside associated specific behaviors. A conceptual model integrating the Theory of Planned Behavior (TPB), Norm Activation Model (NAM), and external costs was created to predict these behaviors. Analysis of 191 responses through Partial Least Squares Structural Equation Modeling (PLS-SEM) revealed that subjective norms and attitudes are significant drivers of sufficient tourism mobility behaviors.

To translate these insights into actionable outcomes, a toolkit was developed through iterative design processes, supported by a co-creation session to identify intervention strategies. This toolkit provides resources for designers and stakeholders to foster sufficient tourism mobility behaviors effectively. While the findings primarily reflect European contexts, they offer a foundation for further exploration of sufficiency in tourism mobility design and may inform similar initiatives in other mobility domains.

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Chapter 01

Introduction

Introduction

Achieving a sustainable future requires effort to transition both current consumption and production patterns towards sustainability as articulated in Sustainable Development Goal (SDG) 12. The necessity to transition consumption patterns is becoming increasingly evident because the attempts to achieve "decoupling" economic growth from energy usage through efficiency and consistency approaches have received several critics as their potentials are limited (Bengtsson et al., 2018; Bithas & Kalimeris, 2013; Cordroch et al., 2022; Shove, 2018). In response, to transition consumption patterns, the concept "sufficiency" has been introduced into sustainability discussion as a complementary measure at the beginning of 2000s within activist circles, where the primary objective was to reduce raw material and energy consumption (Gorge et al., 2015). Until now, it has been widely recognized that the concept of sufficiency represents one of the most straightforward approaches to contributing to sustainable development (Freudenreich & Schaltegger, 2020).

While energy efficiency in the context of sustainability refers to achieving a higher ratio of energy services out to energy input, sufficiency can be summarized as "living well on less", emphasizing a reduction in production and consumption levels without necessarily compromising the quality of life (Herring, 2006). In this context, sufficiency concerns how people should behave regarding consumption and usage, emphasizing the need to "define the boundaries of efficiency" (Sachs, 2015), in other words, "Efficiency without sufficiency is lost" (Alexander, 2019). Moreover, the sustainability contributions of technology innovations in mobility may have been overstated and potentially harm the sustainable progress (Peeters et al., 2016). Therefore, sufficiency, differentiate from the other two approaches, may be a key approach to reducing the carbon footprint (e.g. (Cocolas et al., 2020; Kantenbacher et al., 2019).

From a consumer behavior perspective, sufficiency is categorized into absolute reductions and modal shifts for purchases, and sharing practices and product longevity for product usage (Sandberg, 2021). At the same time, achieving sufficiency involves implementing a variety of measures that support and promote sufficient behaviors across various domains, including business, policy, and so on. In business, the sufficiency measures include providing optional products and service, such as sharing and refurbishment services, along with associated marketing endeavors (Bocken & Short, 2016; Gossen & Kropfeld, 2022). In policy implementation, as an external driver for sufficiency, identifiable measures includes reduction, substitution, and general strategies (Zell-Ziegler et al., 2021).

Across different industries, mobility, in particular, holds significant potential to contribute to a sustainable future, such as promoting sufficient behaviors like "traveling shorter distances" and "shifting from private car use to public transportation", as highlighted by Sandberg (2021). One of the key reasons is that the transport industry has a significant impact on the ecological footprint and is one of the largest emitters of greenhouse gases (GHG). For instance, according to the report of IEA (2020), energy use in transport significantly increased from 23% of total final consumption in 1971 to 29% in 2015, making it the second-largest sector after "industry (manufacturing)". During the same period, energy use in the "residential" sector decreased from 24% to 21%, while the "industry (manufacturing)" sector remained constant at 38% (IEA, 2020). Moreover, the production of mobility-related products also contributes to the carbon footprint. For instance, car production alone may account for 10% of the total product lifecycle (Türe & Türe, 2021). From the demands side, the overall consumption level in mobility has been in a stable growth. Demand for passenger transport has increased from 2009 to 2019, while the split of transport modes has remained stable, with passenger cars and aviation ranking as the top two modes of transportation (EEA, 2020). Overall, achieving climate neutrality will require a 90% reduction in transport emissions by 2050 (EC, 2021; EEA, 2020; Lettenmeier et al., 2014), underscoring the significance of mobility in the sufficiency discussion.

More specifically, tourism mobility, which can be understood as transportation behaviors aimed at tourism activities as primary objectives (Liu et al., 2016; Qiao et al., 2021; Stauffacher et al., 2005; Tråsavik et al., 2024), presents significant potential for addressing sufficiency. This is because, despite its less frequent occurrence compared to other mobility types, it often involves longer travel distances and more resource-intensive modes of transport, making it a crucial area for reducing consumption and environmental impact. For instance, the relative contribution of long-distance journeys (≥100km) to GHG emissions is even larger and probably close to 50% while it only accounts for 1-2% of all person journeys (van Goeverden et al., 2016). Most of the carbon footprints in tourism result from factors such as the distances traveled, modal choice, accommodations utilized, and the corresponding emission factors associated with these activities (Peeters, 2017). Furthermore, the size of the carbon footprint attributed to transportation plays a significant role and tends to increase with rising levels of regional prosperity (Lenzen et al., 2018). Additionally, from the perspective of emission volumes, private car and air travel, which are seen as the top two unsustainable travelling options, continue to constitute a significant proportion of tourism mobility (Böhler et al., 2006; Strömblad, 2024).

It is noteworthy that although some researchers view mobility and tourism mobility more broadly, encompassing transportation planning, infrastructure, and manufacturing, in this graduation research, mobility specifically refers to consumers' ability to move and their accessibility to related travel options. Tourism, on the other hand, is defined as a specific type of tourism activity, primarily for recreation, relaxation, and pleasure during holidays (i.e., time reserved for tourism). Tourism mobility lies at the intersection of the tourism and transportation industries, and is seen as a necessary approach to tourism activities (Verbeek & Mommaas, 2008). If not stated, tourism mobility in subsequent contexts generally refers to the consumption-related behaviors of tourists as they travel to and move within a destination with the purpose of tourism activities.

Improving sufficiency in tourism mobility requires a thorough understanding of tourism mobility behaviors, as Verbeek and Mommaas (2008) suggested that the growth of tourism mobility industry is highly connected to the transport behaviors of tourists. From behavior perspective, tourism-transport space/times have been characterized as three types, which overlaps and intersect with each other: 1) travel between home and destination, 2) transport as tourism activities, and 3) in-destination transport (Hopkins, 2020). As Schlich et al. (2004) suggested, analyzing travel as a derived demand is more common in practice (e.g. (Gühnemann et al., 2021)). Therefore, focusing on the context of travel between home and destination, as well as in-destination transport, is a more prudent approach. At the same time, tourism mobility is also influenced by multiple factors, such as social, economic, and lifestyle aspects. Unlike work-related transport, where the purpose of travel is a pre-determined necessity, tourism mobility is driven by discretionary choices, making it harder to pinpoint the factors that shape travel behavior (Ohnmacht et al., 2009; Schlich et al., 2004).

While there have been studies related to tourists' sustainability, research specifically aimed at sufficiency in tourism mobility behavior has received comparatively less attention, accounting for only about 12% of sustainable tourist behavior studies (Li et al., 2024). Related research includes investigations such as the relationship between global identity, travel, and support for decarbonized mobility systems (Loy et al., 2021), as well as study on tourists' perceptions of distance, which are considered key aspects to achieving sufficiency in tourism mobility (Larsen & Guiver, 2013). Some studies also adopt a descriptive perspective on past behaviors. For instance, Sanyé-Mengual et al. (2014) studied tourists' energy consumption level during various tourism activities on the Menorca island.

Additionally, no study has yet examined tourists' sufficient mobility behaviors from a holistic perspective, although there have been attempts in the domain of general mobility that could be beneficial for research in tourism mobility. For instance, Banister (2008) proposed a framework for sustainable mobility, which includes (1) reducing the need to travel—substitution, (2) transport policy measures—modal shift, (3) urban planning and land-use policy measures—distance reduction, and (4) technological innovation—efficiency increase. From a technical perspective, electrified, autonomous and shared mobility (Sperling & Brown, 2018) as well as the fuel switches in transportation and alternatives to aviation (Girod et al., 2012) would significantly contribute to sufficiency. In policy, (Zell-Ziegler et al., 2021) studied supportive measures to sufficiency which found that related measures frequently occur in the mobility sector (124 out of 230 policies), with substitution representing the largest proportion (50% in mobility sector).

"Design" is frequently discussed and utilized as a method for creating interventions aimed at sustainable behavioral change. However, discussions on design in the context of sufficiency in tourism mobility are also notably absent. This may be because sufficiency has not yet gained widespread traction in design discussions, and there is no clear definition of what constitutes sufficiency in tourism mobility. Therefore, to enhance sufficiency in tourists' mobility behaviors, it is essential to first take a holistic approach to understand the meaning of sufficiency within the context of tourism mobility. This would lead to a series of tourism mobility behaviors that influenced by multiple psychological factors. Determining the relevant influencing factors to these behaviors and furtherly exploring how these factors specifically impact sufficient tourism mobility behaviors identified would be the second step. Finally, the results from the previous two steps need to be translated into a more accessible format, such as a design toolkit, to enhance future design practices and studies.

A main research question is formulated as "How can design support sufficient behaviors in the context of tourism mobility?". Sub research questions shown as follows in Table 1.

Table 1: Sub questions of main research questions

	Sub questions (SQ)	Methods
SQ 1	What are sufficient tourism mobility behaviors?	Literature review
SQ 2	What are the factors that influence sufficient tourism mobility behaviors?	Literature review
SQ 3	How does these identified factors impact the sufficient tourism mobility behaviors?	Partial least squares structural equation modeling (PLS-SEM)
SQ 4	How can design support the development of concepts aimed at promoting sufficient tourism mobility behaviors?	Ideation and iteration process

As presented in the Figure 1, the structure of this graduation research is as follows: First, a comprehensive review of existing literature on sufficiency and tourism mobility is conducted to enhance the understanding of sufficiency behaviors. Subsequently, this study identifies relevant constructs and develops hypotheses for a quantitative investigation into the factors influencing sufficiency behaviors in tourism mobility. The findings from the data analysis are utilized to design toolkit aimed at support strategies and practices for sufficiency in products and services related to tourism mobility. Finally, some recommendations are identified in the evaluation of the final toolkit. Corresponding chapters are also presented in the Figure 1.

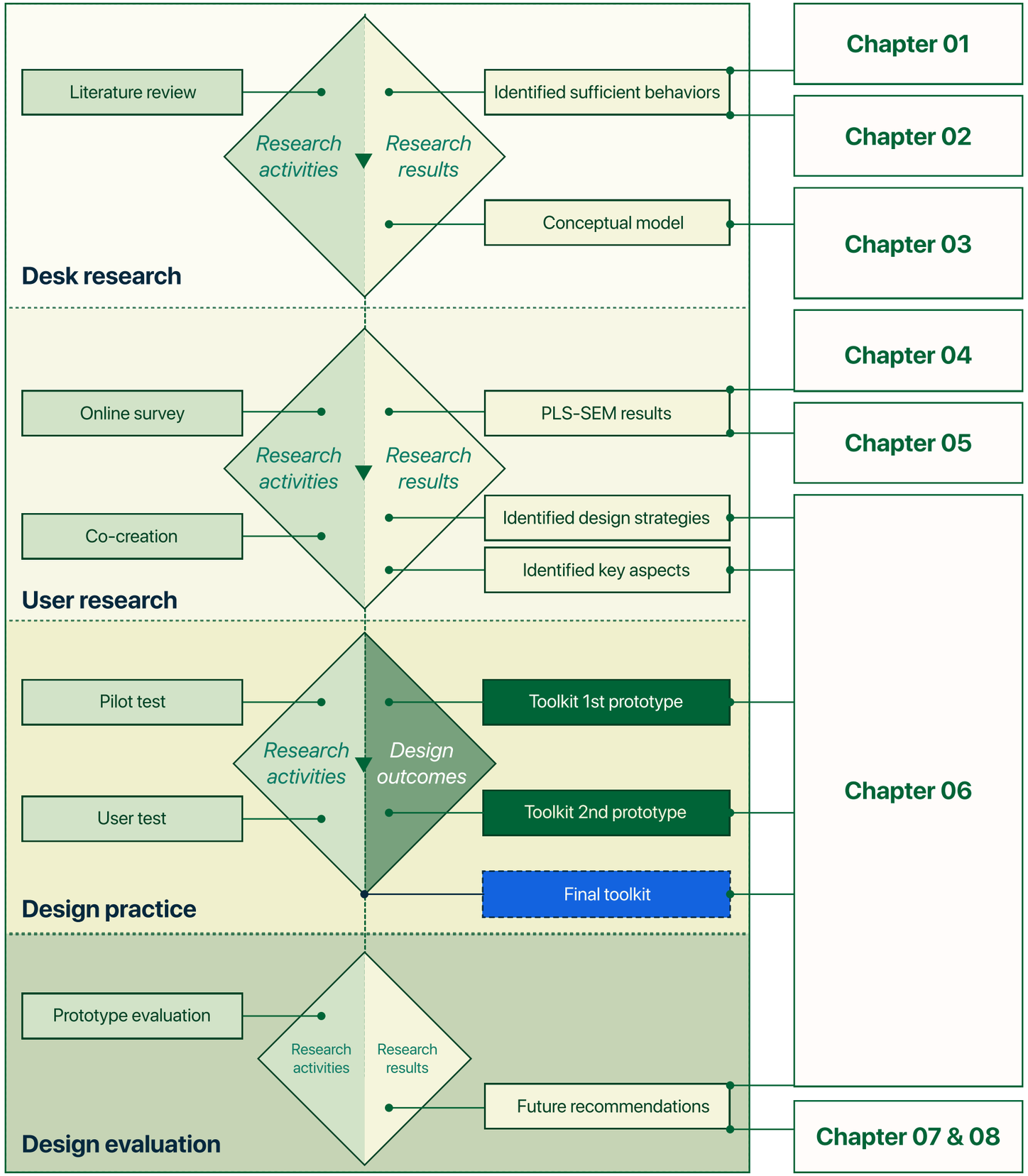


Figure 1. An overview of research process

Chapter 02

Identify sufficient tourism mobility behaviors

Sufficiency as a sustainability concept
Defining sufficiency behaviors of tourism mobility
Conclusion

Identify sufficient tourism mobility behaviors

To design and support sufficient tourism mobility behaviors, the first step is to identify what constitutes "sufficient behaviors" in this context. While previous literature has explored the concept of sufficiency and discussed some of the certain sufficient behaviors, there is limited research that holistically identifies and categorizes these behaviors specifically for tourism mobility. Therefore, a review of existing literature is necessary to identify and classify sufficient tourism mobility behaviors. Additionally, given the broad and conceptual nature of the sufficiency discourse, reflecting on the concept itself will also be beneficial in guiding this process.

At the same time, it is important to note that, while some researchers argue that sufficiency is not only about reducing consumption but also about ensuring individuals maintain a decent standard of living (Spengler, 2016), this research focuses on regions like the Netherlands and potentially broader areas of Europe—commonly viewed as "wealthy regions." Given that emissions in mobility, particularly tourism mobility, have significantly exceeded recommended levels, the lower dimension of sufficiency—related to the minimum social safety boundary, as described by Raworth (2017)—will be excluded from consideration, as it may contribute little to this specific context.

This section is structured as follows. First, it reviews and discusses existing literature on sufficiency as a concept of sustainable development to clarify its role within the mobility agenda. Second, it examines sufficient behaviors found in mobility and tourism mobility literature, ultimately identifying and categorizing three types of sufficient tourism mobility behaviors.

Sufficiency as a sustainability concept

As a counterpart to the concept of the "efficiency" which referring to "doing more with the same" in production, the concept of "sufficiency could be brought up referring to "living well on less" (Herring, 2006) in consumption. Generally speaking, improving the efficiency was seen as weak sustainable consumption (wSC) which mainly relies on the technology innovation, yet the strong sustainable consumption (sSC) emphasizes on reducing the overall consumption level and shifting towards a non-material contributions to a "good-life" (Lorek & Fuchs, 2013). In the work of Sandberg (2021), sSC is the same to "sufficiency. Sufficiency in such discussions of sustainability usually stands as one of the guiding principles and goals of the sustainable future, focusing on reduction and transition of the consumption patterns which serves as a complementary measure regarding efficiency and consistency, ultimately achieving certain standards such as not surpassing planet boundaries. Based on this, further research attempts to understand and analyze how sufficiency can provide guidance on consumption-related (certain) behaviors. From a general consumption perspective, four types of sufficiency behaviors of consumers have been identified as paths towards sufficiency goals: (1) Absolute reductions, (2) Modal shifts, (3) Product longevity and (4) Sharing practices (Sandberg, 2021). While the first two focus on the purchase perspective, the latter two were included in the discussion as product/service usage which eventually contribute to the sufficiency. Not all types of sufficiency behaviors can be easily identified within specific domains. For instance, behaviors associated with product longevity in the realm of mobility may include consumers" purchase of durable vehicles and related maintenance activities because such behaviors can also be regarded as an existing daily routines and habits.

As the main subject of sufficiency, consumer behavior remains a crucial focus of research, particularly in empirical studies. The barriers and facilitators to achieving sufficiency behaviors are diverse, such as in the realm of housing, where factors extend beyond socio-psychological factors such as environmental concern to include objective conditions such as knowledge and economic status (Gaspar et al., 2017). Sufficiency behaviors related to private households may have more objective barriers such as infrastructure, time, convenience (Speck & Hasselkuss, 2015). As psychological gains may positively connected with sufficiency behaviors (Zannakis et al., 2019), achieving sufficiency can be facilitated by reassessing personal needs and reflecting on the collective consciousness (Gorge et al., 2015). Furthermore, in clothing, digital devices and leisure air travel, social media communication can also play a role in promoting sufficiency behaviors in purchasing and usage patterns (Frick et al., 2021; Frick et al., 2020). and external driven forces including non-governmental organizations and policies (e.g. (Chamaret et al., 2023; Hoffmann et al., 2023; Saunders et al., 2021; Zell-Ziegler et al., 2021) targeting at the translating sufficiency from conceptualization to practice.

Sufficiency behaviors could also be influenced by supportive measures in the business domain from multiple aspects such as culture, marketing, and business model, ultimately impacting on consumer behaviors related to sufficiency. Culturally, consumption-orientated dominant social paradigm (Gollnhofer & Schouten, 2017; Kilbourne et al., 1997) such as the materialism and consumerism has been criticized (e.g. (Carrington et al., 2016; Gorge et al., 2015; Peattie & Peattie, 2009), which has provided a strong standpoint of sustainable transition. In marketing, anti-consumption and transitions in purchase and usage patterns are viewed as goals related to sufficiency. Peattie and Peattie (2009) proposed social marketing as a promising concept that encourages consumers to purchase more responsibly in a voluntary manner, thereby contributing to sufficiency. Moreover, increasing quality of the product and service provided by business (Heikkurinen et al., 2019) and communication (Gossen & Heinrich, 2021; Gossen & Kropfeld, 2022) could also contribute to sufficiency consumption behaviors. From the perspective of purchase options and long-term usage, the production and management modal could also be renewed to fit in the sufficiency changes of product longevity and sharing practices (Freudenreich & Schaltegger, 2020). At the same time, business may also expect the profit growth from these measures, specifically in sharing economy (Freudenreich & Schaltegger, 2020), while and to some extent lead to consumers" sufficiency practice (e.g. (Niessen et al., 2023).

In addition to business, external measures from governmental policies and non-governmental organizations also play an important role in sufficiency. From political viewpoint, for instance, Zell-Ziegler et al. (2021) categorized the measures into (1) general, (2) substitute and (3)

reduction. Viewing transport planning as one of the components in political discussions, Waygood et al. (2019) argued the implications of energy usage and participation in activities as for the quality of life will be the contributions of sufficiency to serve the goal of transport: improve quality of life through better access. In the context of air travel, while mandatory reduction measures during the pandemic initially produced favorable outcomes in reduction, voluntary behavior remains pivotal for sufficiency, primarily due to the rebound effect (Hoffmann et al., 2023). Initiatives integrating gamification features may also prove to be effective approach of facilitating the sufficiency behaviors (Chamaret et al., 2023).

Prior research has amassed abundant results that lays the groundwork for formulating a theoretical framework to systematically analyze sufficiency behavior. A theoretical model will be demonstrated in subsequent sections.

Defining sufficiency behaviors of tourism mobility

Although the previous section has explored sufficiency in a broader sustainability context, to address SQ 1, "What are sufficient tourism mobility behaviors?" a more focused overview of sufficiency in tourism mobility is needed. This will provide a clearer starting point before diving into specific behaviors. Therefore, the following sections will first discuss the concept of sufficiency in the context of tourism mobility, followed by a review of sufficient tourism mobility behaviors identified or related to the existing literature.

Potential categories of sufficiency in tourism mobility

Considering that there is limited research on sufficiency specifically in tourism mobility, but more extensive studies in the broader mobility domain, referring to this research will be beneficial for our discussion. Moreover, mobility is intrinsically linked to tourism; in other words, there is no tourism without mobility (Verbeek & Mommaas, 2008). Additionally, according to encyclopedia Britannica, tourism is "the act and process of spending time away from home in pursuit of recreation, relaxation, and pleasure, while making use of the commercial provision of services" (Walton, 2024). Therefore, the following section will include discussions from the mobility domain while ensuring that the essence of the concepts related to tourism mobility remains intact.

Banister (2008) and Zell-Ziegler et al. (2021) studied sufficiency in mobility from the perspectives of transport planning and policy interventions. In contrast, Sandberg (2021) examined sufficiency within a general consumption context. Theoretically, categorization of Sandberg (2021) can also be applied to the tourism mobility context, with adjustments based on prior research in both tourism mobility and broader mobility domains. Therefore, this section starts with the four types of sufficiency proposed by Sandberg (2021), and discuss the meaning of each type in the context of tourism mobility.

According to Sandberg (2021), "absolute reductions" means reducing the level of consumption such as avoid car purchase. In mobility, consumption of distance can serve as a quantitative indicator translated from these two objectives (Heisserer & Rau, 2017) which naturally leads reducing travel distance or taking fewer trips as sufficient tourism mobility behaviors. On the other hand, Creutzig et al. (2018) suggested that the "avoid" should also be a part of the absolute reductions behaviors in mobility. This includes avoiding unnecessary travel demands as well as avoiding additional purchases. Combining their opinions, two sub-types could potentially exist within the category of "absolute reductions" in tourism mobility: (1) Reduce the absolute distance of travelling such as choosing closer tourism destinations, and (2) Reduce the "waste" products related to travelling such as avoid renting an extra vehicle during the trips.

Modal shifts," on the other hand, also operate at the purchase level but refer to behaviors where consumers choose more sustainable options rather than avoiding a purchase altogether. Creutzig et al. (2018) use the term "improve" to describe similar behaviors, such as using products or services with greater efficiency, leading to reduced emissions over the long term. Additionally, the shifts may not only happen in product, but also the consumption patterns such as shift from air travelling to train travelling (Girod et al., 2012; Girod et al., 2014). Therefore, "modal shifts" also contains two subtypes which can be separated by examining if the sufficiency is contributed by the switch of purchase patterns or the purchase of product with high efficiency. This categorization is partly extended from the typology proposed by Girod et al. (2014) in which they see the sufficiency can be contributed by choice of similar but less GHG intensive products (changing patterns) or the same product produced with less GHG emissions (product improvement).

"Sharing practice" generally refers to behaviors that increase the frequency of specific product usage during its lifespan (Niessen & Bocken, 2021; Sandberg, 2021). Although the scholarly understanding of the sharing economy varies considerably (Pankov et al., 2021), two types of sharing practices can be found by examples. One can be seen as accessing to a service- and sharing-oriented businesses (Freudenreich & Schaltegger, 2020) such as using Car2Go to access the usage rights of certain product and the profit are use-related or the subscription-based business as Swapfiets (Ma et al., 2020; Niessen et al., 2023). The other can be seen as co-ownership such as co-using a car or everyday object (Speck & Hasselkuss, 2015), which focus more on the usage of products by individuals (Sandberg, 2021) including online car-hailing (e.g. (Li et al., 2017; Schatzinger et al., 2017).

"Product longevity" includes the behaviors which prolong the mobility product life (of usage) as the products (and service) degrade with the time and frequency of usage (Niessen & Bocken, 2021; Sandberg, 2021). It contains the actions such as product repair, restore, refurbish. and the related behavior on consumption including selling and buying second-hand products. Although "product longevity" exists in tourism mobility theoretically, it is worth noting that such behaviors are more commonly observed in the broader mobility context rather than in tourism mobility specifically, as vehicles are typically not restricted to a single usage context.

To sum up, the effects of sufficiency in mobility can be categorized into two main types, each with two sub-types. Table 2 presents these types of measures along with corresponding examples.

In Table 2, the name of four main types of mobility sufficiency are the same to the names of sufficiency changes identified by Sandberg (2021) and subtypes are developed partly based on the work of Girod et al. (2014). In general, this categorization can be seen as extended definitions which gives more detailed explanation of these types specifically in mobility context.

At the same time, it is noteworthy that although some groups may take such behaviors, the driven motives may origin from the financial perspective, and the air travel seems inevitable in certain destinations (Böhler et al., 2006). As another factor of "consumption of distance", materials will be seen as products associated to the mobility behaviors (e.g. food consumption for walking, vehicle parts for maintaining) in the following discussions. For the easiness of discussion and reading, the word "product" does not include fuel or electricity which can be seen as direct energy but include the nutrition products such as food and meals as indirect energy for human transportation.

Table 2: Different types of sufficiency in mobility context

Types	Sub-types	Examples
Absolute reductions (AR)	(1) Reduce the absolute distance of travelling.	Adjusting the travel destination closer to the current location (Banister, 2008).
	(2) Reduce the "waste" products related to travelling.	Maintaining the vehicle such as a car well and avoid the extra vehicle purchases (Caulfield, 2012).
Modal shifts (MS)	(1) Pattern improvement: turn to the mobility pattern with higher mobility (energy) efficiency.	Taking trains or buses instead of taking fuel private car (Waygood et al., 2019).
	(2) Product improvement: select the same item but less resource-reliable/consuming.	Taking electrified vehicles instead of taking fuel vehicles (Vafaei-Zadeh et al., 2022).
Sharing practices (SP)	Increase the frequency of product usage (among different users) during its lifespan.	Using shared services such as car and bike sharing (Niessen et al., 2023; Svennevik, 2019).
Product longevity (PL)	Increase the product lifespan (from cradle to cradle) while maintaining its functions.	Improving the lifespan of EV battery (Khowaja et al., 2022).
		Selling and purchasing second hand vehicles(Alhakamy et al., 2023).

Although changes in consumption levels and patterns are separate from product usage, these four types of mobility sufficiency behaviors function together within a comprehensive framework. Three recurring keywords emerge: (1) product(s), (2) distance, and (3) energy. Absolute reductions and modal shifts directly impact these aspects, making them more effective measures. For instance, absolute reduction emphasizes minimizing all types of mobility activities, while modal shifts aim to introduce more sustainable alternatives into the system. On the other hand, sharing practices and product longevity specifically target the "product" aspect, suggesting a more indirect impact. Sharing practices aim to enhance the efficiency of vehicle use across multiple users, while product longevity focuses on extending the lifespan of vehicles, thereby slowing down product degradation.

Identifying specific sufficient tourism mobility behaviors

The previous section discussed the concept of sufficiency in tourism mobility at a conceptual level. However, the specific behaviors that constitute sufficient tourism mobility remain unclear. The goal of this section is to identify and clarify the specific sufficient tourism mobility behaviors that are presented in the existing literature.

To begin with, tourism mobility includes three types, which overlaps and intersect with each other: 1) travel between home and destination, 2) transport-as-tourism, and 3) in-destination transport (Hopkins, 2020). In the following discussions, the focus is the first and third types of tourism mobility (i.e. directed travel).

Regarding the general goal of sufficiency in tourism mobility, reduction on car and aviation travelling seems crucial for sufficient tourism mobility behaviorsconsidering its significant role in global emission (Lenzen et al., 2018). In such context, restraining behaviors of car and aviation travelling is of course necessary (Peeters et al., 2019). However, achieving this goal may be hindered by practical reasons. For instance, in certain circumstances, local regions may facilitate consumers' choices of cars and airplanes, particularly in rural areas where public transportation options are limited (Dickinson & Robbins, 2008). Another potential goal of sufficiency in tourism mobility is to challenge the demand for travel or long-distance travel, even though tourism activities are driven by multiple motives (Speck & Hasselkuss, 2015). For instance, it is possible to spend some leisure time at or near home (Götz et al., 2002) as well as engage in non-motorized travel options (Lanzendorf, 2002).

To better identify specific sufficiency behaviors in tourism mobility, a literature search regarding sustainable tourism behaviors studies was conducted.

The search was conducted using the "Web of Science" database with the keywords "sustainb*", "transport*", "mobility", "behavior*" and "touris*". Only examples that specifically mentioned behaviors in tourism will be listed, including the critics of current behaviors.

Among all the results, sufficiency tourism mobility behaviors regarding PL did not appear with the previous keywords. One of the reasons may be that PL is integrated into the everyday life instead of a certain mobility behavior. Therefore, "mobility", "transport" and "lifespan" were used as keywords in the search of PL behaviors.

Sampling strategy partly includes the snowball strategy, and the collection process stopped when the data was saturated.

Summarized behaviors of tourism mobility sufficiency were listed in the following Table 3. Some of the behaviors in the original text did not clarify the exact sufficiency type. For these behaviors, the categorizations were made based on the context and keywords.

The first notable result is that in the current discussions, PL is not prominently recognized as a significant aspect of sufficient behaviors in tourism mobility. In earlier discussions, PL within the context of mobility sufficiency has typically included actions such as maintaining and repairing vehicles and using second-hand products. However, when narrowing the focus to tourism mobility, these behaviors become less specific, and it is difficult to argue that they clearly fall under the category of sufficiency in this context. For instances, existing research related to PL in mobility encourage maintaining the car (Ratner et al., 2021), reducing the negative impact of batteries of the vehicles (Ahuja et al., 2020), including lead-acid batteries (Lou et al., 2022; Zhang et al., 2022) and Li-on batteries (Pražanová et al., 2024; Rallo et al., 2020). When applying these behaviors to tourism activities, they seem less applicable for tourists to follow throughout their trips and more aligned with everyday travel contexts. Such results also correspond to the doubts raised in the previous section.

The private fuel car and air travel seems to be the behaviors that are not sufficiency currently due to its distance, frequency, and overall emissions (Dillimono & Dickinson, 2015; Ram et al., 2013). Long distance travelling (Lettenmeier et al., 2014) and short duration of stay for tourism (Daniel Scott et al., 2010) were also criticized as not sustainable. Addition to the behaviors identified above, the first to make changes may be high-income groups and travelers from high-income regions, as they account for a considerable carbon footprint in the mobility sector (Lenzen et al., 2018; Millward-Hopkins et al., 2020).

Table 3: Promoted behaviors from the literature

Absolute Reductions (AR)	Modal Shifts (MS)	Sharing Practices (SP)
Short-haul travel (Dickinson et al., 2011; Ram et al., 2013)	Public transportation (Ram et al., 2013)	Using shared mobility services such bike sharing. (Gühnemann et al., 2021; Soomauroo et al., 2020)
the choice of closer destinations (Daniel Scott et al., 2010)	climatically more sustainable transport modes (Daniel Scott et al., 2010)	E-bikes and electric car rentals. (Eckert & Pechlaner, 2019)
increases in average length of stay (Daniel Scott et al., 2010)	Walking and cycling as modes of transport, also referred to as active mobility (AM) (Schlemmer et al., 2019)	E-bike sharing usage. (Bardi et al., 2019)
Fewer trips (Dickinson et al., 2011)	Shift from car renting to public transport (Martín Martín et al., 2019)	Shared van in "Mobility as a Service". (Kim et al., 2021)
Shift towards shorter trips and closer destinations. (Gühnemann et al., 2021)	Travelling by EVs. (Martín Martín et al., 2019)	
Reduction of trip frequency (less frequent holidays, potentially with longer duration). (Gühnemann et al., 2021)	prefer train, coach, cycle and foot travel instead of **air and car.** (Dickinson et al., 2011)	
Reduce air travel. (Gühnemann et al., 2021; D. Scott et al., 2010)	air transport is rejected in favour of more environmentally benign forms of overland transport (Dickinson et al., 2011)	
Reduce car usage. (Maltese & Zamparini, 2023)	Low-carbon travel (Dickinson et al., 2011)	
limiting the distance travelled to 10,000 km/(person·a). (Lettenmeier et al., 2014)	Coach tourism (Dickinson et al., 2011)	
Utilizing outdoor options requiring few resources (walking, jogging, canoeing, ...). (Lettenmeier et al., 2014)	mode shift from conventional motorcycles to electric motorcycles. (Nguyen-Phuoc et al., 2023)	
	Multimodal travel. (Gühnemann et al., 2021; Maltese & Zamparini, 2023)	
	Use of low-emission or zero-emission vehicle technologies and fuels. (Gühnemann et al., 2021)	
	Scootering. (Maltese & Zamparini, 2023)	
	Shuttle service and bike sharing to reduce car usage. (Curtale et al., 2024)	
	Air transport is substantially replaced by rail transport. (Peeters et al., 2019)	

The promoted sufficiency tourism mobility behaviors can be seen as responses to the unsustainable status and tendency. This is more obvious in the AR and MS, while the SP are more focused on product and service comparison.

Conclusion

Overall, three types of sufficiency could be found in the context of tourism mobility, absolute reductions, sharing practices and modal shifts. Although product longevity is not obvious to be seen in tourism mobility, it exists in general mobility context, such as buying second-hand vehicles or components of vehicles (Mardani et al., 2017).

In absolute reductions, the focus was primarily on reducing travel distance. It also partly encompasses vehicle-related purchases, although this aspect is not prominently addressed in the literature. In the context of modal shifts, behaviors are categorized into patterns and product improvements, which is unique, as such distinctions may not be as prevalent in other contexts, such as clothing, where pattern changes are less common. On the other hand, sharing practices in tourism mobility are largely centered around the sharing economy, which may differ from other contexts as well. For instance, in the context of food consumption, sharing may occur more between family and friends rather than as a business transaction.

Additionally, in the existing literature, fuel-based cars and air travel are often viewed as behaviors to be avoided, with sufficient alternatives such as public transportation and electric vehicle use being promoted. However, comparisons and discussions regarding these sufficient alternatives are less frequently addressed. For instance, it is evident that walking in a nearby park emits far less carbon than purchasing and driving an electric car for 1,000 kilometers to reach tourist attractions. However, within the context of tourism, it is challenging to isolate and compare these two behaviors without considering the broader scope of long-term impacts or local scenarios. For example, the reasonable tourism demand in certain areas may be higher than in others due to specific working and holiday policies. On the other hand, this significant variation among sufficient behaviors aligns with the concept of "enoughness," which emphasizes staying within a certain scope without exceeding the boundaries of the ecological ceiling and social foundation. Therefore, in this research, sufficient tourism mobility behaviors are depicted as a series of actions that tourists should adopt, although the level of contribution to sustainability may vary significantly among these promoted behaviors. Simultaneously, the research also outlines a series of behaviors that tourists should avoid or engage in less frequently.

Last but not least, considering that sufficiency, efficiency, and consistency are strongly interconnected and collectively contribute to sustainability, sufficient behaviors may also be dynamic over time. For instance, the environmental impact of frequently traveling long distances in fuel-powered cars could be reduced with advancements in fuel engine technology and the use of biofuels. Therefore, while the following sections will continue to classify certain tourism mobility behaviors as "insufficient," this does not negate the possibility that these behaviors may hold different meanings regarding sufficiency in the future.

Chapter 03

Research model and hypothesis development

Theory of planned behavior (TPB)
Norm activation model (NAM) in predicting altruistic behavior.
Integrating NAM and TPB
Habit
External cost
Proposed theoretical model
Conclusion

Research model and hypothesis development

The previous chapters discussed sufficiency in tourism mobility and identified sufficient behaviors, including absolute reductions, modal shifts, and sharing practices within the context of tourism mobility. Building on that, this chapter focuses on investigating the factors that influence sufficient tourism mobility behaviors.

When discussing tourism travel and tourism mobility, it is important to note that, most of the time, these are planned and conscious behaviors rather than unconscious activities. Tourists typically make deliberate decisions about their travel choices, destinations, and modes of transportation, reflecting a higher level of intentionality compared to everyday mobility. On the other hand, when discussing sustainability in tourism mobility and consumer behaviors, sufficient tourism mobility behaviors may also be driven by moral obligations, as argued in much of the literature on responsible consumption (e.g. (Webb et al., 2008) and sustainable tourism travel (e.g. (Gehlert et al., 2013). These behaviors are often influenced by ethical considerations, where tourists feel a sense of responsibility to minimize their environmental impact and make choices that contribute to sustainable future. Therefore, the theory of planned behavior (TBP) (Ajzen, 1991), and norm activation model (NAM) (Schwartz, 1977) show the potential in explaining these behaviors. TPB and NAM have been widely adopted in research investigating pro-environmental behavior (e.g. (Gelaidan et al., 2023) and (Fu, 2021).

While TPB has been widely acknowledged as an effective framework for forecasting consumer behaviors, certain scholars have advocated for the integration of supplementary constructs to enhance TPB's predictive efficacy (Bamberg et al., 2003). For instance, nonvolitional factors, such as an individual's financial status and the road conditions of tourism destinations, also exert a strong influence on tourism mobility behaviors (Ajzen, 1991). These external constraints can limit the ability of tourists to engage in sufficient behaviors, even if they have the intention to do so. Financial limitations may restrict access to more sustainable travel options, while poor infrastructure at destinations can hinder the adoption of environmentally friendly modes of transport. Therefore, making the extension model with additional contextual constructs such as external cost is imperative (Conner & Abraham, 2001; Kropfeld, 2023; Liao et al., 2018).

Moreover, sufficient tourism mobility behaviors may also be partly influenced by an individual's travel habits. For instance, coastal areas often tend to be popular tourism destinations year-round, while mountainous regions attract seasonal tourists, particularly during the snow season. These habitual preferences can shape tourists' choices, making certain destinations and modes of travel more likely in an unconscious and automatic way. Over time, these ingrained habits can override deliberate decision-making, leading to routine travel behaviors that may not align with sufficiency goals, even when more sustainable options are available.

Thus, combining TPB and NAM provides an opportunity in examining sufficient tourism mobility behaviors from the perspectives of rationality and morality, while external cost and habit could serve as additional factors from the perspective of nonvolitional aspect and unconscious behaviors.

This section is therefore organized as follows: firstly, it delves into the TPB model and the NAM model in predicting sufficiency behaviors; secondly, it introduces supplementary constructs; and finally, it proposes an integrated theoretical model and corresponding hypotheses for predicting behaviors related to sufficiency in the context of tourism mobility.

Theory of planned behavior (TPB)

Theory of planned behavior (TPB) is one of the most commonly used theory in consumer behavior studies, including some of the literature mentioned previously. TPB have been proved to be suitable for sustainable related studies in examining pro-environmental behaviors systematically (Liao et al., 2018; Onwezen et al., 2013; Spangenberg & Lorek, 2019). Existing research on mobility behaviors with TPB and its extension models including destination choosing (Hsu & Huang, 2012; Lam & Hsu, 2006; Neto et al., 2020; Sparks & Pan, 2009), travel mode choosing (Bachmann et al., 2018; Cai et al., 2019; Heath & Gifford, 2002; Si et al., 2020; Timmer et al., 2023), usage reduction (Lanzini & Khan, 2017; Y. Liu et al., 2017), and related purchase (Hauslbauer et al., 2022; Riverso et al., 2023) and identifying travel segments (Anable, 2005). In most of these studies, TPB demonstrates strong explanatory capability in predicting both intentions and actual behaviors.

According to the theory, an individual's behavior was determined by the persons'' intention of perform the behavior, where intention itself was influenced by attitude, perceived behavioral control and subjective norm (Ajzen, 1991). Mobility behavior is largely governed by rationality, and thus the TPB has shown strong efficacy in predicting relevant behaviors (Bamberg et al., 2003). When applying TPB into the domain of tourism mobility sufficiency (specifically the types identified in the Table 2), subjective norms pertain to the perceived societal pressure regarding the execution or abstention from sufficiency behaviors. Attitude denotes the degree to which an individual approves tourism mobility sufficiency. Perceived behavioral control, on the other hand, addresses the individual's perception of their capability to execute tourism mobility sufficiency. These studies have shown that attitude, subjective norm, and perceived behavioral control all positively affected the behavioral intention. Accordingly, this research proposes three hypotheses as follows:

Hypothesis 1 (H1)	Attitude towards tourism mobility sufficiency (ATT) has a positive influence on behavioral intention towards tourism mobility sufficiency (INT).
Hypothesis 2 (H2)	Perceived behavior control of tourism mobility sufficiency (PBC) has a positive influence on behavioral intention towards tourism mobility sufficiency (INT).
Hypothesis 3 (H3)	Subjective norm (SN) has a positive influence on behavioral intention towards tourism mobility sufficiency (INT).

Norm activation model (NAM) in predicting altruistic behavior

The norm activation model was first introduced by Schwartz (1977) which is originally developed to explain altruistic behavior. According to NAM, the behavior intention is influenced by the personal norm (the moral obligation of an individual to believe that he or she should act in a certain way), while the norm activation process is determined by two factors, awareness of consequences (AC) (the extent to which individuals are aware of the possible consequences of their actions) and ascription of responsibility (AR) (degree of individual attribution of responsibility for the consequences of not acting pro-socially) according to the model 2 in the work of Steg and de Groot (2010). NAM has been widely used in sustainability mobility research as sustainable mobility is also considered as one of the altruistic behaviors. Existing research includes travel modes choice (Haustein et al., 2009; Møller et al., 2018; Sheng & Zhang, 2022; Si et al., 2020), reduce car driving (Y. Liu et al., 2017; Olsson et al., 2018), sharing mobility (Lee et al., 2020; Wang et al., 2021).

Therefore, related hypothesis is made as follows.

Hypothesis 4 (H4) Personal norm of sufficient tourism mobility behaviors (PN) has a positive impact on intention to tourism mobility sufficiency behaviors.

Integrating NAM and TPB

TPB and NAM both presents good ability in predicting individual behaviors from the perspective of reasoned action and pro-social behaviors. Researchers furtherly propose the combined model of TPB and NAM to improve the forecasting capabilities (e.g. (Y. Liu et al., 2017; Park & Ha, 2014). It is noteworthy that in some of the studies, SN does not show significant impact on the INT (e.g. (Cao Minh & Nguyen Thi Quynh, 2024; Liao et al., 2018; Sadeghian et al., 2022). In such instances, SN usually has a significant effect on PN (e.g. (Bobeth & Kastner, 2020; Cao Minh & Nguyen Thi Quynh, 2024; Nordlund & Garvill, 2003). Furtherly, it can be assumed that the recognition of the tourism mobility sufficiency typically begins with SN, and subsequently become internalized as PN.

Therefore, related hypothesis is made as follows.

Hypothesis 5 (H5) Subjective norm of sufficient tourism mobility behaviors (SN) has a positive impact on the personal norm (PN) of sufficient tourism mobility behaviors.

Habit

Past behaviors reflect habit strength and have a direct effect on future performance and adding the habit into TPB model can increase the forecasting capabilities (Ouellette & Wood, 1998). The central tenet of habitual behavior posits that individuals'' actions are influenced not only by rational decision-making and moral obligation, but also by past successful experiences of similar behaviors (Haustein et al., 2009). The connection between habit and behavior intention in mobility related behaviors has been examined (Bamberg et al., 2003; Lam & Hsu, 2006; Stern, 2000). Traditional opinion is that the influence from habit on intentions usually happens in the occasions that are relatively stable (Aarts & Dijksterhuis, 2000; Bamberg et al., 2003; Lanzini & Khan, 2017), and may furtherly impact the norm activation process (Klöckner & Matthies, 2004). On the other hand, HAB could also positively connected with ATT and PBC from the aspect of habitual actions (Stern, 2000), and furtherly making the intervention more comprehensive. However, regarding SN and PN, habitual behaviors may have little connection with SN and PN. SN are primarily concerned with the perceived expectations from others, while PN are driven by factors of AR and AC, which have less influence on unconscious or automatic behaviors.

Therefore, hypotheses are made as follows.

Hypothesis 6 (H6) An individual's habit on mobility sufficiency (HAB) has a positive impact on intention towards tourism mobility sufficiency (INT).

Hypothesis 7 (H7) An individual's habit on tourism mobility sufficiency (HAB) has a positive impact on attitude towards tourism mobility sufficiency (ATT).

Hypothesis 8 (H8) An individual's habit on tourism mobility sufficiency (HAB) has a positive impact on perceived behavioral control towards tourism mobility sufficiency (PBC).

External costs

The external costs consist of both economic and social aspects, such as accessibility to private cars, and time spent in organizing with travel partners. External cost (EC) may also influence on the tourism mobility sufficiency. According to Schoenau and Müller (2017), the lower the external costs are, the easier it is for an individual to achieve a certain behavior. Regarding sufficiency behaviors in tourism mobility, it can be assumed that the external cost of adopting sufficiency behaviors would have a negative impact on the enthusiasm of consumers'' behavioral intentions.

The connection between EC and habits could be positively related, and have been proved in the study of Schoenau and Müller (2017). There are also potential connections between EC and other factors identified previously. However, the primary rationale for incorporating EC into the theoretical model is to investigate the strength of the impact of unconscious aspects more accurately on INT. Furthermore, the theory model is primarily focused on measuring the direct impact of potential factors on INT. Therefore, the hypotheses are formulated as follows.

Hypothesis 9 (H9) The higher the external costs (EC) associated with the adoption of sufficient tourism mobility behaviorsare, the less likely an intention to tourism mobility sufficiency (INT) is.

Hypothesis 10 (H10) The higher the external costs (EC) associated with the adoption of sufficient tourism mobility behaviorsare, the less likely an individual's habit on mobility sufficiency (HAB) is.

Proposed theoretical model

In summary, a theory model of sufficient tourism mobility behaviors is formed as shown in Figure 2.

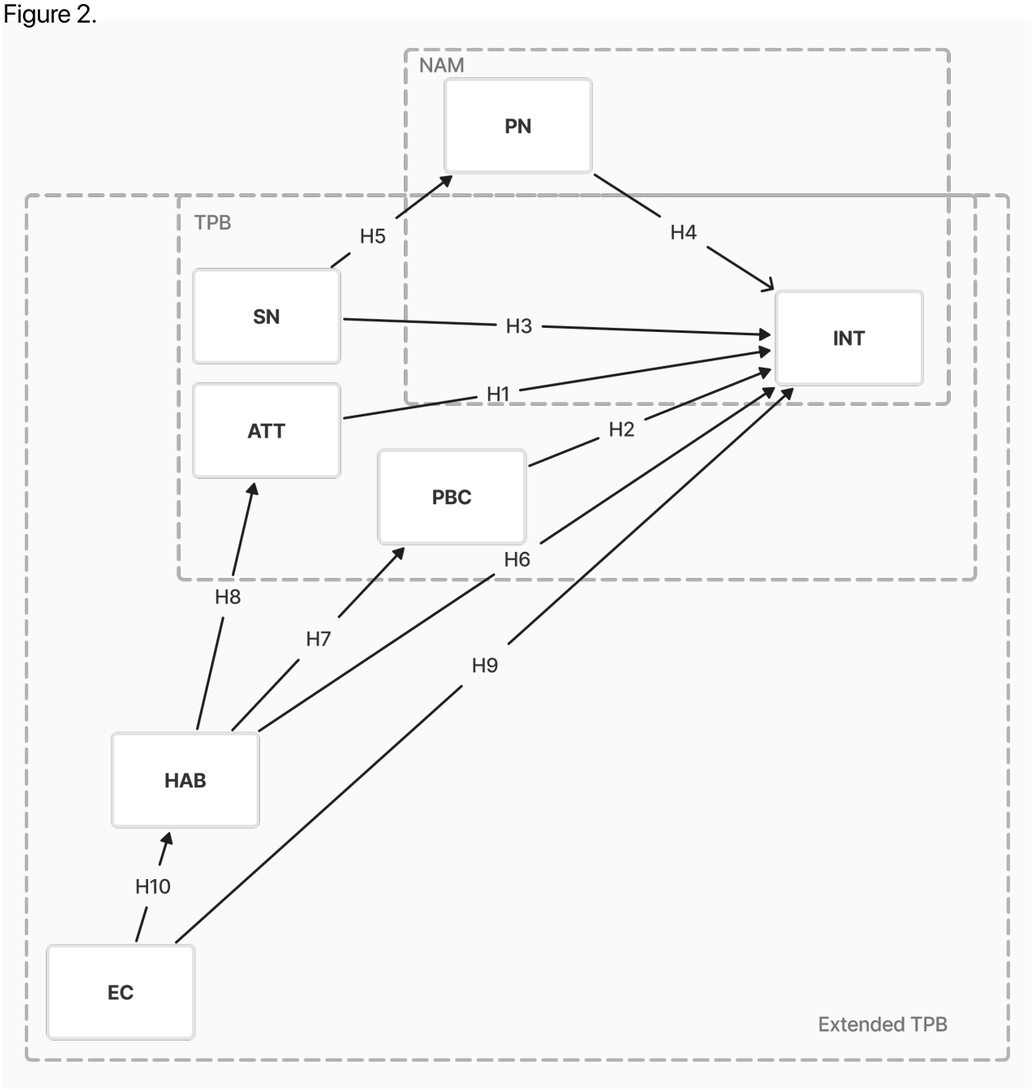


Figure 2. Conceptual theory model

As Figure 2 presents, the proposed theory model seeks to integrate an extended TPB model with HAB as an additional construct and NAM to explore toursim mobility sufficiency activities from ethical, rational, and habitual viewpoints. It is noteworthy that the model primarily evaluates the direct impact of each factor on INT rather than the indirect effects, such as the associations between SN, ATT, and PBC. This approach simplifies the comparison of driving factors and provides a clearer foundation for potential design interventions. By focusing on direct impacts, the model allows for a more straightforward analysis of how each factor influences INT, facilitating the identification of specific areas for improvement or intervention within the design process.

Conclusion

In summary, this chapter presents a combined model for predicting sufficient tourism mobility behaviors, as identified in the review section. The model primarily focuses on the psychological aspects of behavior and integrates the Theory of Planned Behavior (TPB) with the personal norm component from the Norm Activation Model (NAM). Additionally, habit is introduced as a supplementary construct from a habitual perspective, and external costs are considered as a non-volitional factor to enhance forecasting capability. The model comprises seven constructs and proposes ten hypotheses, all of which are intended to be tested within the context of this combined theoretical framework.

At the same time, it is important to note that, since absolute reductions, modal shifts, and sharing practices were identified earlier as three distinct types of sufficient tourism mobility behaviors, the factor INT in the proposed model may carry multiple meanings. This is because the model may yield different results depending on whether INT refers to specific types of sufficient tourism mobility behaviors. Specifically, INT can represent absolute reductions, modal shifts, and sharing practices individually, as well as all three types collectively. Therefore, in the following sections, unless otherwise specified, INT will typically refer to these four different meanings combined.

Chapter 04

Measure the model through online survey

Measure of the constructs
Data collection

Measure the model through online survey

This chapter will discuss the measurement of the constructs discussed in the previous section and the data collection and analysis methods.

Measure of the constructs

The following Table 3 presents the proposed measure item for each construct. These questions are modified from the existing research and have been labeled accordingly. Some of the expressions regarding sufficiency as a sustainability concept were also adapted for the easiness of understanding.

Considering that four types of sufficient tourism mobility behaviorsmay be influenced by identified independent variables differently, the measure items for INT were divided into four sessions as well. First, participants are given a short-listed behaviors of each sufficiency tourism mobility types. Then, they are requested to fill in four measure items regarding their intentions to each sufficiency tourism mobility behavior type from the aspects of intention strength and frequency of plannings. The introductions of each type were listed below.

Table 4: Listed behaviors for measure items of INT

Types	Listed behaviors
AR	Choosing closer tourism destinations and travelling for shorter distance.
	Increasing length of stay in the destination.
	Fewer trips and shorter duration of trips.
	Limiting car and air travelling.
MS	Taking sustainable transport modes including public transportation, cycling, walking, jogging, train, coach.
	Taking electrified vehicles including electric cars, bikes and scooters.
	Using multimodal travel (multi-trip transportation) options including shuttle bus
SP	Using shared mobility service including car sharing, bike sharing, e-bike sharing.
	Using electric car rental services.

32 items were used as indicators as shown in Table 5. All the items were measured by 7-point Likert scales anchored from strongly disagree to strongly agree. Gender, age, educational level, and income level are also collected as demographic statistics at the end of the questionnaire. In total, 36 questions were included in the questionnaire.

Table 5: Indicator variables and latent constructs.

Constructs		Wordings	Source
Intention	AR1	I strongly intend to adopt these behaviors for my tourism travels.	(D. Liu et al., 2017)
	AR2	As far as possible, I will choose to adopt these behaviors for my tourism travels in the coming year.	
	AR3	I will encourage the members of family and friends to adopt these behaviors for tourism travels.	
	MS1	I intend to adopt modal shifts in my tourism transportation behaviors.	
	MS2	As far as possible, I will choose to apply modal shifts in my tourism transportation behaviors in the coming year.	
	MS3	I will encourage the members of my family and friends to adopt modal shifts in tourism transportation behaviors.	
	SP1	I intend to adopt sharing practices in my tourism transportation behaviors.	
	SP2	As far as possible, I will choose to apply sharing practices in my tourism transportation behaviors in the coming year.	
	SP3	I will encourage my family members and friends to adopt sharing practices in tourism transportation behaviors.	
Attitude	ATT1	I think tourism transportation with behaviors that prioritize sufficiency is wise.	(Sun et al., 2022)
	ATT2	I think tourism transportation with behaviors that prioritize sufficiency is good.	
	ATT3	I think tourism transportation with behaviors that prioritize sufficiency is worthwhile.	
	ATT4	I think tourism transportation with behaviors that prioritize sufficiency is beneficial.	
Perceived behavioral control	PBC1	I believe I have the ability to adopt sufficiency behaviors in tourism travels.	(Paul et al., 2016)
	PBC2	If it were entirely up to me, I am confident that I will adopt sufficiency behaviors in tourism travels.	
	PBC3	I have resources, time and willingness to adopt sufficiency behaviors in tourism travels.	
	PBC4	Sufficiency travel options are generally available to me when I go for tourism.	
Subjective norm	SN1	Most people who are important to me think I should adopt sufficiency behaviors in tourism travels.	(Paul et al., 2016)
	SN2	Most people who are important to me would want me to adopt sufficiency behaviors in tourism travels.	
	SN3	Related policies influence me to adopt sufficiency behaviors in tourism travels.	
	SN4	My friend"s positive opinion influences me to adopt sufficiency behaviors in tourism travels.	
Personal norm	PN1	I have an obligation to cherish the limited resources of the earth.	(Onwezen et al., 2013), Guilty item (Zhang et al., 2017)
	PN2	I have an obligation to learn more about the natural environment.	
	PN3	I have an obligation to respect the life-sustaining needs and rights and interests of all living things in the environment.	
	PN4	I have an obligation to maintain a good natural environment so that the next generation can have the same life quality.	
Habit	HAB1	I adopt sufficiency behaviors in tourism travels frequently.	(Haustein et al., 2009; Verplanken & Orbell, 2003)
	HAB2	I adopt sufficiency behaviors in tourism travels automatically.	
	HAB3	I adopt sufficiency behaviors in tourism travels without having to consciously remember.	
	HAB4	It makes me feel weird if I do not adopt sufficiency behaviors in tourism travels.	
External costs	EC1	For me, the financial cost of adopting sufficiency behaviors in tourism transportation is high.	(Dong et al., 2020)
	EC2	For me, the time cost of adopting sufficiency behaviors in tourism transportation is high.	
	EC3	For me, the overall effort required to adopt sufficiency behaviors in tourism transportation is high.	

Measure items for ATT, PBC, SN and PN were modified from the existing relevant scales. Habits were also measured by the first four items from Self-Report Habit Index (SRHI) developed by (Verplanken & Orbell, 2003).

Measure items for EC follows the argument that the cost includes financial and psychological aspects (Ashinze et al., 2021; Schoenau & Müller, 2017). As this graduation research focus on examining travelers'' behaviors of moving to and in the destinations, the financial cost can be measured by the two items accordingly as Dong et al. (2020) did. The psychological aspect, on the other hand, can be measured by the effort and overall feeling of adopting the sufficiency options (Masri et al., 2021; Schoenau & Müller, 2017).

The expressions of each item were developed first by me first, and then reviewed by a pilot test with 4 participants. Considering the scale can only be presented vertically in the mobile device, the 7-point likert scale was adopted. In total, it will take around 5 mins to fill in the whole survey.

Data collection

Following the data management protocol, an online questionnaire with the items in Table 5 was designed and developed via TU Delft Qualtrics, and later distributed in the researcher's personal network. The questionnaire is also attached in Appendix A.

Considering that the survey consists of 36 questions in total, one of the testing questions were added in the survey, asking participants to choose ''Agree'' to prove the validity of the reply.

Chapter 05

Results of PLS-SEM

Data analysis

Demographics of the surveyed sample.

Assessment of measurement model

Assessment of structural model

Conclusion

Results of PLS-SEM

A total of 256 responses were received for the survey. However, some of these responses are unreliable due to various reasons, such as failing the attention check, completing the survey too quickly, or repeatedly providing the same answer, which suggests unreliable data.

Therefore, a data screening process was implemented based on three criteria. First, responses that did not pass the attention check were removed. Second, responses that took less than 80 seconds to complete were deleted. Finally, any responses that provided the same answer for more than 12 consecutive questions were also removed. For responses with 12 consecutive identical answers, if these answers covered three complete variables, the responses were similarly deleted. While this screening process might have eliminated some valid responses, they were still removed to ensure the reliability of the subsequent analysis.

In the end, 191 responses were selected for the further analysis. Figure 3 illustrates the data selection process.

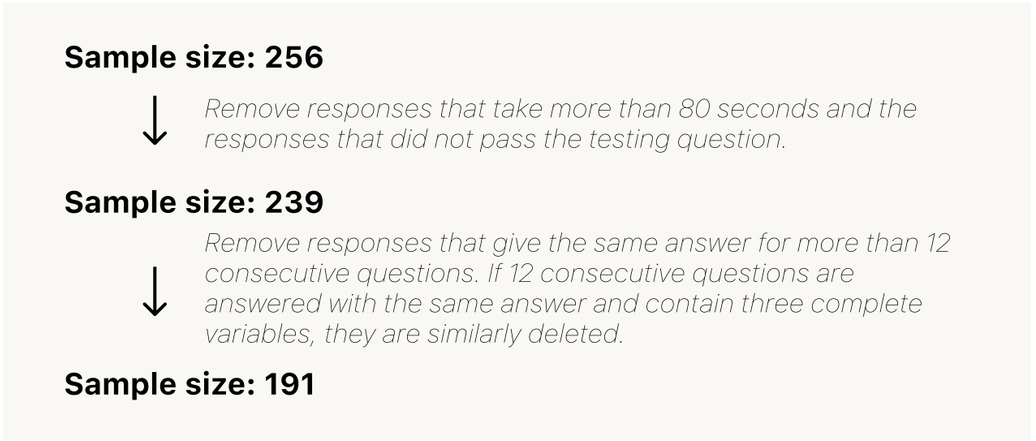


Figure 3: Data selection of the survey

Data analysis

Partial least squares technique (PLS-SEM) was used as the method of data analysis. According to Hair et al. (2019), PLS-SEM is suitable to use in explorative study and with small number of samples.

Software SmartPLS 4.0 was used for executing PLS-SEM.

Demographics of the surveyed sample

The responses that did not pass the test question and the responses with the duration less than 90 seconds were deleted. In total, 191 valid responses were collected for data analysis. Demographic characteristics of the projects and respondents are summarized in Table 6 on the next page.

Table 6: Demographic statistics of the responses.

Demographic characteristics		Number of cases	Percentage
Age	Below 20	1	0.5
	20-35	96	50.3
	36-50	72	37.7
	Above 50	22	11.5
Gender	Male	79	41.4
	Female	111	58.1
	Other	1	0.5
Education level	Secondary school	14	7.3
	Diploma	15	7.9
	Bachelor's degree	68	35.6
	Master's degree	85	44.5
	PhD	9	4.7
Income level	Below 1500 €	50	26.2
	1500-2500 €	22	11.5
	2500-3500 €	39	20.4
	3500-4500 €	40	20.9
	Above 4500 €	40	20.9

Assessment of measurement model

Collinearity statistics

Collinearity of indicators was tested by variance inflation factor (VIF). According to Hair et al. (2019), value of VIF should below 5 to avoid collinearity issues. However, according to James et al. (2013), it is still acceptable if VIF are below 10. Therefore, to ensure the content validity and the explanatory power of the model, following analysis will use James' criteria.

However, according to James et al. (2013), it is still acceptable if VIF are below 10. Therefore, although the collinearity performance could be improved by deleting ATT3, to ensure the content validity and the explanatory power, the rest analysis would keep ATT3 as one of the indicators.

Table 7: Collinearity statistics (VIF) of original measurement model.

Indicators		VIF	Indicators		VIF
AR	AR1	2.647	**PBC**	PBC1	2.032
	AR2	2.874		PBC2	2.597
	AR3	2.657		PBC3	1.843
				PBC4	2.383
ATT	ATT1	3.868			
	ATT2	4.186	**PN**	PN1	3.005
	ATT3	3.994		PN2	2.592
	ATT4	3.546		PN3	2.47
				PN4	2.155
EC	EC2	2.718			
	EC1	2.671	**SN**	SN1	3.452
	EC3	1.841		SN2	3.871
				SN3	2.806
HAB	HAB1	3.092		SN4	2.083
	HAB2	3.849			
	HAB3	2.517	**SP**	SP1	3.682
	HAB4	1.494		SP2	3.914
				SP3	2.842
MS	MS1	3.884			
	MS2	4.129			
	MS3	2.297			

From the Table 7, all the items have met the VIF criteria.

Factor loadings, convergent validity and consistency reliability

Outer loadings, convergent validity, and consistency reliability were tested four times because the INT construct was analyzed not only as a whole, but also separately for AR, MS, and SP.

According to Hair et al. (2019), the acceptable value of outer loading should above 0.708, while according some researchers (Chin, 1998; Memon & Rahman, 2014), 0.5 is still acceptable. The acceptable value of Cronbach's alpha should above 0.70, the value of Composite reliability should between 0.70 to 0.95 and the Average variance extracted (AVE) should above 0.50.

The following tables presents the tested results of each model.

Table 8: Outer loadings, convergent validity and consistency reliability of original measurement model when intention is absolute reductions, modal shifts and sharing practices.

Indicators		Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
ATT	ATT1	0.914	0.939	0.947	0.956	0.844
	ATT2	0.925				
	ATT3	0.917				
	ATT4	0.919				
EC	EC 2	0.935	0.865	0.937	0.916	0.785
	EC1	0.895				
	EC3	0.823				
HAB	HAB1	0.895	0.875	0.899	0.915	0.731
	HAB2	0.926				
	HAB3	0.877				
	HAB4	0.707				
INT	AR1	0.693	0.841	0.844	0.876	0.44
	AR2	0.664				
	AR3	0.636				
	MS1	0.744				
	MS2	0.703				
	MS3	0.669				
	SP1	0.605				
	SP2	0.606				
	SP3	0.641				
PBC	PBC1	0.848	0.866	0.889	0.907	0.711
	PBC2	0.895				
	PBC3	0.764				
	PBC4	0.86				
PN	PN1	0.909	0.898	0.907	0.929	0.765
	PN2	0.88				
	PN3	0.857				
	PN4	0.852				
SN	SN1	0.898	0.906	0.909	0.934	0.78
	SN2	0.916				
	SN3	0.883				
	SN4	0.833				

As shown in Table 8, it is noteworthy that the AVE for intention does not meet the standard threshold of 0.50 or above. Consequently, the items AR3, SP1, and SP2, which had the lowest outer loadings, were removed from the model when intention was considered as a combination of absolute reductions, modal shifts and sharing practices.

The revised results after removing these items are as follows.

Table 9: Outer loadings, convergent validity and consistency reliability of original measurement model when intention covers absolute reductions, modal shifts and sharing practices (after removing AR3, SP1 and SP2).

Indicators		Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
ATT	ATT1	0.7	0.939	0.947	0.956	0.844
	ATT2	0.67				
	ATT3	0.914				
	ATT4	0.925				
EC	EC 2	0.917	0.865	0.937	0.916	0.784
	EC1	0.919				
	EC3	0.935				
HAB	HAB1	0.903	0.875	0.901	0.915	0.731
	HAB2	0.815				
	HAB3	0.896				
	HAB4	0.926				
INT	AR2	0.877	0.803	0.803	0.861	0.512
	AR3	0.705				
	MS1	0.822				
	MS2	0.782				
	MS3	0.755				
	SP3	0.848				
PBC	PBC1	0.896	0.866	0.89	0.907	0.711
	PBC2	0.761				
	PBC3	0.86				
	PBC4	0.91				
PN	PN1	0.881	0.898	0.909	0.929	0.765
	PN2	0.858				
	PN3	0.85				
	PN4	0.898				
SN	SN1	0.916	0.906	0.909	0.934	0.78
	SN2	0.883				
	SN3	0.833				
	SN4	0.526				

From the Table 9 we can find that AVE is now above 0.5/ Therefore, in the following analysis, AR3, SP1 and SP2 were excluded when intention covers absolute reductions, modal shifts and sharing practices.

Table 10: Outer loadings, convergent validity and consistency reliability of original measurement model when intention is absolute reductions.

Indicators		Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
ATT	ATT1	0.914	0.939	0.946	0.956	0.844
	ATT2	0.926				
	ATT3	0.917				
	ATT4	0.918				
EC	EC 2	0.926	0.865	0.904	0.917	0.786
	EC1	0.889				
	EC3	0.842				
HAB	HAB1	0.895	0.875	0.898	0.915	0.732
	HAB2	0.925				
	HAB3	0.876				
	HAB4	0.709				
INT	AR1	0.905	0.886	0.891	0.929	0.814
	AR2	0.914				
	AR3	0.887				
PBC	PBC1	0.846	0.866	0.892	0.907	0.71
	PBC2	0.898				
	PBC3	0.76				
	PBC4	0.862				
PN	PN1	0.91	0.898	0.907	0.929	0.766
	PN2	0.879				
	PN3	0.863				
	PN4	0.846				
SN	SN1	0.897	0.906	0.909	0.934	0.78
	SN2	0.915				
	SN3	0.882				
	SN4	0.836				

Table 11: Outer loadings, convergent validity and consistency reliability of original measurement model when intention covers modal shifts.

Indicators		Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
ATT	ATT1	0.913	0.939	0.95	0.956	0.844
	ATT2	0.925				
	ATT3	0.916				
	ATT4	0.92				
EC	EC 2	0.931	0.865	0.929	0.915	0.783
	EC1	0.92				
	EC3	0.796				
HAB	HAB1	0.897	0.875	0.902	0.915	0.731
	HAB2	0.927				
	HAB3	0.876				
	HAB4	0.703				
INT	MS1	0.931	0.9	0.909	0.938	0.834
	MS2	0.934				
	MS3	0.874				
PBC	PBC1	0.846	0.866	0.89	0.907	0.711
	PBC2	0.895				
	PBC3	0.762				
	PBC4	0.863				
PN	PN1	0.911	0.898	0.912	0.929	0.765
	PN2	0.879				
	PN3	0.855				
	PN4	0.853				
SN	SN1	0.899	0.906	0.91	0.934	0.78
	SN2	0.919				
	SN3	0.883				
	SN4	0.829				

Table 12: Outer loadings, convergent validity and consistency reliability of original measurement model when intention covers sharing practices.

Indicators		Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
ATT	ATT1	0.912	0.939	0.952	0.956	0.844
	ATT2	0.926				
	ATT3	0.915				
	ATT4	0.921				
EC	EC 2	0.946	0.865	1.005	0.913	0.779
	EC1	0.907				
	EC3	0.787				
HAB	HAB1	0.895	0.866	0.898	0.915	0.731
	HAB2	0.924				
	HAB3	0.878				
	HAB4	0.707				
INT	SP1	0.916	0.908	0.92	0.942	0.844
	SP2	0.931				
	SP3	0.91				
PBC	PBC1	0.843	0.866	0.884	0.908	0.712
	PBC2	0.894				
	PBC3	0.772				
	PBC4	0.86				
PN	PN1	0.905	0.898	0.905	0.929	0.765
	PN2	0.88				
	PN3	0.856				
	PN4	0.858				
SN	SN1	0.897	0.906	0.908	0.934	0.78
	SN2	0.913				
	SN3	0.885				
	SN4	0.836				

According to Tables 10, 11, and 12, all measurement items demonstrate satisfactory results, so no adjustments are necessary at this point when intention specifically refers to absolute reductions, modal shifts or sharing practices.

Discriminant validity

Hair et al. (2019) suggested to assess discriminant validity by heterotrait-monotrait (HTMT) ratio of the correlations (Henseler et al., 2015) instead of Fornell-Larcker criterion (Fornell & Larcker, 1981) in PLS-SEM because the Fornell-Larcker criterion does not perform well, particularly when the indicator loadings on a construct differ only slightly (Henseler et al., 2015). According to Henseler et al. (2015), the value of HTMT should below 0.90, and an HTMT value above 0.90 would suggest that discriminant validity is not present.

The results of HTMT are as follows.

Table 13: Heterotrait-monotrait (HTMT) ratio of correlations when intention covers absolute reductions, modal shifts and sharing practices.

	ATT	EC	HAB	INT	PBC	PN	SN
ATT							
EC	0.05						
HAB	0.581	0.123					
INT	0.622	0.093	0.571				
PBC	0.504	0.062	0.747	0.507			
PN	0.542	0.108	0.476	0.478	0.495		
SN	0.518	0.107	0.716	0.707	0.622	0.455	

Table 14: Heterotrait-monotrait (HTMT) ratio of correlations when intention covers absolute reductions.

	ATT	EC	HAB	INT	PBC	PN	SN
ATT							
EC	0.05						
HAB	0.581	0.123					
INT	0.461	0.058	0.486				
PBC	0.504	0.062	0.747	0.423			
PN	0.542	0.108	0.476	0.316	0.495		
SN	0.518	0.107	0.716	0.566	0.622	0.455	

Table 15: Heterotrait-monotrait (HTMT) ratio of correlations when intention covers modal shifts.

	ATT	EC	HAB	INT	PBC	PN	SN
ATT							
EC	0.05						
HAB	0.581	0.123					
INT	0.478	0.087	0.366				
PBC	0.504	0.062	0.747	0.309			
PN	0.542	0.108	0.476	0.334	0.495		
SN	0.518	0.107	0.716	0.474	0.622	0.455	

Table 16: Heterotrait-monotrait (HTMT) ratio of correlations when intention covers sharing practices.

	ATT	EC	HAB	INT	PBC	PN	SN
ATT							
EC	0.05						
HAB	0.581	0.123					
INT	0.355	0.064	0.375				
PBC	0.504	0.062	0.747	0.361			
PN	0.542	0.108	0.476	0.348	0.495		
SN	0.518	0.107	0.716	0.466	0.622	0.455	

According to Tables 13, 14, 15, and 16, all measurement items demonstrate satisfactory results regarding HTMT (below 0.90), so no adjustments are necessary at this point.

Assessment of structural model

Results of hypotheses verification

The bootstrapping procedure was employed to test the previously proposed hypotheses, using the following settings: 5,000 subsamples, one-tailed testing, and a significance level of 0.05.

The results of hypotheses verification are as follows.

Table 17: Results of hypotheses verification when intention covers absolute reductions, modal shifts and sharing practices.

Hypothesis		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
H1	ATT -> INT	0.273	0.277	0.089	3.057	0.001	Yes
H10	EC -> HAB	0.1	0.107	0.093	1.08	0.14	No
H9	EC -> INT	-0.06	-0.063	0.064	0.936	0.175	No
H8	HAB -> ATT	0.546	0.548	0.049	11.052	<0.001	Yes
H6	HAB -> INT	0.026	0.031	0.103	0.257	0.399	No
H7	HAB -> PBC	0.672	0.674	0.041	16.324	<0.001	Yes
H2	PBC -> INT	0.024	0.02	0.093	0.254	0.4	No
H4	PN -> INT	0.085	0.083	0.068	1.244	0.107	No
H3	SN -> INT	0.417	0.413	0.072	5.8	<0.001	Yes
H5	SN -> PN	0.415	0.417	0.067	6.223	<0.001	Yes

Table 18: Results of hypotheses verification when intention covers absolute reductions.

Hypothesis		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
H1	ATT -> INT	0.196	0.196	0.09	2.181	0.029	Yes
H10	EC -> HAB	0.1	0.11	0.091	1.098	0.272	No
H9	EC -> INT	0.002	0.005	0.068	0.029	0.977	No
H8	HAB -> ATT	0.545	0.547	0.05	11.003	<0.001	Yes
H6	HAB -> INT	0.067	0.067	0.098	0.682	0.496	No
H7	HAB -> PBC	0.673	0.674	0.041	16.417	<0.001	Yes
H2	PBC -> INT	0.06	0.058	0.1	0.601	0.548	No
H4	PN -> INT	-0.01	-0.009	0.083	0.116	0.908	No
H3	SN -> INT	0.343	0.341	0.083	4.156	<0.001	Yes
H5	SN -> PN	0.415	0.417	0.066	6.243	<0.001	Yes

Table 19: Results of hypotheses verification when intention covers modal shifts.

Hypothesis		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
H1	ATT -> INT	0.291	0.292	0.1	2.91	0.002	Yes
H10	EC -> HAB	0.099	0.105	0.091	1.089	0.138	No
H9	EC -> INT	-0.078	-0.085	0.079	0.989	0.161	No
H8	HAB -> ATT	0.548	0.55	0.049	11.132	<0.001	Yes
H6	HAB -> INT	-0.011	-0.007	0.114	0.098	0.461	No
H7	HAB -> PBC	0.672	0.674	0.041	16.426	<0.001	Yes
H2	PBC -> INT	-0.042	-0.042	0.113	0.371	0.355	No
H4	PN -> INT	0.067	0.064	0.087	0.766	0.222	No
H3	SN -> INT	0.298	0.294	0.096	3.11	0.001	Yes
H5	SN -> PN	0.416	0.418	0.066	6.253	<0.001	Yes

Table 20: Results of hypotheses verification when intention covers sharing practices.

Hypothesis		Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
H1	ATT -> INT	0.094	0.099	0.097	0.968	0.167	No
H10	EC -> HAB	0.102	0.109	0.094	1.088	0.138	No
H9	EC -> INT	-0.008	-0.009	0.103	0.082	0.467	No
H8	HAB -> ATT	0.547	0.55	0.049	11.194	<0.001	Yes
H6	HAB -> INT	0.01	0.012	0.109	0.089	0.464	No
H7	HAB -> PBC	0.669	0.671	0.041	16.128	<0.001	Yes
H2	PBC -> INT	0.054	0.046	0.103	0.521	0.301	No
H4	PN -> INT	0.123	0.127	0.08	1.536	0.062	No
H3	SN -> INT	0.296	0.292	0.096	3.096	0.001	Yes
H5	SN -> PN	0.415	0.417	0.067	6.226	<0.001	Yes

From Tables 17, 18, and 19, hypotheses H1, H3, H5, H7, and H8 are supported. Additionally, intention, as the dependent construct, is positively influenced by ATT and SN. However, according to Table 20, hypothesis H1 is not supported, indicating that intention of sharing practices is not significantly influenced by ATT. Despite this, the four tests show similar results, highlighting the similarities between AR, MS, and SP.

Explanatory capacity

In PLS-SEM, explanatory capacity are measured by R square. R square values range from 0 to 1, with higher values indicating stronger explanatory power. In social sciences, R square values of 0.25, 0.50, and 0.75 are typically considered weak, moderate, and substantial, respectively.

The following tables present the R square results for each model.

Table 21: Results of R square when intention covers absolute reductions, modal shifts and sharing practices.

	R square		R square adjusted	
	Original sample (O)	Sample mean (M)	Original sample (O)	Sample mean (M)
ATT	0.298	0.303	0.295	0.299
HAB	0.01	0.02	0.005	0.015
INT	0.462	0.485	0.444	0.469
PBC	0.452	0.456	0.449	0.453
PN	0.173	0.178	0.168	0.174

Table 22: Results of R square when intention covers absolute reductions.

	R square		R square adjusted	
	Original sample (O)	Sample mean (M)	Original sample (O)	Sample mean (M)
ATT	0.297	0.302	0.293	0.298
HAB	0.01	0.021	0.005	0.015
INT	0.308	0.332	0.285	0.31
PBC	0.452	0.456	0.449	0.454
PN	0.172	0.178	0.168	0.174

Table 23: Results of R square when intention covers modal shifts.

	R square		R square adjusted	
	Original sample (O)	Sample mean (M)	Original sample (O)	Sample mean (M)
ATT	0.3	0.305	0.296	0.301
HAB	0.01	0.019	0.005	0.014
INT	0.267	0.302	0.243	0.279
PBC	0.452	0.456	0.449	0.453
PN	0.173	0.179	0.169	0.175

Table 24: Results of R square when intention covers sharing practices.

	R square		R square adjusted	
	Original sample (O)	Sample mean (M)	Original sample (O)	Sample mean (M)
ATT	0.3	0.305	0.296	0.301
HAB	0.01	0.021	0.005	0.015
INT	0.218	0.252	0.193	0.228
PBC	0.447	0.451	0.444	0.448
PN	0.172	0.178	0.168	0.174

From Tables 21, 22, 23, and 24, it can be observed that the R square results are similar whether intention is measured by absolute reductions, modal shifts, sharing practices, or a combination of these three constructs, although the path coefficients may vary. It is also noteworthy that HAB consistently shows a very low R square across all four tables, suggesting that HAB may not be a strong explanatory construct.

Model fit

In PLS-SEM, model fit evaluates how well the model aligns with observed data, but it is less emphasized compared to covariance-based SEM. Hair et al. (2019) caution researchers to interpret model fit measures with care in PLS-SEM. For supplementary evaluation, standards such as standardized root mean square residual (SRMR) < 0.08 and normed fit indices (NFI) > 0.90 are used here as according to the SmartPLS website. The following tables present the model fit results when applying different items to INT.

Table 25: Results of model fit when intention covers absolute reductions, modal shifts and sharing practices.

	Saturated model	Estimated model
SRMR	0.077	0.211
d_ULS	2.566	19.401
d_G	0.999	1.286
-square	1036.221	1193.065
NFI	0.765	0.73

Table 26: Results of model fit when intention covers absolute reductions.

	Saturated model	Estimated model
SRMR	0.063	0.221
d_ULS	1.378	17.171
d_G	0.628	0.836
-square	699.936	822.376
NFI	0.824	0.794

Table 27: Results of model fit when intention covers modal shifts.

	Saturated model	Estimated model
SRMR	0.063	0.221
d_ULS	1.415	17.147
d_G	0.63	0.849
-square	707.053	840.327
NFI	0.825	0.792

Table 28: Results of model fit when intention covers sharing practices.

	Saturated model	Estimated model
SRMR	0.064	0.222
d_ULS	1.425	17.225
d_G	0.699	0.919
-square	759.283	886.181
NFI	0.814	0.783

Although the normed fit indices (NFI) are below 0.90, they are all above 0.70, which are still acceptable. Similar results of low NFI can also be found in tourism study using TPB (Wang et al., 2022) by PLS-SEM.

Discussion

Sufficient tourism mobility as planned behaviors

As mentioned in the previous section, the Theory of Planned Behavior (TPB) posits that attitude, perceived behavioral control, and subjective norm are positively linked to behavioral intentions. The results from the PLS-SEM analysis confirm that attitude and subjective norm are the two strongest predictors of intention, indicating that sufficient tourism mobility behaviors are largely intentional in nature.

Subjective norm (SN) consistently shows a significant impact on behavioral intentions, regardless of whether the intention is related to absolute reductions, modal shifts, sharing practices or a combination of these. The finding that SN has a positive impact on intentions suggests that SN might be the strongest predictor of intentions on sufficient tourism mobility behaviors. While there is limited behavioral research specifically on sufficient mobility behaviors, similar results can be found in studies related to sustainable transport. For instance, SN was found positively impact on intentions of reducing car usage (Y. Liu et al., 2017), reducing air travel (Hansmann & Binder, 2021), EV purchase (Haustein & Jensen, 2018) subscript to public transportation (Brohi et al., 2021; Hauslbauer et al., 2022) and using bike sharing services (Si et al., 2020). Additionally, SN was showed as the strongest predictor among the four tests, which is surprisingly contradict to the theory of Ajzen (2002) that SN may be the weakest. However, the finding on the other hand, matches the study of Hauslbauer et al. (2022) regarding intention of subscription to public transportation and study of (Van Veldhoven et al., 2022) regarding intention of using shared mobility.

Attitude (ATT) is the second most influential construct, significantly affecting intention in most cases, except when intention refers to sharing practices. The positive impact of ATT is commonly seen in many of the studies regarding sustainable transport behaviors, such as previously mentioned studies regarding subscript to public transportation (Brohi et al., 2021; Hauslbauer et al., 2022) and reducing air travel (Hansmann & Binder, 2021). The result that ATT did not present significant impact on intention of sharing practices can also be found in the study Van Veldhoven et al. (2022) conducted in Belgium which investigate the intention of using shared mobility service.

Perceived behavioral control (PBC), did not show significance in any of the test, while in other studies, such as the study of (Si et al., 2020) about intention towards bike sharing and the study of Ahmed et al. (2021) regarding intention towards taking public transportation. However, the insignificant impact of PBC can also be found in the studies regarding intentions towards using

public transportation service (Hauslbauer et al., 2022). This may because the items of PBC is more focused on the accessibility and easiness of conducting sufficient tourism mobility behaviors, and the options are usually available to the participants.

Sufficient tourism mobility as norm-driven behaviors

Personal norm (PN) did not exhibit significant direct effects on intention. Similar results could be found in studies of children's school travels (Mehdizadeh et al., 2020), but more studies showed contradictory such as study of purchasing and using EVs (Ashraf Javid et al., 2021), and study of using low-carbon transportation (Adu-Gyamfi et al., 2021).

Although Norm Activation Model suggests that sufficient tourism mobility behaviors may be influenced by norm as previously mentioned, it did not show in the results of PLS-SEM, suggesting that sufficient tourism mobility behaviors may not be highly driven by moral obligation, or the personal norm was not activated yet. Another possible explanation is that in the context of tourism travel, behaviors are often less influenced by individual moral concerns and more shaped by group expectations at the destination, as well as the available transportation options to reach those destinations.

Other factors

External cost (EC) also did not show significant effects, possibly because sufficient behaviors are primarily about reducing consumption levels, and the cost of sufficient tourism mobility options, like using public transportation or visiting local destinations, is already relatively low. Another possible reason is that intentions regarding sufficient tourism mobility behaviors may be influenced by one's perception of the value of these behaviors. While external cost might negatively affect this perception, other factors, such as a sense of satisfaction and happiness, could have a stronger positive influence. As a result, even if someone perceives the external cost as high, they might still choose to engage in sufficient tourism mobility because the perceived benefits outweigh the costs. For instance, supporting evidence for this can be found in Kim et al. (2018), which shows that while cost negatively influences perceived value, perceived value has a positive impact on intentions.

Additionally, in this research, habit (HAB) did not exhibit a high R square in the sections assessing explanatory capacity. This suggests that HAB may not be a suitable psychological factor to consider in practices aimed at promoting sufficient behavioral change in tourism mobility. One possible explanation for this finding may be that sufficient behaviors are still a relatively novel concept for most tourists. As a result, engaging in these behaviors requires more deliberate and intentional action rather than unconscious, habitual behavior. Another possible reason is that an insufficient habit may negatively influence sufficient intentions, rather than the presence of sufficient habits themselves. Supporting evidence for this can be found in the study by Hansmann and Binder (2021), where the habit of frequently taking airplanes was negatively associated with the intention to reduce air travel. In conclusion, regardless of the underlying reason, both explanations suggest that incorporating HAB into the design process for promoting sufficient tourism mobility behavior may not be an effective approach. Consequently, HAB will be excluded from consideration in the subsequent sections.

Overall, although some constructs such as PBC, EC, and PN did not show significant direct effects on intentions, they still hold theoretical importance. The lack of significance may be attributed to measurement errors. In the next phase of design ideation, designers should consider these constructs for effective behavioral change interventions aimed at tourists' sufficient mobility behaviors. However, HAB may not be applicable in design practices due to its relatively low explanatory capability.

Final model

To summarize, the results of each model are as follows.

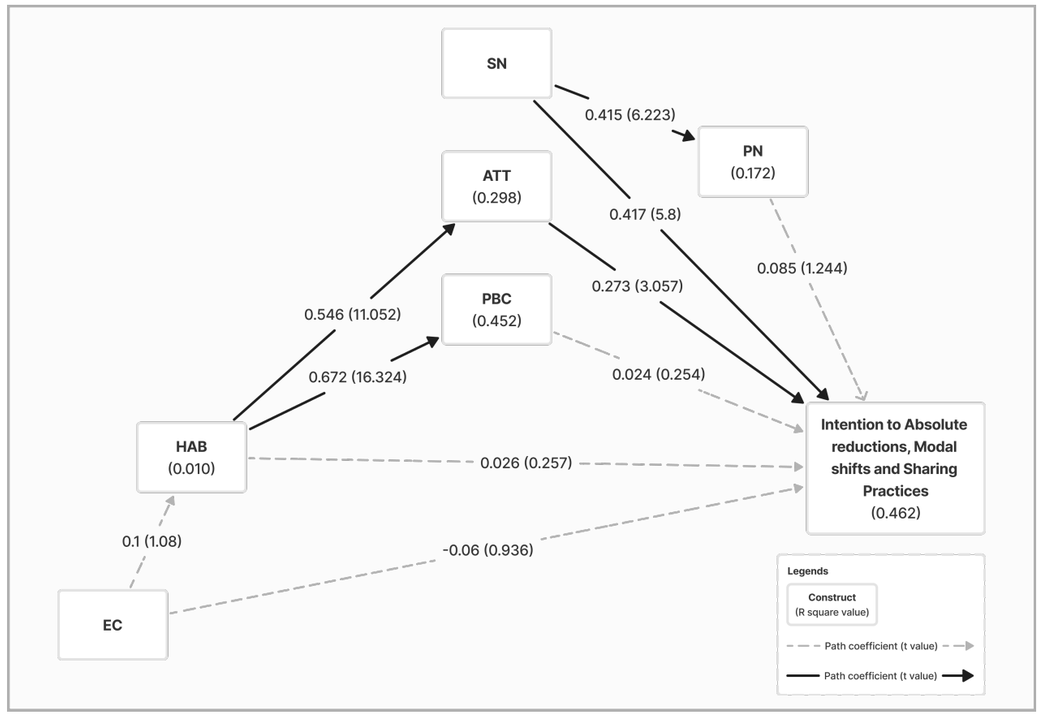


Figure 4: PLS-SEM when intention covers Absolute reductions, Modal shifts, and Sharing practices

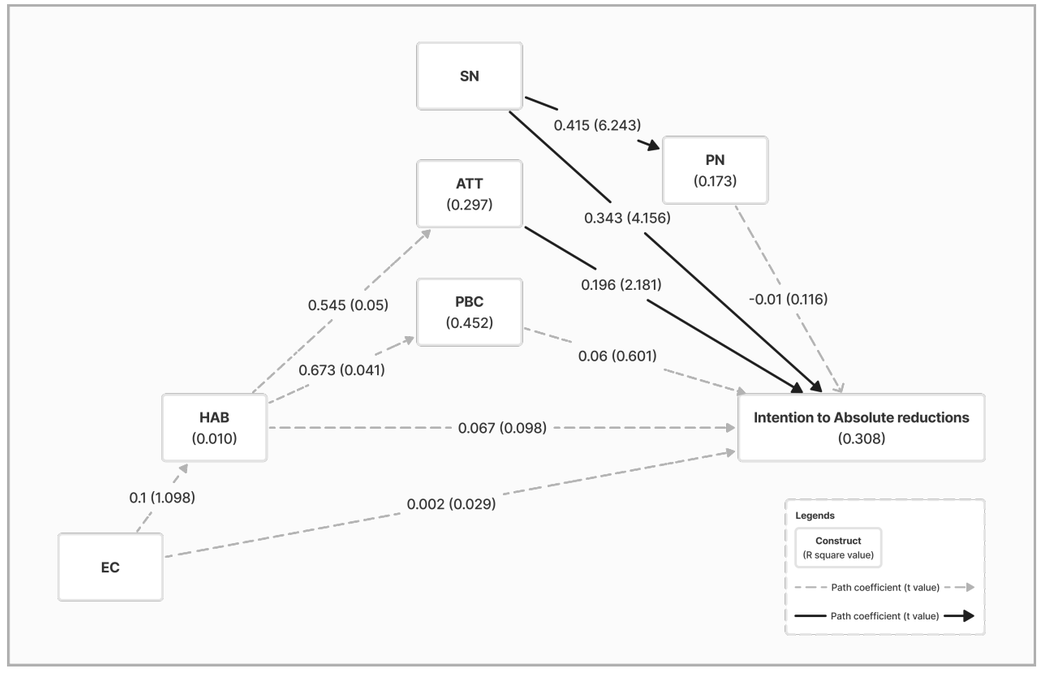


Figure 5: PLS-SEM when intention covers Absolute reductions

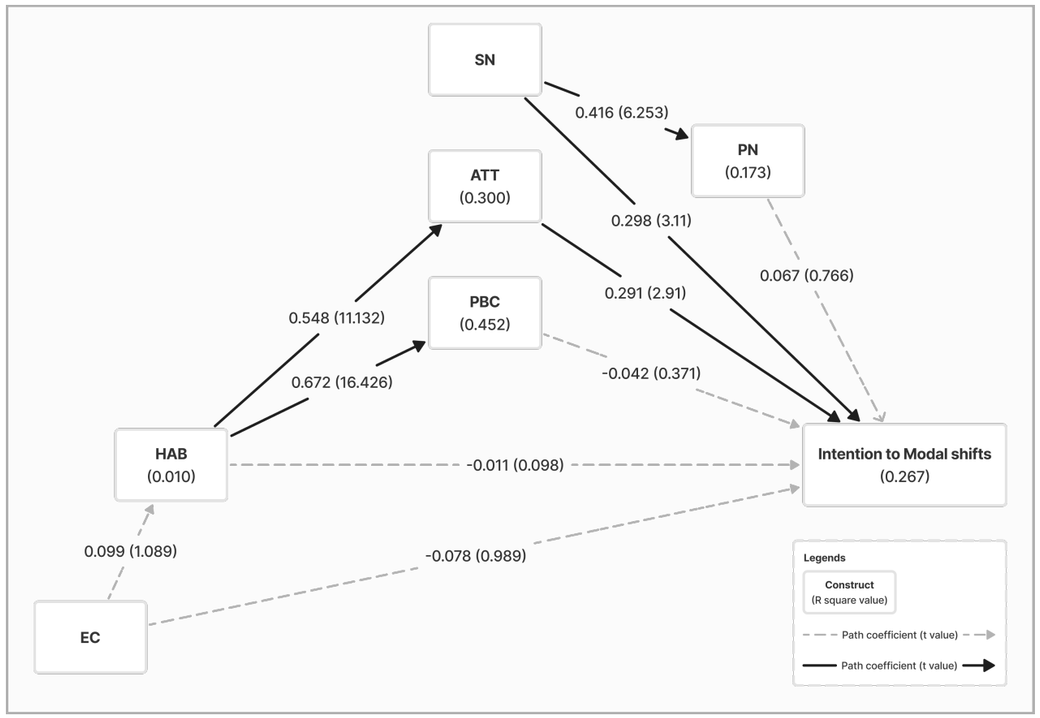


Figure 6: PLS-SEM when intention covers Absolute reductions

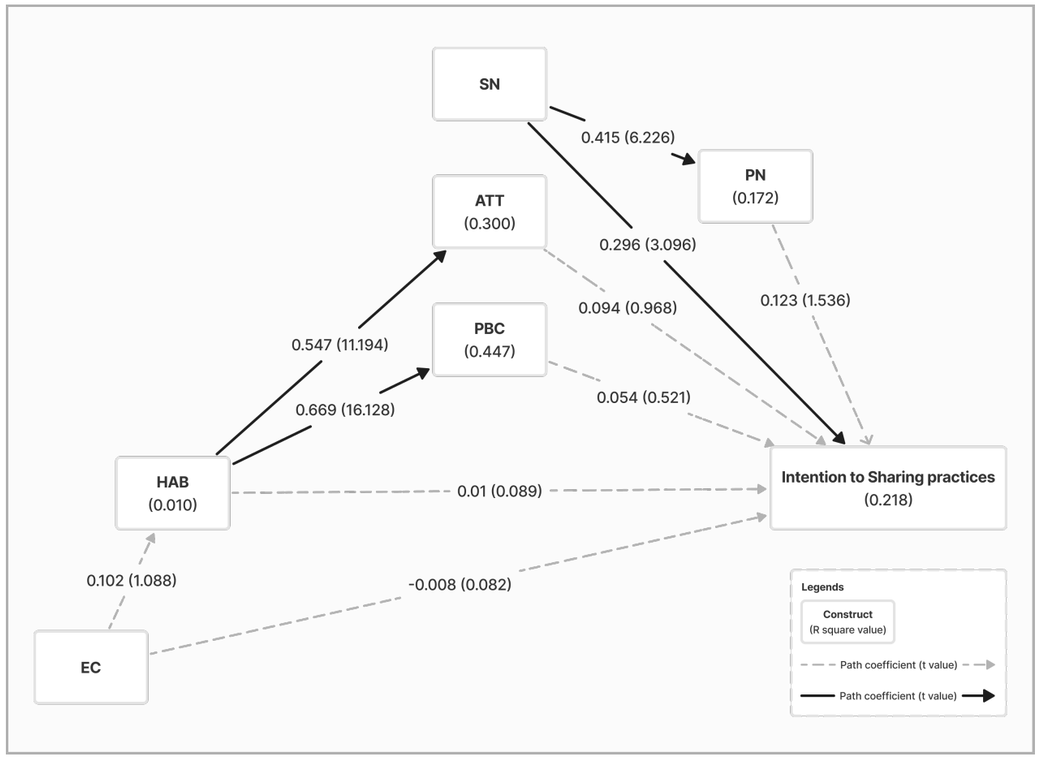


Figure 7: PLS-SEM when intention covers Sharing practices

Conclusion

According to the results, hypotheses H3, H5, H7, and H8 are supported. Additionally, INT, as an independent construct, is positively influenced by ATT except when INT refers to SP.

In the upcoming research activities, ATT and SN will be prioritized over the other constructs, while still considering additional constructs such as EC, PBC, and PN. HAB will not be considered for the following reasons: first, it exhibited a very low R square; and second, HAB may, in some respects, represent the behaviors themselves rather than serving as a design approach.

Chapter 06

Toolkit Development for sufficiency design in tourism mobility

Co-creations session design
Results of the co-creation session
Toolkit Design
First version of the toolkit
Pilot tests of the toolkit
User tests
Final toolkit
Evaluation of final toolkit

Toolkit Development for sufficiency design in tourism mobility

The previous sections addressed the definitions of sufficiency in tourism mobility and empirically examined how sufficient tourism mobility behaviors are influenced by psychological factors, from the perspectives of planned behavior, norm-driven behavior, and habitual behavior. To apply the knowledge gained from these research activities, developing a toolkit to assist designers in effectively utilizing this knowledge and implementing strategies could be highly beneficial due to the following reasons.

First, there already existing some of the related design strategies that could support sufficient tourism mobility behaviors. For instance, the sustainable transport framework proposed by Banister (2008) and suggestions from (Hansmann & Binder, 2021) regarding reducing air travel. However, these strategies may have different focuses and may not be easily referred to or utilized. Additionally, they may not be visible to designers in their practices, potentially undermining the rationality of the ideation process. Furthermore, creativity, a crucial element of design practice, may be disconnected from these research findings.

Therefore, a toolkit that can integrate the findings of sufficient tourism mobility behavioral research and design strategies for sufficient behavioral change, and creativity techniques would be helpful for the designers and developers in the domain of tourism mobility. However, so far, this research has primarily focused on knowledge-level aspects, such as existing sufficient behaviors and the related influencing factors, without connecting them to design practices for fostering sufficient behavioral change in the context of tourism mobility. To address this gap and identify specific strategies for how design can support sufficient behavioral change in tourism mobility, a co-creation session was conducted to gain insights from experienced designers and group knowledge. The results of the co-creation session were then used to create three design strategy tables that support sufficient tourism mobility from a holistic perspective, as well as a map highlighting the key aspects that designers should focus on during the project.

In the end, a creativity session, along with supportive materials—both physical and digital—was developed as a toolkit. This toolkit is designed to help utilize the identified strategies and key aspects, thereby accelerating the design process for promoting sufficient behaviors in tourism mobility.

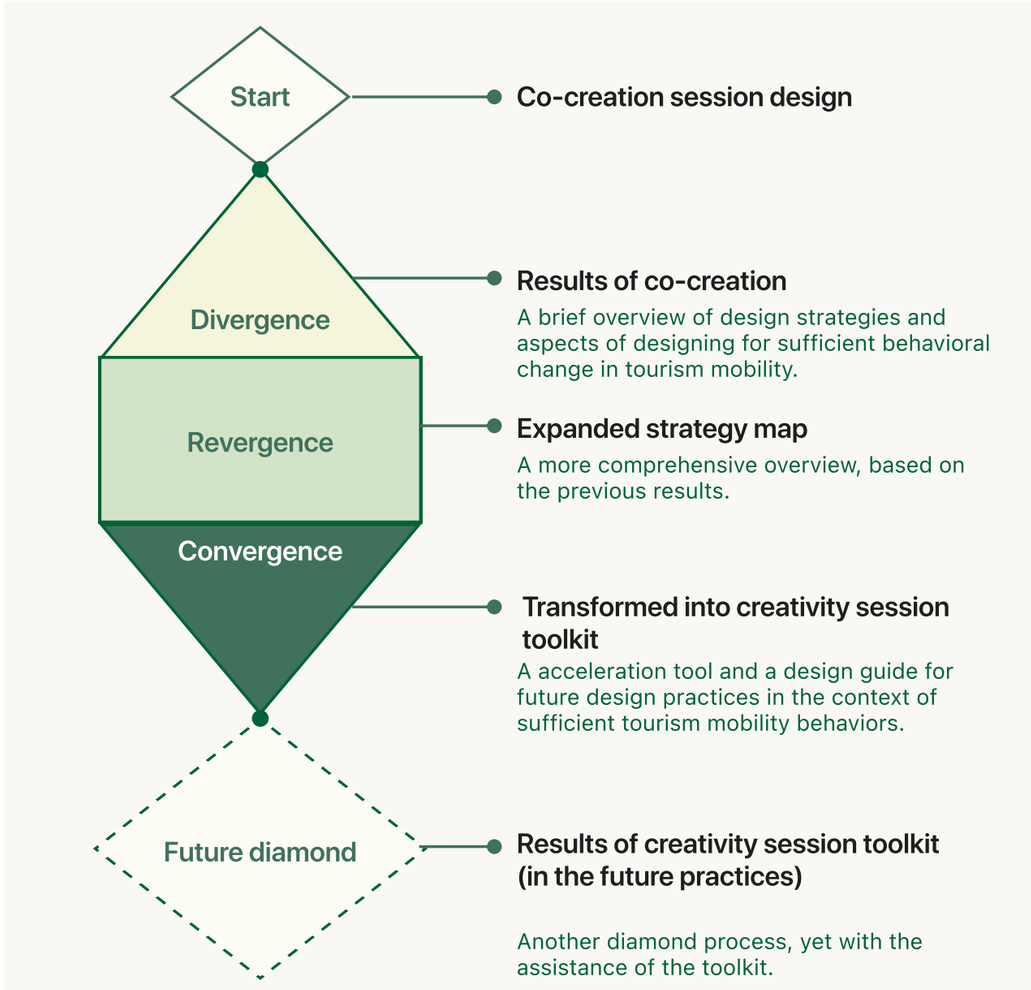


Figure 8: Process of toolkit development

Co-creation session design

The goal of the co-creation session is to identify potential design strategies that support sufficient behaviors in tourism mobility, as well as to pinpoint the key aspects to consider. Additionally, the session aims to explore whether designers can integrate knowledge about influencing psychological factors and apply the PLS-SEM results into the co-creation outcomes.

To encourage creativity, various techniques were incorporated, such as energizer activities and the rotation method. Energizers are ice-breaker games designed to help participants quickly become acquainted while boosting their creative thinking during the session. The rotation technique involves participants responding to and expanding on ideas from their neighbors in a continuous cycle, fostering dynamic and collaborative ideation. These techniques also increase participant interaction, leading to more engagement and teamwork throughout the session. A visualization of the co-creation session process can be seen in Figure 9.

The session includes four steps, covering the creative phase of divergence, revergence and convergence. As illustrated by Figure 9. The first step is a warm-up session, where participants read introductory materials on sufficiency and sufficient tourism mobility behaviors (see in Appendix B: Co-creation session materials), along with the results of the PLS-SEM analysis. Afterward, they are asked to share their impressions of both the concept and the findings, followed by a group reflection on each other's comments. This helps participants familiarize themselves with the key ideas and encourages initial discussions before moving into the ideation phase.

In the second step, participants were split into two groups and tasked with brainstorming possible design strategies on a mirrored template (see Appendix B: Co-creation session materials). The template maps sufficient tourism mobility behaviors across the concepts of absolute reductions (AR), modal shifts (MS), and sharing practices (SP) in the context of in-destination travel, as identified earlier. Participants were instructed to ideate on the strategies presented directly in front of them. After seven minutes, they rotated the template to ideate on the remaining behaviors. Additionally, participants used different colored sticky notes (see Appendix B) to denote various psychological factors, where applicable, to guide their design ideas.

The third step is the same as the second step, but participants were instructed to use the template (see Appendix B: Co-creation session materials) about sufficient tourism mobility behaviors in the context of tourists travel from home to the destination.

The fourth step focuses on identifying the key aspects that designers and developers should consider for the design strategies generated in Steps 2 and 3. The rotation technique is applied here, where participants first were asked to ideate one key aspect, then pass their ideas to the next participant in a clockwise direction. Each subsequent participant either points out additional key aspects or criteria based on the previously identified ones, or introduces new aspects. This collaborative process helps to refine and expand on important considerations for the design strategies.

The session was conducted with 5 participants who had experience and knowledge in sustainability or related design practices. The duration was approximately 60 minutes, excluding an energizer at the beginning and potentially another one in the middle.



Figure 9: Process of co-creation session (materials see in Appendix X: Co-creation session materials)

Results of the co-creation session

Five participants with a background in design, specifically from the Master's program in Industrial Design Engineering at TU Delft, joined the session. The outcomes include two A0 templates covered with sticky notes and a flip chart outlining key aspects. Additionally, some comments and reflections were noted during the session.

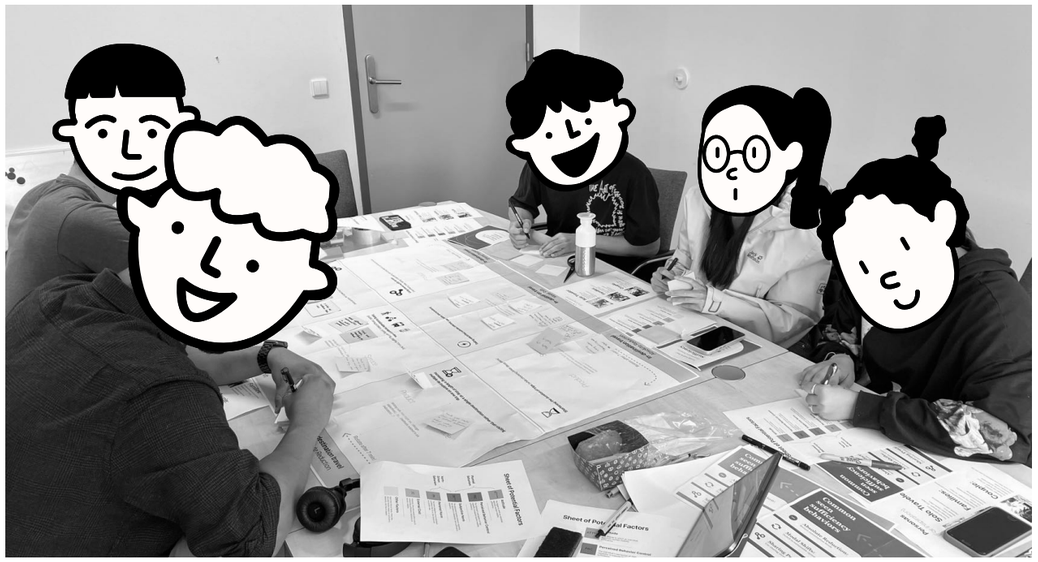


Figure 10: A photo during the co-creation session

Results of Step 2 and Step 3

The data from Step 2 and 3 was first analyzed using a clustering approach. Each cluster was assigned a theme, and then the clusters were manually mapped to the five independent variables. This manual mapping was necessary because some of the ideas from the sessions are not applicable to the psychological factors. The coded results are show in the following Figure 11.

First, the original results were digitized for better accessibility. Then, the design strategies were categorized into clusters based on their respective domains, such as financial and communication. Some strategies were eliminated because they either did not effectively support sufficient tourism mobility behaviors or could cause conflicts between stakeholders. The remaining strategies within each domain were further grouped into specific types, such as "increasing moral concerns".

Finally, the strategies were mapped on a table by intervention levels and key player involved. On vertical scale, design strategies range from weak interventions like "providing sufficient alternatives" (focused on guiding change) to strong interventions such as "restricting insufficient mobility behaviors" (focused on catalyzing change towards sufficient tourism mobility). The lower position a strategy is located, the stronger intervention on tourists' behaviors it might be. However, the strong interventions are not necessarily leads to higher possibility of behavioral change, because the sufficient tourism mobility behaviors are also connected to psychological factors as mentioned previously. The idea of mapping strategies vertically based on intervention levels is partly inspired by the works of Tang (2010) and Bhamra et al. (2011), which link the antecedents of behavioral and habitual change with varying levels of design intervention strategies. Horizontally, the strategies are mapped across three key players: businesses, governments, and social organizations/communities. This horizontal mapping corresponds to the stakeholders of sufficiency highlighted by Sandberg (2021). At the same time, related psychological factors of each strategy example were also mapped on the right side of the table.



Original Data
(see Appendix B: Co-creation session results)

Refined clusters
(see Appendix B: Co-creation session results)

(Expanded) clusters mapped by constructs
(will be presented later in the report)

Figure 11: Process of data analysis of co-creation Step 2 and 3

Overall, more strategies were identified under the sections of AR and MS, while fewer strategies were identified under SP. This may be because SP has been established for a longer period as a business model, leading to more mature and well-defined practices. In contrast, AR and MS encompass a broader range of behaviors, offering greater flexibility and more opportunities for innovative design strategies.

The findings from Steps 2 and 3 reveal that the division of sufficient tourism mobility behaviors —such as in-destination travel versus travel from home to the destination, or specific behaviors under AR, MS, or SP—does not significantly impact the design strategies. It appears that the different sticky notes are interchangeable within the same column (AR, MS, or SP), indicating that the design strategies can be applied across these different contexts without losing relevance.

Furthermore, these strategies can generally be divided into two categories: "guide the change to sufficient tourism mobility" and "catalyze the change to sufficient tourism mobility". "Guide the change to sufficient tourism mobility" strategies aim to make sufficient options visible to tourists and encourage them to see sufficient tourism mobility behaviors positively, while the "catalyze the change to sufficient tourism mobility" strategies, instead, make sufficient options favorable to tourists and encourage them to adopt sufficient tourism mobility behaviors actively. In essence, the former category allows consumers more freedom in choosing sufficient behaviors, while the latter involves offering certain incentives—either psychological or physical —to motivate consumers to engage in those behaviors.

Within both categories, there are varying levels of intervention. The weakest intervention strategy involves simply providing information and making it visible to tourists. The strongest intervention, on the other hand, would involve restricting behaviors through political or economic measures. Eight intervention levels are found regarding absolute reductions while seven were found in modal shifts and sharing practices (with the trip planning service missing).

When mapping the design strategies to the constructs of ATT, SN, PBC, PN, and EC, it was observed that each strategy often connects to more than one construct, though with a particular emphasis. For example, the strategy of "reducing tax" is more focused on EC, while "promoting the benefits of e-bike riding" is more focused on ATT. This indicates that while strategies may influence multiple constructs, they typically have a primary area of impact.

Overall, many of the strategies focus on ATT, PBC and EC, while SN and PN primarily appear in communication-related strategies and user community-building efforts. This distribution suggests that SN, while influential in these areas, might be less critical in design practices aimed specifically at promoting sufficiency, and could potentially be deprioritized in certain design contexts focused on sufficient tourism mobility behaviors.

The results of Step 2 and 3 were visualized in the following tables on the following pages, which also provides a starting point of designing the toolkit.

Table 29: Design strategies for supporting absolute reductions regarding tourism mobility behaviors.

	Key players	Government	Business	Social organizations and communities	Potential related factors
Focus of design strategies	**Types of design strategies**	Examples of design strategies			
Guide the change to sufficient tourism mobility Make sufficient options visible to tourists and encourage them to see sufficient tourism mobility behaviors positively.	**Provide trip planning service to make sufficient options visible** Make sufficient options visible and accessible to tourists.		Travel package for certain period of time to increase the average length of stay at the same location.		**EC, PBC**
			Design tourism routes on foot or bike with tour guide.		**PBC**
			Guided and organized 1-day trips for locals and residents who live nearby.		**PBC**
			Provide elegant and compacted trip to reduce the travel distances overall.		**PBC, PN**
	Provide sufficient alternatives Provide tourists the sufficient alternatives.	World Park.			**PBC**
			VR experience: travel from home (Metaverse travel).		**PBC, EC, ATT**
	Advertise sufficient alternatives Encourage tourists to think positively on sufficient tourism mobility behaviors.		Encourage and advertise destinations that are close to populated areas.		**ATT, SN**
			Promote outdoor activities like hiking.		**ATT, SN**
			Publish posts on how to enjoy extended stays in a single or less locations (instead of longer routes).		**ATT, PN**
	Spread the knowledge of sufficiency. Encourage tourists to reflect upon their behaviors and furtherly adopt sufficient behaviors in tourism		Explain the concept of sufficiency to people and the environmental benefits of applying sufficient behaviors in tourism mobility.		**ATT, PN**
			Explain other benefits including saving budget, better for local economy and so on.		**ATT,PN, EC**
Catalyze the change to sufficient tourism mobility Make sufficient options favorable to tourists and encourage them to adopt sufficient tourism mobility behaviors actively.	**Inspire and encourage tourists to choose sufficient options.** Inspire users to adopt sufficient tourism mobility behaviors through providing rewardings and 'prompts'.		Reward such as free tour guide for tourists who choose in-depth travel (and other sufficient behaviors during their trips).		**ATT,PN, EC**
			Record and provide tourists their individual traveling distance (visualized) records.		**ATT,SN, EC**
			Mix the boundaries between travel, work and life, such as encouraging digital nomad.		**ATT**
			Make sufficiency in tourism mobility 'cool' and worth to share.		**ATT, SN**
			Promote in-depth travel experiences to encourage tourists to extend their stays within the same city (rather than visiting multiple cities).		**ATT, SN**
	Improve the attractiveness of sufficient options. Attract users to adopt sufficient tourism mobility behaviors through increasing the attractiveness and experience of sufficient options.	Improve the connection of train and bus travel to reduce the air and private car travel.			**ATT, PBC**
		Improve destinations for electric vehicles (EVs) and public transportation, rather than air travel or private cars.			**ATT, EC**
		Enhance the attractiveness of city for local tourists such as giving discount for local travelers.			**ATT, EC, PBC**
	Provide sufficient options with lower cost Facilitate users to adopt sufficient tourism mobility behaviors through lowering the time, effort and financial cost of sufficient options.		Bundle mobility costs for a specific period to encourage shorter stays.		**ATT, EC**
			Offer affordable bike rental services as an alternative to reduce vehicle emissions.		**ATT, EC**
			Offer discount on transportation costs for nearby-travelers and local residents.		**ATT, EC**
		Cheaper travel of alternative destinations during tourism seasons.			**ATT, EC**
	Restrict insufficient mobility behaviors Restrain insufficient behaviors and to persuade tourists behaviors by putting restrictions.	Restrict tourists' behaviors through tourism policies and requirements.			**ATT, EC, PBC**
		Charge more on flights and private car travels by policy such as tax increase.			**ATT, EC, PBC**

Table 30: Design strategies for supporting modal shifts regarding tourism mobility behaviors.

	Key players	Government	Business	Social organizations and communities	Potential related factors
Focus of design strategies	**Types of design strategies**	Examples of design strategies			
Guide the change to sufficient tourism mobility Make sufficient options visible to tourists and encourage them to see sufficient tourism mobility behaviors positively.	**Provide sufficient alternatives** Make sufficient options visible and understandable to tourists.		Integrate portable vehicles into public transportation service.		**PBC**
			Provide combo ticket and day-pass options.		**PBC**
			Rent & Return in different locations.		**EC, PBC**
	Advertise sufficient alternatives Encourage tourists to think positively on sufficient tourism mobility behaviors.		Advertisements to promote electric vehicle rental services.		**ATT**
			Convince tourists that modal shifts are cheap and easy to conduct.		**ATT, EC**
			Convince tourists taking modal shifts by rising their environmental concerns.		**ATT, PN**
			Inform tourists the health benefits of taking e-bikes or bikes.		**ATT, PN**
			Depict taking private cars as wicked.		**ATT**
		Advertisements to promote trains and buses over taxis.			**ATT**
	Spread the knowledge of sufficiency. Encourage tourists to reflect upon their behaviors and furtherly adopt sufficient behaviors in tourism mobility.		Explain the concept of sufficiency to people and the environmental benefits of applying sufficient behaviors in tourism mobility.		**ATT, PN**
			Present the consequence of tourism mobility behaviors that are not sufficient.		**ATT, PN**
Catalyze the change to sufficient tourism mobility Make sufficient options favorable to tourists and encourage them to adopt sufficient tourism mobility behaviors actively.	**Inspire and encourage tourists to choose sufficient options.** Inspire users to adopt sufficient tourism mobility behaviors through providing rewardings and 'prompts'.		An award/medal/certificate for accomplishment of certain sufficiency behavior, such as walking in the destination more than certain distance.		**ATT, EC**
			A 'tournament' that tourists can compete with their partners/strangers on taking sufficiency options.		**ATT,SN**
			A game to meet different nationalities through taking public transportation.		**ATT,SN**
		An account with 'sustainable points' based on the past recorded behaviors, ultimately can be transferred into bonus tickets or discounts.			**ATT, EC**
	Improve the attractiveness and experience of sufficient options. Attract users to adopt sufficient tourism mobility behaviors through increasing the attractiveness and experience of sufficient options.		Provide products to assist carrying luggage during the trip, or setting up space for luggage on the train.		**ATT, EC, PBC**
			Seamless connection of public transport network, such as accessible e-bikes and e-scooters near train station.		**ATT, EC, PBC**
			Improve the accessibility to the charging systems for EVs.		**ATT, EC, PBC**
		Improve the public transportation system experience.			**ATT**
		Make sufficiency in tourism mobility 'cool' and worth to share.			**ATT, SN**
	Provide sufficient options with lower cost Facilitate users to adopt sufficient tourism mobility behaviors through lowering the time, effort and financial cost of sufficient options.		Convenient payment for tickets.		**ATT, EC, PBC**
			Quick and cheap charging stations for EVs.		**ATT, EC**
			Lowering the cost of public transportation (like Luxemburg).		**ATT, EC**
			Reduce the cost of choosing EVs and Uber (as well as other shared mobility platform).		**ATT, EC**
	Restrict insufficient mobility behaviors Restrain insufficient behaviors and to persuade tourists behaviors by putting restrictions.	Restrict tourists' behaviors through tourism policies and requirements.			**ATT, EC, PBC**
		Charge more on flights and private car travels by policy such as tax increase.			**ATT, EC, PBC**

Table 31: Design strategies for supporting sharing practices regarding tourism mobility behaviors.

		Key players	Government	Business	Social organizations and communities	Potential related factors
Focus of design strategies	Types of design strategies	Examples of design strategies				
Guide the change to sufficient tourism mobility Make sufficient options visible to tourists and encourage them to see sufficient tourism mobility behaviors positively.	**Provide sufficient alternatives** Make sufficient options visible and understandable to tourists.			Option to combine train tickets with a week-long e-bike rental.		**EC, PBC**
				Reduce driving distances by offering off-site car rental and return options.		**EC, PBC**
				Provide shared tourism buses for guided tours.		**PBC**
			Integration of SP into multimodal transportation options.			**EC, PBC**
	Advertise sufficient alternatives Encourage tourists to reflect upon their behaviors and furtherly adopt sufficient behaviors in tourism mobility.			Convince tourists the health benefits of bike sharing.		**ATT**
				Convince tourists the benefits on saving budgets.		**ATT, EC**
				Convince tourists the convenience of adopting sharing practices in tourism mobility.		**ATT, EC**
				Questioning the necessity of possessing private cars, and promoting sharing practices as an alternative.		**ATT, PN**
	Spread the knowledge of sufficiency. Encourage tourists to reflect upon their behaviors and furtherly adopt sufficient behaviors in tourism			Explain the concept of sufficiency to people and the environmental benefits of applying sufficient behaviors in tourism mobility.		**ATT, PN**
				Present the consequence of tourism mobility behaviors that are not sufficient.		**ATT, PN**
Catalyze the change to sufficient tourism mobility Make sufficient options favorable to tourists and encourage them to adopt sufficient tourism mobility behaviors actively.	**Inspire and encourage tourists to choose sufficient options.** Inspire users to adopt sufficient tourism mobility behaviors through providing rewardings and 'prompts'.			An app that allows solo travelers to share rides with others heading to the same destination.		**ATT, EC, PBC**
				Facilitate the creation of travel groups to encourage them share the vehicle and travel together.		**ATT, EC, PBC, SN**
				An App that help users find co-travelers and connect car renters with others when their vehicles are not full.		**ATT, EC, PBC, SN**
				The sharing service that drivers can plan trips together with fellow passengers.		**ATT, EC, PBC, SN**
				Pre-screen travelers before sharing rides to ensure compatibility.		**ATT, PBC**
	Improve the attractiveness and experience of sufficient options. Attract users to adopt sufficient tourism mobility behaviors through increasing the attractiveness and experience of sufficient options.			Track individual location data to ensure mobile availability of data support.		**ATT, EC, PBC**
				Simplified rental process and provide tourists the tracking information about the available vehicles.		**ATT, EC, PBC**
				Support for multiple languages during the rental process.		**ATT, EC, PBC**
			A platform that centralizes various shared mobility services into a single app, integrating multiple service providers.			**ATT, EC, PBC**
	Provide sufficient options with lower cost Facilitate users to adopt sufficient tourism mobility behaviors through lowering the time, effort and financial cost of sufficient options.			Share private vehicles by coordinating pickups and sharing expenses.		**ATT, EC**
				Exchange private cars in a system similar to Airbnb, allowing users to share vehicles and split costs.		**ATT, EC, PBC**
	Restrict insufficient mobility behaviors Restrain insufficient behaviors and to persuade tourists behaviors by putting restrictions.	Restrict tourists' behaviors through tourism policies and requirements.				**ATT, EC, PBC**
		Charge more on flights and private car travels by policy such as tax increase.				**ATT, EC, PBC**

Results of Step 4

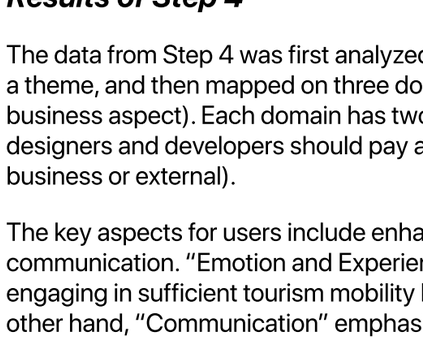
The data from Step 4 was first analyzed using a clustering approach. Each cluster was assigned a theme, and then mapped on three domains: user, business and external (apart from user and business aspect). Each domain has two sub aspects, presenting some of the key aspects that designers and developers should pay attention to if the project happens more (on user, business or external).

The key aspects for users include enhancing their overall experience and ensuring effective communication. "Emotion and Experience" focuses on improving how tourists feel when engaging in sufficient tourism mobility behaviors, whether through products or services. On the other hand, "Communication" emphasizes building trust and increasing the appeal of sustainable options, ensuring that users find these choices attractive and feel confident in adopting them.

For businesses, innovation and financial support are critical aspects. "Innovation on Business" refers to whether the product or service offered is novel and provides value within a niche market, making sufficient options more practical and appealing. Meanwhile, "Support Financially" highlights the need for financial backing, as many sufficient mobility options may not initially seem profitable. Businesses must consider sustainable ways to support these options.

For external domains such as government and social organizations, infrastructure and social movements are key considerations. "Supportive infrastructure" involves ensuring the necessary facilities are in place, such as electricity for charging stations and seamless connections between public transportation systems to enable sufficient trip planning services. Meanwhile, "Social Changes" refers to the influence of social movements, highlighting the importance of societal pressure and advocacy in driving behavioral changes toward more sufficient tourism mobility practices.

The data analysis process is illustrated in the Figure 12. The right part of the Figure 12 illustrates the key aspects from the aspects of user, business and external.



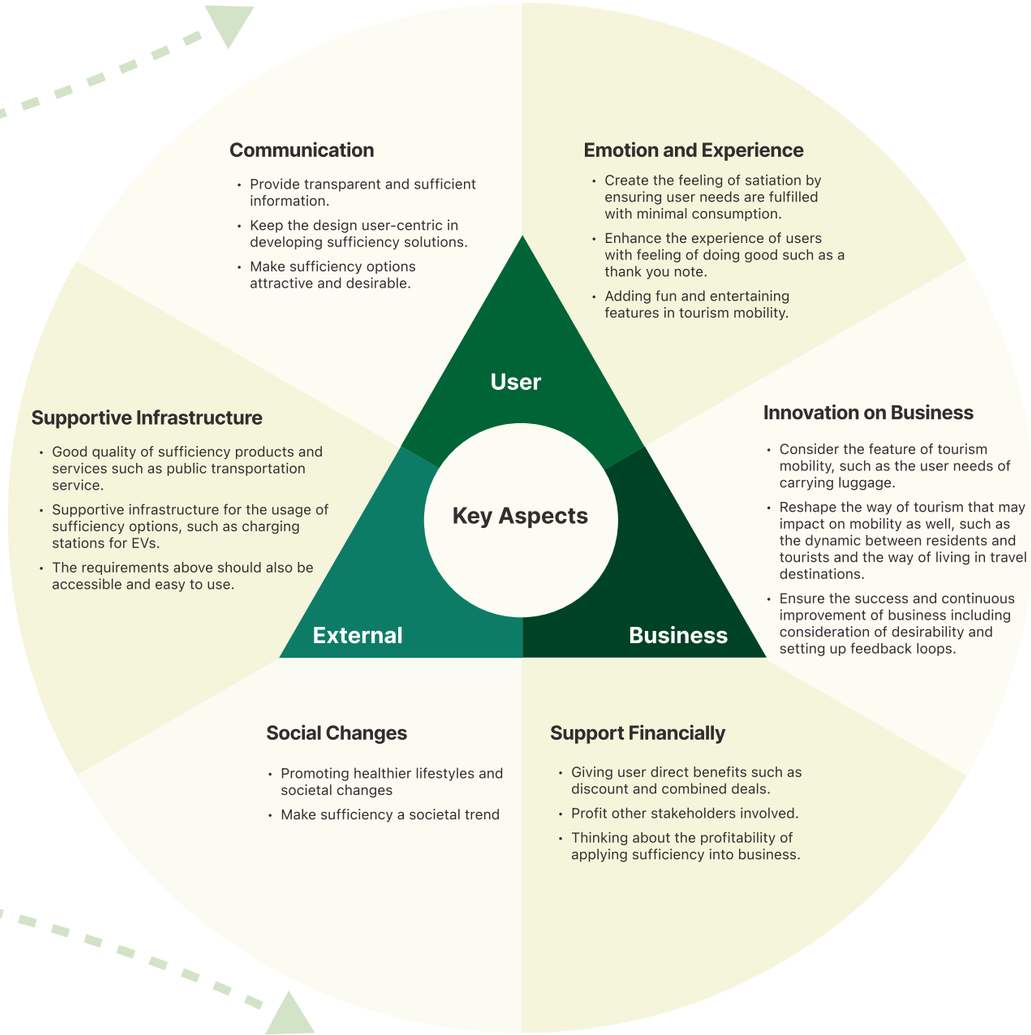
Original Data

(see Appendix B: Co-creation session results)



Coded data

(see Appendix B: Co-creation session results)



Wheel of key apsects

Figure 12: Process of data analysis of co-creation Step 4

Toolkit iterations

To effectively apply the extensive information and knowledge acquired in the previous sections to design practices, the most effective approach would be to develop a toolkit, accompanied by visual materials for a creativity session focused on designing for sufficient tourism mobility behaviors. Considering the need for accessibility and the involvement of multiple stakeholders, creating a digital version of the toolkit is also crucial.

The design of the toolkit and session is based on the following criteria:

Toolkit

- The information within the toolkit should be straightforward and easy to understand.
- The toolkit should include visualizations that aid in comprehension and stimulate creativity.
- The toolkit should encourage designers and developers to think holistically.

Session

- The session process should be simple to conduct, ensuring smooth participation.
- The session should be interactive and enjoyable, fostering engagement among participants.
- The session should follow a structured creativity process, incorporating phases of divergence, revergence, and convergence to explore and refine ideas systematically.

The first version of the toolkit (as well as the session planning) is illustrated in Appendix C: Toolkit prototype for pilot test.

Integrate previous research activities into toolkit

As illustrated in Figure 13, the results from previous research activities include identified sufficient tourism mobility behaviors, a conceptual model, and its PLS-SEM results that highlight the psychological factors influencing sufficient tourism mobility behaviors. Additionally, the expanded co-creation outcomes present strategies related to sufficient tourism mobility. The relationship between these results and the toolkit is that the findings will serve as informational resources within the toolkit, aiding potential users in enhancing work efficiency during problem empathizing, defining, and ideating phases. Moreover, the outcomes of different activities should also be applied at various stages throughout the toolkit's usage process.

Since the results are primarily rooted in the knowledge level, the toolkit can be designed with the goal of accelerating solution-creation activities. According to IxDF (2016), design thinking could be divided into five phases including "Empathize (research your users' needs)", "Define (state your users' needs and problems)", "Ideate (challenge assumptions and create ideas)", "Prototype (start to create solutions)", and "Test (try your solutions out)". From the definition, toolkit is more on the "ideate" phases and could partly cover the "define" and "prototype" activities. From the perspective of design for behavioral change, the target of the toolkit on design process is at "behavioral statement", "intervention development" and "iterative testing and development" according to the behavioral design process identified by (Cash et al., 2017).

Reflecting on the knowledge gained from the previous research activities, the identified sufficient tourism mobility behaviors, the conceptual model with its PLS-SEM results, and the intervention strategies can be mapped directly into the stages of design thinking and behavioral design as mentioned earlier. The connections between this knowledge and the design stages are illustrated in Figure 13, showcasing how each insight aligns with different phases of the design process.

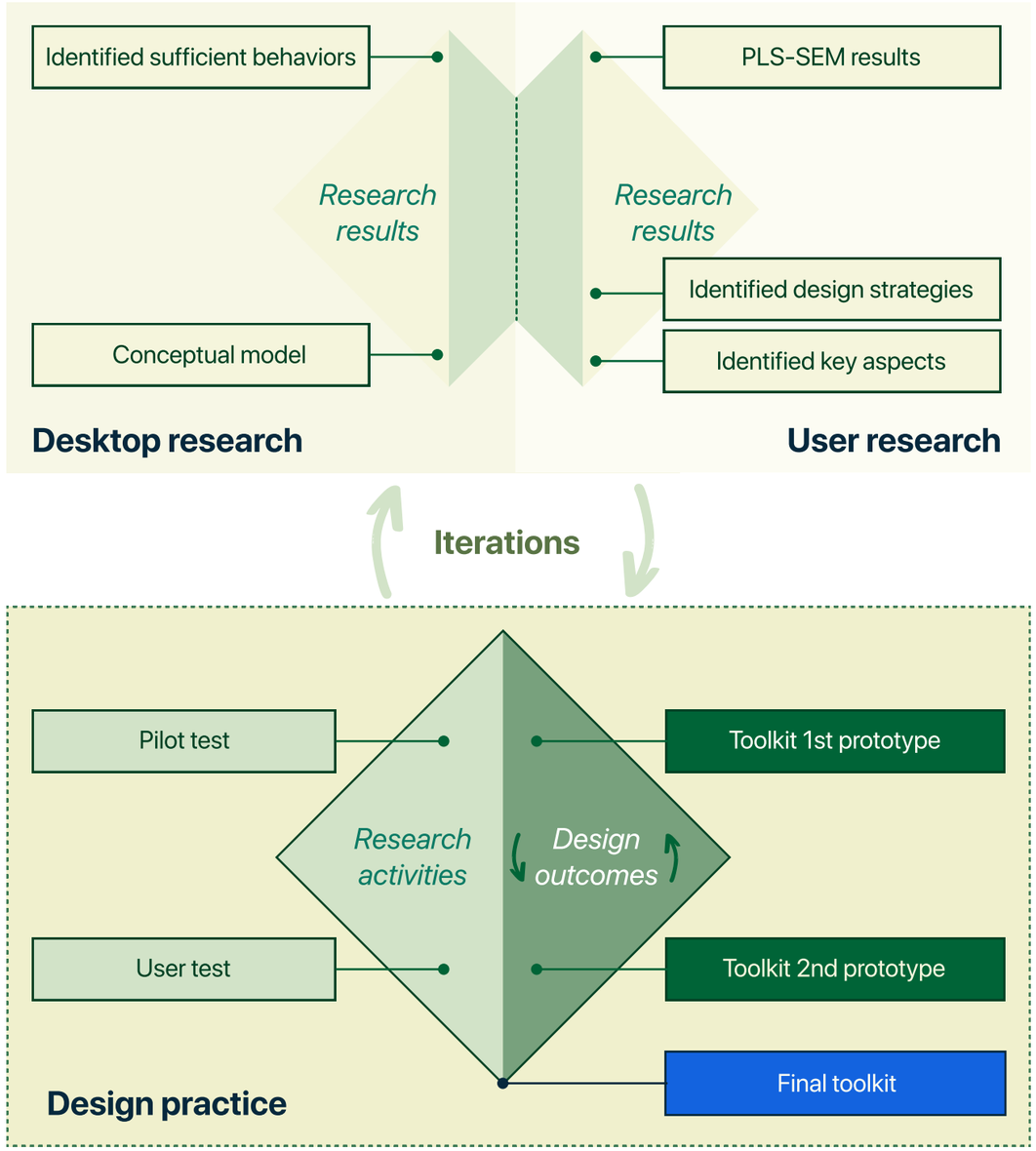


Figure 13: Relations between toolkit and previous research activities

Unlike the order of the research activities, the conceptual model and its PLS-SEM results were utilized more in the "prototype" and "iterative testing and development" stages. Although the PLS-SEM analysis occurred before the identification of the design strategies for sufficient tourism mobility behaviors, participants in the co-creation session indicated that they typically preferred to devise an intervention strategy first, and then associate it with psychological factors. Moreover, the identified strategies were primarily centered around intervention ideation, rendering the immediate introduction of the conceptual model and PLS-SEM results less helpful during initial ideation phases. However, these results proved valuable as tools to assess and predict the effectiveness of the intervention strategies devised. Therefore, this knowledge was incorporated in the "prototype" and "iterative testing and development" stages. Additionally, the results from

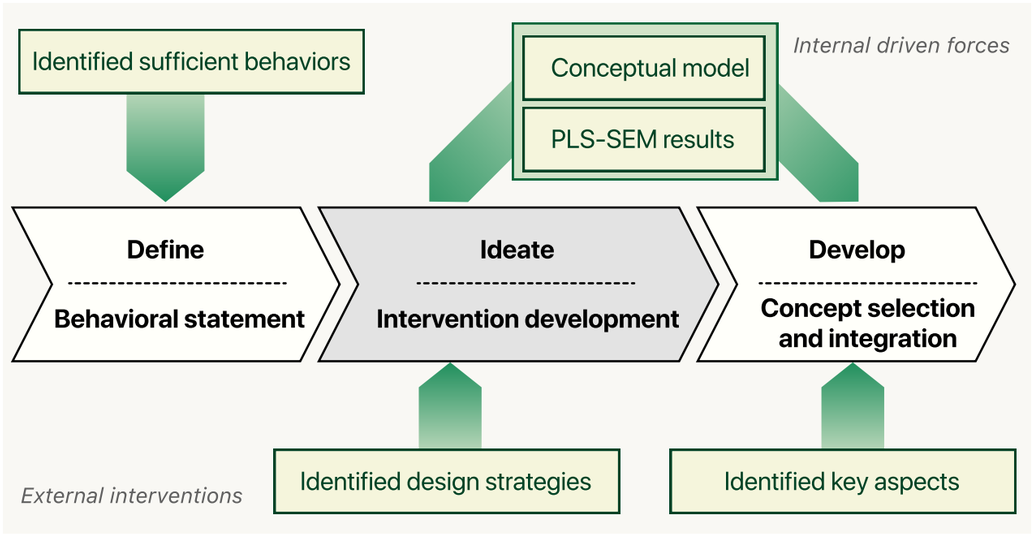


Figure 14: Apply the results into toolkit design

Step 4 of the co-creation session (as illustrated in Figure 14) were also integrated into these stages, as they concentrated on the key aspects of potential deliverables, partially overlapping with testing criteria for prototypes.

First prototype of the toolkit

The first prototype of the toolkit consists of three parts:

Introduction Materials

- This section provides an overview of the concept of sufficiency and explains the specific sufficient behaviors in tourism mobility. It serves as a introductory guide, helping users understand the context and related behaviors.

Ideation Template

The ideation template is divided into several sections:

- Scoping of the Design: The middle section is focused on defining the scope of the design in the beginning as well as the context of behaviors.
- Forcing and Offering: Located in the upper part of the template, these sections allow users to brainstorm strategies with the provided sticky notes focused on identified strategies.
- Constructs: The lower part of the template is dedicated to mapping the ideas to psychological constructs such as ATT, SN, PBC, PN and EC. This helps in idea selection and refinement.

Wheel of Key Aspects:

- This part features a visual tool, same to what is illustrated in Appendix C: Toolkit prototype for pilot test, that outlines the key aspects designers should consider during the project. The wheel serves as a quick reference guide, helping to identify critical elements during the design process.

From the perspective of session planning, Step 0 focuses on reading and understanding the sufficiency concepts. Steps 1, 2, and 3 guide participants through the creative process, moving from divergence to revergence and finally narrowing down to the selected solutions (convergence). Step 4, on the other hand, is a mapping session which ultimately concludes the process by formulating design criteria based on the insights gained.

Pilot tests of the toolkit

Given the extensive amount of information integrated into the toolkit, conducting a pilot test before the formal user test is advisable. This allows for iterative improvements based on feedback. Consequently, two pilot tests were conducted and four participants were involved.

In the pilot tests, participants worked in pairs, each assuming the role of a designer from a fictional travel company. They were first provided with a fictional project brief focused on behavioral change in tourism mobility. Using the toolkit guide, participants ideated on the project using FigJam, a popular platform for brainstorming among designers.

After completing Steps 0, 1, 2, 3, and 4, participants provided feedback on the prototype. The feedback focused on various aspects such as if the toolkit helps with the design process, ease of use, overall session planning, and other relevant aspects.

Each pilot took about 60 minutes to complete, and are facilitated by myself.



Figure 15: Photos of the two pilot tests

Second version of the toolkit

The feedback on the toolkit is mostly focused on quantity of provided information and the ideation process of the session. On the one hand, participants do feel that the toolkit helps with the design process to some extent. However, on the other hand, they also complained about the toolkit consists of too much reading materials. For instance, one of the participants said, "I'm already overwhelmed understanding the sufficiency, and at the same time I also need to understand the information on the sticky notes, and match them with the maps (strategy maps of AR, MS and SP)."

Another point is that the logic between Step 2 and 3. Participants felt confused why they need to categorize their ideas with 'stamp' function, which little contribute to the idea selection. One of the participants said, "I would not remove any of the idea here because I think diversity is important, and information on the sticky notes has already limited the creativity... and I am not fully understand how to use constructs to select idea, maybe this step could be improved."

The flow of the session was also evaluated, revealing some issues. Participants found the process quite complicated and felt that conducting the session without a facilitator would be challenging. Additionally, the workflow progressed from the center part first, then the upper part, and finally the lower part, which did not align well with natural human thinking. One participant remarked, "We need to jump between the blocks without any clear instructions. There should be markers for Step 1, 2, or 3 so we can easily follow the process."

Therefore, to improve the prototype, the following improvements need to be taken.

- *Reduce the quantity of the provide information while improve the readability of the materials.*
- *Enhance the creativity in Step 2 by giving fewer sticky notes with the specific examples.*
- *Improve the workflow between Step 2 and 3.*
- *Enhance the connections between all steps, involve call-back sessions.*

In addition to the issues mentioned by the participants, the second prototype also includes a physical version. This decision was made because participants experienced difficulties using the sticky notes template in FigJam during the pilot tests. The physical version aims to address these challenges and improve the overall user experience.

Another improvement is that new boards are developed for Step 3, on which the participants are required to map the ideas based on the related constructs, and furtherly contribute to the formulation of design goal.

The improved prototype is illustrated by in Appendix D: Second version of the toolkit.

User tests

Similar to the pilot tests, user test were also conducted in pairs, with each assuming the role of a designer from a fictional travel company via the toolkit. However, both digital toolkit and physical toolkit were tested comparing with the pilot test with 6 participants of TU Delft IDE master background.

Comparing with the first prototype, in Step 3 and 4, the work of Step 1 was call back again in the second prototype. In digital prototype, participants were asked to copy the design scoping card and paste it next to the mapping boards in order to formulate the design objectives and finish the design scoping cards based on the mapping results. In physical prototype, participants were asked to put the design scoping card in the middle of the two mapping boards.

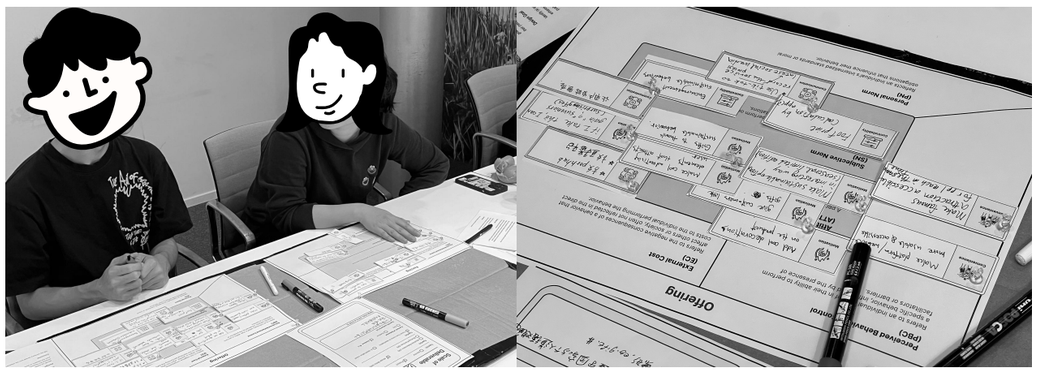


Figure 16: Photos of physical user test

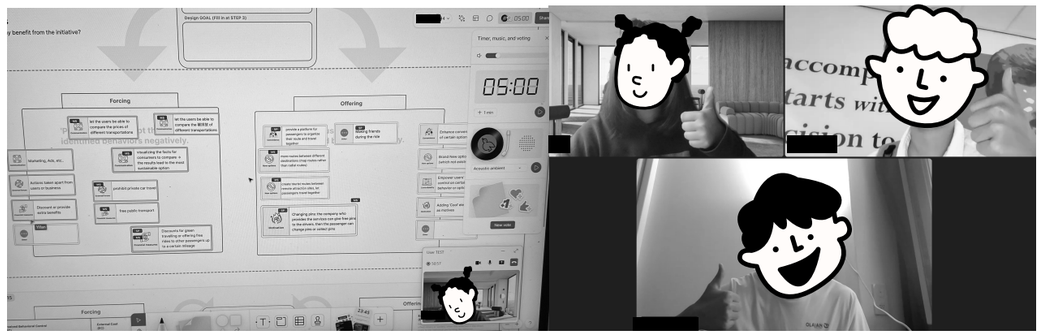


Figure 17: Photos of digital user test

Feedbacks of user test

The improved prototype received more positive feedback than negative. For example, one participant praised the design of Step 3, noting that it effectively combined psychological factors with idea screening method. He also found the layout of the idea mapping boards to be "very interesting" as it also considered the occasions that an idea may related to more than one factors. Additionally, all participants agreed that the toolkit offered a holistic approach to ideation. Comparing the pilot and user tests, the latter generated more ideas during the session, indicating an improvement in creativity and output.

However, there were still some suggestions for further improvement. One participant commented on the process, saying, "From my perspective, Step 1 feels more like a convergence phase rather than a divergence phase, because we categorize ideas by themes at the beginning, even though the themes are broad." Another participant echoed this sentiment, saying, "It helps me ideate more systematically, but I wonder if the creativity is somewhat confined by this process". For this issue, an extra step could be added in between step 1 and step 2, asking users first to ideate without determine the theme, and then cluster the ideas and rename the clusters. Then, in Step 3, map the clusters instead of the ideas.

Sticky notes with specific strategies under each theme were also provided to the participants. Participants are free to choose if they need to read and use them, and they can see the detailed examples only when they remove the sticky notes from the top. However, neither the group choose to use the sticky notes in the beginning, but only when they are tired of the ideation activity.

Regarding the content of the sticky notes, participants occasionally expressed confusion about the information provided. This issue may stem from the fact that the strategy topics were positioned on the same level of intervention, lacking a clear hierarchical structure. As one participant remarked, "...the information is simply divided into two categories, but there is little connection between the different strategy topics." A similar concern arose during the pilot test, though it was less pronounced during the user test. This indicates a potential need for clearer differentiation and integration of the strategy topics to enhance participant understanding.

Apart from the comments on the visual materials and process design, some wording mistakes in the content were also identified during the user test. These errors highlighted the need for improved clarity and accuracy in the text to ensure that participants fully grasp the information presented and can engage effectively with the materials.

Improvements need to be made according to the user test

Although the second version of the prototype shows improvement compared to the first, there remains room for further enhancement to develop a final version. The suggested improvements are as follows.

Content-wise, first, the clarity of the introductory materials could be improved in terms of wording, content, and visualizations to help users quickly grasp the concept and the sufficient tourism mobility behaviors. Second, the given strategies (see the strategies maps used in the first and the second prototypes in the Appendix E: Frist version design strategies for sufficient behaviors in tourism mobility) could be reorganized to better map the different topics based on the stakeholders involved and the level of interventions. Third, the instructions should be consolidated to allow the session to be conducted autonomously by users, with little or no assistance from a facilitator.

In terms of session planning, the ideation step (step 2) could be split into two phases: free ideation and clustering of ideas. This approach allows for creativity to flourish during the free ideation phase, while still ensuring that ideas are connected to the identified strategy topics during the clustering phase.

Overall, to develop the final prototype based on the feedback from the pilot test and user test, significant effort is still required, particularly in refining the content. This includes improving clarity, reorganizing strategies, and ensuring the process can be executed more autonomously by users.

Final toolkit

Based on all the results gained and discussed in the previous sections, the final toolkit is therefore developed as illustrated in the Figure 18.

From a session planning perspective, the final toolkit usage includes several key steps: participants begin by reading the introduction materials, followed by defining the target for sufficient behaviors and design projects. This is then followed by free ideation, clustering the ideas based on the levels of intervention, mapping the strategies according to psychological factors, refining the design goals, and finally, evaluating the important aspects of the project.

In total, the toolkit would take 90 minutes to use as a session. The session also requires a facilitator to host and organize each step of usage.

Session planning

Step 0: Understand sufficiency in tourism mobility and sufficient tourism mobility behaviors

Step 0 serves as a warm-up session. Depending on the circumstances, energizers can be added to boost creativity. The main goal of Step 0 is to ensure all participants share a common understanding of sufficiency and sufficient tourism mobility behaviors.

Users start the step 0 by reading an introductory material that explains the definition of sufficiency and describes tourists' sufficient behaviors in the context of tourism mobility. After the reading, they will reflect on the concepts and identified behaviors, considering perspectives such as a sustainable future, related design practices, and stakeholders.

Step 1: Formulate the design goal

Step 1 focuses on setting goals for the overall session. It begins with defining the features of the (potential) design project and concludes with a written design goal related to the targeted sufficient tourism mobility behaviors.

Users will formulate a design goal step by step, based on the project brief and, if applicable, previous user research results.

Step 2: Ideation on Features and Functions

The goal of Step 2 is to generate a broad range of possible solutions that address the design goals or context, as well as the behaviors identified in Step 1. During this ideation phase, participants are encouraged to think creatively and expansively, considering both the nature of sufficient tourism mobility behaviors and the insights gathered from user research. This step is designed to take about 15 minutes.

Participants will use sticky notes to present their ideas, and they are also encouraged to include illustrations to visually represent their concepts, enhancing clarity and creativity. To maintain energy and creativity, techniques like rotation (where participants rotate materials and build on each other's ideas), and short energizers can be incorporated. However, facilitators (if applicable) should be mindful of not distracting users from their on-going activities.

Step 3: Cluster and select the concepts based on intervention level

The goal of Step 3 is to integrate the ideas and concepts generated in Step 2 by organizing them according to the levels of design intervention, as outlined in Table 29, Table 30, and Table 31. Participants systematically cluster their ideas on the template of Step 3, each representing a specific intervention level.

Once clustered, participants need to conduct a round of idea selection. This selection process should reflect the participants' preferences regarding whether they want to provide tourists with more freedom in choosing (such as simply offering relevant information) or enforce behavioral change (such as restricting insufficient behaviors). Participants can also use the key aspects wheel as inspiration for formulating selection criteria.

Step 4: Idea Selection by Constructs

In Step 4, psychological constructs identified and studied in the previous research activities (online survey and PLS-SEM) are introduced. The objective is to refine and converge the ideas generated in Step 2 and Step 3 by evaluating them based on these influential constructs. This step is located at the bottom part of the template and is interconnected based on the earlier study.

Participants begin by reading a brief introduction to each construct and its impact level on intentions. Then, they mark the clusters according to these constructs. Finally, they select and integrate their ideas based on the results.

Step 5: Formulate and visualize the design outcome

The goal of Step 5 is to integrate the selected concepts into a single, specific design outcome. Participants first reflect on the selected ideas in Step 4 and integrate them to a expected design outcome. After that, participants write the design outcome on the template of Step 5, and make

a poster by collage and illustration. Participants can refer to the provided sample in the template to help frame the wording of the design outcome effectively.

Materials design

The usage flow of the final toolkit and the materials involved are presented in the Figure 19. Detailed content of the toolkit, for example, the text in the introductions, can be found in Appendix F: Final toolkit.

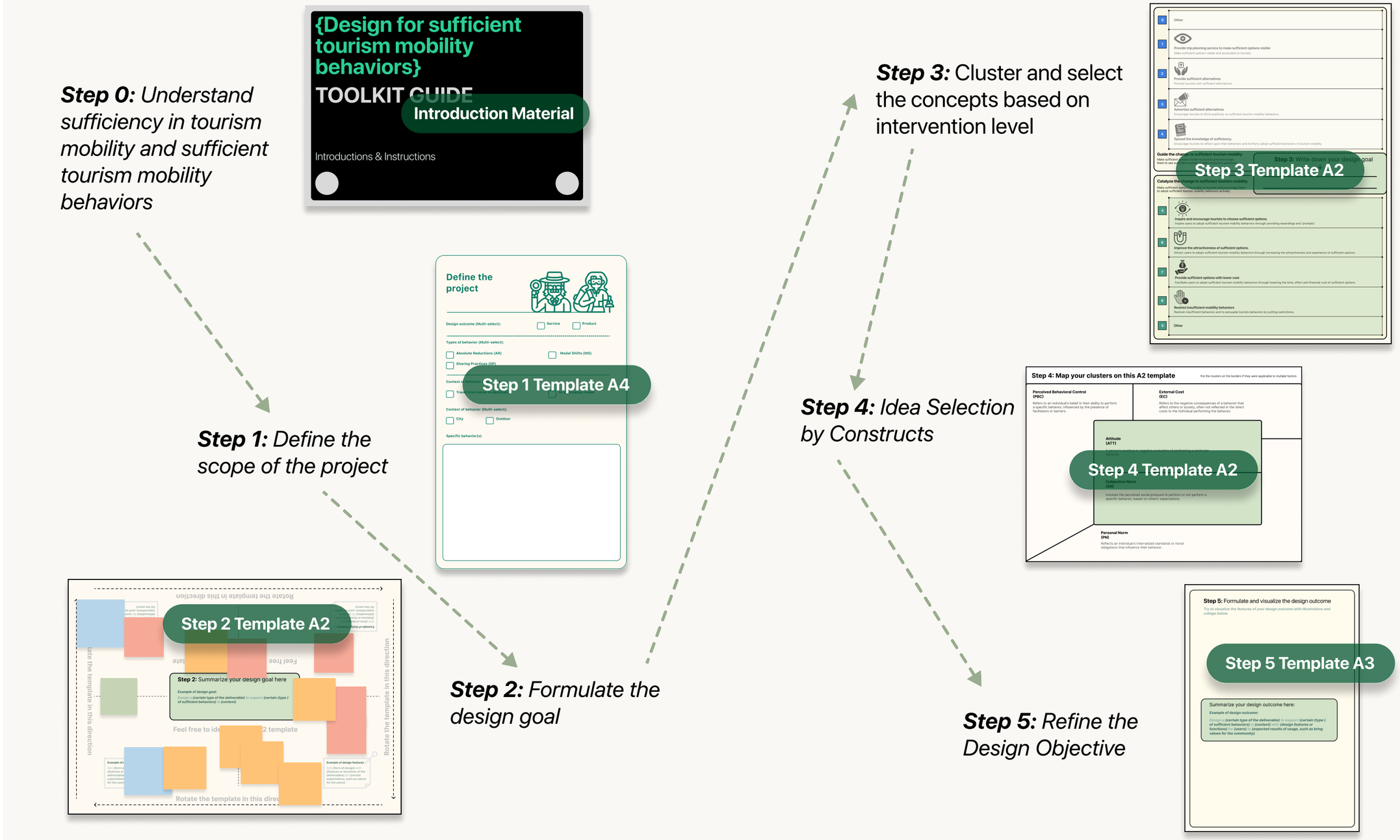


Figure 19: Process of toolkit usage (materials see in Appendix F: Final toolkit)

Evaluation of final toolkit

The evaluation of the final toolkit was conducted both digitally and physically. Five participants with relevant design backgrounds and work experience were involved in the evaluation sessions. Three participants assessed the digital toolkit, while two participants evaluated the physical toolkit.

Table 30: Participants involved in the evaluation sessions

Participant ID	Career	Type of toolkit
ED-P1	PhD student in design	Digital
ED-P2	Product management trainee	Digital
ED-P3	Second year DFI master	Digital
EP-P4	DFI master working on thesis	Physical
EP-P5	Graduate SPD student	Physical

Process of evaluation

The participants were first introduced to the toolkit materials and provided with an explanation of the session planning. During this explanation, participants were encouraged to give feedback on the toolkit's usage and to propose any questions they might have. After the toolkit overview, participants were asked to comment on the toolkit based on the following four aspects:

Efficiency and Creativity: In terms of efficiency and creativity, how do you feel the toolkit impacts the process of working on sufficiency-related projects in tourism design?

Quality of Projects: How do you think the toolkit influences the quality of sufficiency-related projects in tourism design, both in terms of the design process and the final design outcome?

Ease of Use: How would you rate the overall ease of use of the toolkit? Were there any parts that felt more intuitive or challenging?

Future Adaptations: Looking ahead to future projects, how might you adapt or improve the toolkit to better suit your design practice?

The feedback was transcribed using Microsoft Teams and subsequently analyzed through clustering.

Results of evaluation

The following sections discuss the results of the feedback from the evaluation sessions. Overall, the toolkit performed well across all aspects, receiving positive feedback for its usefulness and efficiency. However, some concerns were raised, indicating areas where improvements could be made. These concerns suggest there is still space for further refinement to enhance its effectiveness in certain steps of the design process.

Efficiency

Overall, participants agreed that the toolkit enhances efficiency. This improvement was particularly noticeable in Step 2 of the process, where the rotation method was applied. As one participant, ED-P1, remarked, "The rotation is new to me... it allows people to build up their ideas in a laddering manner, which is definitely useful." Additionally, from the perspective of the design process, the toolkit was seen as a tool that significantly improves efficiency. ED-P1 further noted, "... now I can do it (the ideation and idea selection) in an hour, but in other circumstances, I might need a whole day for that."

However, the improvement in efficiency was less apparent in other steps and raised concerns regarding the ideation process in Step 2. Some participants felt that the transition to ideation was too abrupt, and the facilitation of creativity heavily relied on the facilitator's skills. As EP-P5 remarked, "There is little transition between Step 1 and Step 2... so the user feels more like they are jumping into ideation rather than smoothly moving to the next phase." EP-P4 further suggested, "You could introduce other creativity facilitation techniques in the ideation as well... not just rely on the rotation."

Quality

Participants agreed that the toolkit enhances the quality of both the design process and the final design outcomes, primarily from a rigorous perspective. This is because the concepts are selected based on both intervention strategies and internal driving factor, which ultimately helps with the decision-making process. As ED-P3 noted, "... the toolkit examines the ideas from a holistic perspective, making the quality better." ED-P3 further added, "... the evaluation in Step 4 is based on quantitative results, making it more convincing in business practice."

In addition, the quality of the outcomes was enhanced by the diversity of concepts generated during the co-creation sessions, compared to scenarios where designers and developers work independently. ED-P1 remarked, "... the results of co-creation sessions are usually more valuable than designers integrating the insights solo. Also, different stakeholders can share their values during the session."

However, there are concerns that non-designers may not be familiar with the co-creation process, which could result in concepts generated during Step 2 being too vague for categorization and selection in Steps 3 and 4. As EP-P5 remarked, "some of the non-designers may propose ideas that are mainly on the form level, such as 'design an app'. It still requires effort from the facilitator to provide instructions during the ideation phase."

Ease of use

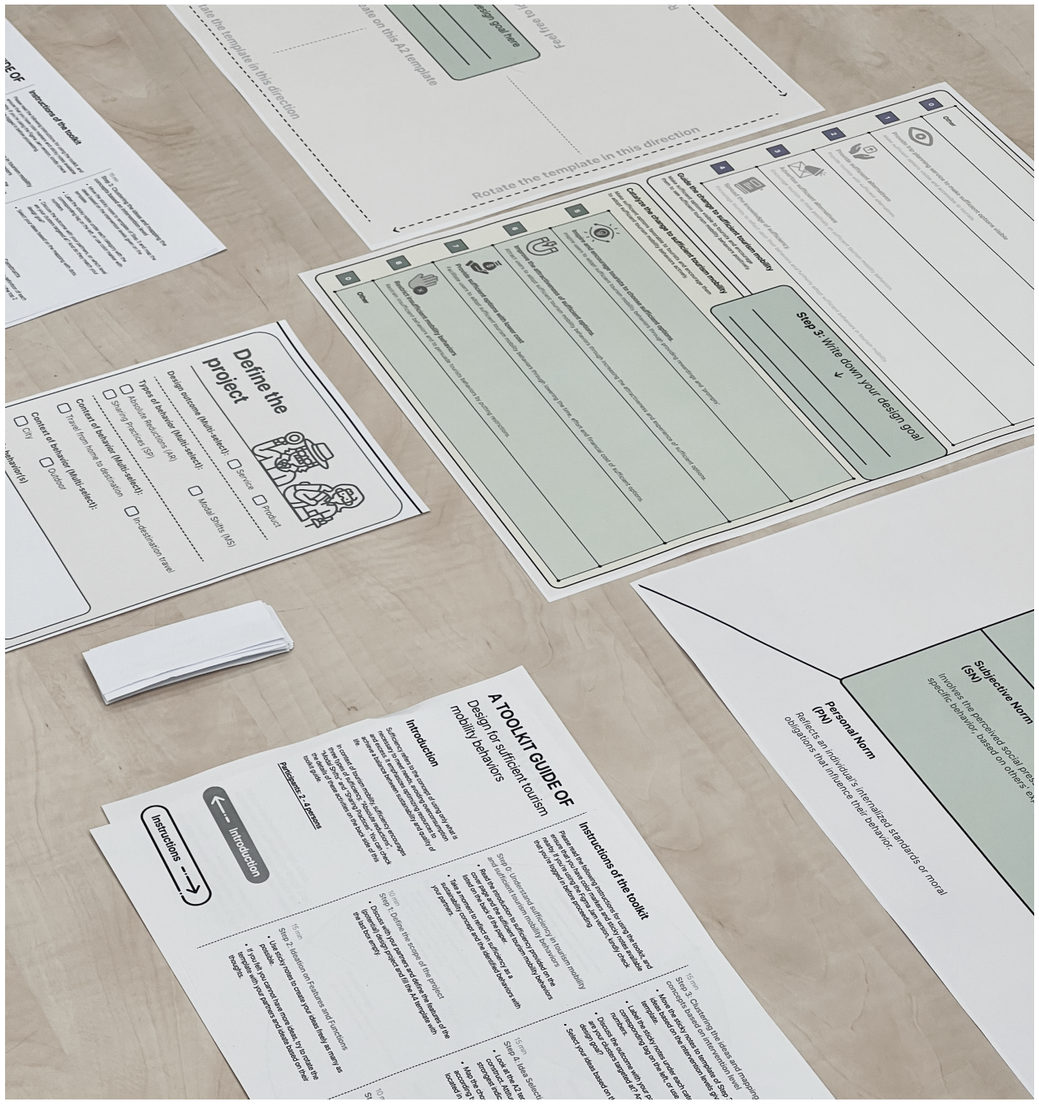
Overall, the feedback on the final toolkit was more positive compared to previous prototype versions. However, certain steps still offer room for improvement, particularly Step 3. For instance, ED-P2 remarked, "the criteria for voting in Step 3 are vague for potential participants, even though you've mentioned that the criteria can refer to the wheel in the reading material and feasibility..." EP-P5 added, "it's good that intervention levels were introduced in Step 3, but how the result of mapping links to the selection criteria is unclear... Although the toolkit guide mentions that different interventions imply different outcomes, each project seems to have its own specific criteria."

ED-P3 provided suggestions for improvement, saying, "In my experience, we usually have a series of design criteria or focused aspects, such as 'users should feel happy during usage.' It could be integrated at the beginning of the session, where users are asked to formulate both the design criteria and the design goal."

Other improvements

Most of the feedback addressed the toolkit's efficiency, quality, and ease of use. However, some comments also touched upon the participants' understanding of the information provided within the toolkit. For instance, EP-P4 remarked, "you explained a lot in this session, and I assume the facilitator would need to do the same because participants usually don't read that much." EP-P2 added, "I feel like I was provided with a lot of information during the session, and it may take time to digest and transform the knowledge into ideas."

The feedback highlights potential concerns about information overload, suggesting that participants may require more time to absorb and apply the concepts. It also underscores the importance of the facilitator's role in ensuring participants understand the material in a concise, digestible way to avoid confusion or delays during the ideation process.



Recommendations of future improvement

To enhance the toolkit's effectiveness in the design process, several improvements can be made. First, it is essential to improve the transition between steps in the toolkit. One approach is to implement gradual transition techniques that involve short activities or warm-up exercises, helping participants shift their mindset from analysis to ideation. Additionally, providing facilitators with training or examples on how to manage these transitions effectively will empower them to foster a creative mindset and ensure that participants feel comfortable moving into the ideation phase.

Another area for enhancement is the facilitation of the ideation process itself. To address feedback regarding the reliance on the rotation method, the toolkit could introduce more creativity techniques as alternatives. Moreover, clear instructions for facilitators on guiding ideation sessions effectively, especially with non-designers, will also help ensure that the generated ideas are actionable and relevant.

Clarifying the voting criteria in Step 3 is another crucial recommendation. The criteria should be refined to ensure they are specific and easily understandable, or an extendable template which provides more flexibility. Creating a visual reference or checklist for participants during the voting process could aid comprehension is also helpful.

To mitigate information overload, it is important to streamline the information delivery within the toolkit and during sessions. Facilitators should also be encouraged to summarize key points throughout the session, which can facilitate better digestion and retention of crucial information. In addition, providing resources or brief training materials on co-creation prior to sessions can help non-designers familiarize themselves with the concept and prepare more effectively. As an alternative, initiating sessions with a discussion about co-creation will encourage participants to share their expectations and understanding of the process, thus aligning perspectives and improving the quality of ideas generated.

Chapter 07

Discussion

Findings and innovations
Limitations
Reflections

Discussion

This chapter discusses the research findings from a holistic perspective while also reflecting on future prospects. By synthesizing the key insights gathered throughout the study, the chapter aims to provide a comprehensive overview of how sufficient tourism mobility behaviors can be understood and influenced.

Findings and innovations

The goal of this study is to investigate sufficiency within the domain of tourism mobility and subsequently develop a design toolkit based on the findings. The investigation comprises two key aspects: first, exploring the concept of sufficiency in tourism mobility and identifying specific sufficient behaviors; second, examining the driving factors behind these behaviors and identifying related design intervention strategies. Through the integration of behavioral insights and design intervention strategies, the toolkit aims to support designers in creating solutions that encourage sufficiency in tourism mobility.

As mentioned previously, sufficiency has been a topic of academic discussion for many years. However, in the context of tourism mobility sufficiency, clear identification of sufficient behaviors and understanding how these behaviors are influenced by psychological factors has been scarcely explored prior to this research. This study approached sufficient behaviors as an integrated series of actions rather than isolating specific behaviors.

Although some path coefficients in the PLS-SEM model were not significant—potentially perceived as weak—the R-squared value of behavior intentions still suggests that the model has acceptable explanatory power. Subjective norm and attitude emerged as the top two predictors, aligning with many sustainable design practices aimed at behavioral change, such as gamification (subjective norm-oriented) and marketing (attitude-oriented) strategies.

At the same time, the non-significance of factors like external costs, personal norm, and perceived behavioral control suggests that strategies often assumed to be effective, such as offering discounts for tourists, may have limited impact in the context of tourism mobility. These findings challenge preconceived notions and indicates that more nuanced approaches are needed to influence tourist behavior toward sufficiency.

The toolkit developed based on the identified strategies and the results of the PLS-SEM model offers a unique approach to facilitating future design projects related to sufficiency in tourism mobility. By integrating creativity facilitation techniques and idea selection strategies from both the design intervention perspective (external) and the driving factors behind sufficient tourism mobility behavior (internal), the toolkit ensures a balance of rigor in the design process while enhancing both creativity and efficiency. This dual focus allows designers to generate more comprehensive and effective solutions that are grounded in behavioral insights while fostering innovative approaches to promote sufficiency.

Limitations

The research does have limitations.

First of all, the research does not specify which behaviors are “better” than others in terms of sufficiency level. In this study, different behaviors within the same sufficiency category are treated as equally sufficient, regardless of their varying emission levels. The advantage of this approach is that it aligns with the concept of sufficiency, which emphasizes remaining within a sustainable scope rather than adhering to a rigid boundary. However, this approach may offer limited insights for developing effective design intervention strategies, as behaviors like walking and taking public transportation are considered equivalent. Future research could investigate these behaviors separately within the same category to better understand their distinct contributions to sufficiency and inform more tailored intervention strategies.

Secondly, the PLS-SEM study and the identification of intervention strategies were conducted in parallel within this research. While the former focuses on internal driving forces (such as individual attitudes and norms) and the latter on external driving forces (like policies and infrastructure), interactions between these two aspects certainly exist. For example, stronger willingness or pro-sufficiency behavior among local residents could influence amendments in related tourism policies. However, these relationships were not explored in this study in order to reduce complexity. Future research could benefit from examining the interplay between internal and external factors to provide a more holistic understanding of how sufficiency behaviors are shaped and how interventions could be more effectively designed.

Additionally, the research examines sufficiency in tourism mobility in an isolated manner. For example, if an individual meets all the recommendations for sufficient tourism mobility, this does not imply that the person practices sufficiency in a broader sense, as they may still overconsume in other areas, such as food or energy at their accommodation, vice versa. Moreover, while the research encourages tourists to reduce, shift, and share, it does not specify the extent to which these behaviors should be adopted. This lack of clarity stems from the absence of a shared understanding of sufficiency limits in current academic discussions. Researchers are still debating the relationship between sufficiency, the social foundation, the environmental ceiling, and the potential conflicts between achieving sufficiency while satisfying consumption desires. As these discussions progress, the understanding of sufficiency and its limits may become clearer over time.

Reflections

Reflecting on sufficiency, many uncertainties remain. One prominent issue is the potential conflict between promoting sufficiency and encouraging economic growth. On the one hand, sufficiency aims to reduce consumption, as seen in strategies like absolute reductions and product longevity. On the other hand, sufficiency also requires technological advancements, which involve resource investment, such as product improvements in modal shifts and technological infrastructure for the sharing economy. This paradox presents a tricky situation: while sufficiency is described using the concept of "enoughness," which implies flexibility and dynamism with other sustainability efforts, avoiding discussions of these tensions will not facilitate further research into sufficiency.

Another paradox emerges when examining Tables 29, 30, and 31, where businesses appear to be the most significant player across all forms of sufficiency in tourism mobility. This indicates that, to promote sufficiency, we will eventually need to confront the tensions between business growth and the reduction in consumption. Business models that embrace characteristics of the sharing economy align well with the vision of sufficiency, as do some businesses linked to modal shifts. However, the role of businesses in the category of absolute reductions is less clear.

One possible solution could be enhancing the experience value of local tour guide services, shifting the profit model towards services rather than relying on expansion in manufacturing or energy consumption. This would allow businesses to profit from creating richer experiences rather than from driving unsustainable consumption (e.g. in travel distance). Additionally, businesses should take responsibility in their growth strategies by avoiding expansions that promote insufficient consumption. For example, expanding a sharing mobility service to include fuel car rentals would contradict sufficiency goals.

In such cases, the government and social organizations should actively guide and regulate business practices to ensure that they align with sustainability goals. These entities can set the both incentives and restrictions for businesses to grow in ways that support sufficiency, ensuring that economic growth is decoupled from unsustainable consumption.

Moreover, the role of design and designers in sufficiency-related initiatives is still unclear and not widely acknowledged. In co-creation sessions, key players in sufficiency typically include businesses, governments, and external organizations. Designers often belong to these groups rather than acting as independent driving forces. However, design plays a crucial role in bridging the gap between intervention deliverables and people's experiences, as well as in supporting the sustainability agendas of their organizations. Designers are frequently seen as executors who may influence decision-making by managers, but they are not the primary decision-makers themselves.

To elevate the role of design in the sufficiency agenda, closer communication between departments is essential, and designers must clearly articulate their value within sufficiency efforts. By doing so, designers can assert themselves not just as executors but as critical players in shaping the sufficiency agenda. This will help empower the design profession to have a more significant impact on how sufficiency is approached across sectors.

Although there are anticipated challenges in designing for sufficiency, as the researcher behind this project, I remain optimistic about the future. The reasons for this optimism lie in the growing number of policies supporting sufficiency and the gradual adoption of sufficiency principles in everyday life, particularly among younger generations. This shift suggests that awareness of sustainable living is increasing, and societal values are evolving in ways that align with the goals of sufficiency.

Chapter 08

Conclusion

Conclusion

The goal of this master's thesis is to investigate sufficiency and sufficient behaviors in tourism mobility, further identifying related design strategies and applying the knowledge acquired to create a design toolkit that facilitates future related projects.

The research identified three types of sufficient tourism mobility: absolute reductions, modal shifts, and sharing practices, along with specific sufficient tourism mobility behaviors associated with each type. A conceptual model was proposed, integrating elements of the Theory of Planned Behavior (TPB), Norm Activation Model (NAM), habit formation, and external costs to predict these identified behaviors. Through the analysis of 191 valid responses, the PLS-SEM results indicated that subjective norm and attitude emerged as the two strongest driving factors influencing sufficient tourism mobility behaviors.

To synthesize the knowledge of sufficiency in tourism mobility and the findings from the PLS-SEM analysis, a toolkit was developed through two rounds of iterations. A co-creation session was conducted to identify related design intervention strategies, providing a foundational basis for the toolkit's development. Ultimately, the toolkit includes materials that offer introductions and instructions for a creativity session, as well as templates for each step within the session. This comprehensive approach aims to equip designers and stakeholders with effective tools to promote sufficient tourism mobility behaviors in their future projects.

The findings of this research provide a solid foundation for investigating sufficiency in design for tourism mobility in the future, an area that has seen limited exploration thus far. Additionally, the toolkit developed through this research offers significant benefits for future design practice, enhancing both the efficiency of idea development and the overall quality of design outcomes. By integrating strategies for fostering sufficient behaviors in tourism mobility, this toolkit serves as a valuable resource for designers and stakeholders aiming to support tourists' sufficient mobility behaviors.

The research does have some limitations, as previously discussed. In addition to those points, it is important to note that the results may not be applicable to areas outside of Europe, as the study primarily focuses on contexts and behaviors specific to this region. Furthermore, the demands and perspectives of minority groups may have been overlooked, given that the data analysis was conducted with the aim of capturing general scenarios. Future research should consider incorporating diverse geographical contexts and a broader range of demographic voices to ensure a more comprehensive understanding of sufficiency in tourism mobility. However, the logic of the toolkit development may be useful for similar projects in other domains, for instance, designing for sufficiency in work mobility.

Chapter 09

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Chapter 10

Appendices

Appendix A: Online Questionnaire
Appendix B: Co-creation session results
Appendix C: Toolkit prototype for pilot test
Appendix D: Second version of the toolkit
Appendix E: Frist version design strategies for sufficient behaviors in tourism mobility
Appendix F: Final toolkit

Appendix A: Online Questionnaire

Appendix A Questionnaire

Dear participants,

Hello! I am a design student, and for my master graduation project, I investigate how design can support travelers be more sustainable in their mobility behaviors. This survey will examine your perceptions, and the aggregated data will be published in my thesis.

The survey is completely anonymous, and it will take around 5 minutes to fill in. By filling in the survey you agree to the treatment of data as described.

Please be sure to answer each question.

Dependent variables

Please read the following passage, introducing the concept of sufficiency in tourism mobility:

Sufficiency is an approach to sustainable consumption that emphasizes reducing ecological footprints by changing consumption patterns and lowering consumption levels. In tourism mobility, which involves a tourist's transportation from home to their destination and travel within the destination, three types of sufficiency can be identified: (1) absolute reductions, (2) modal shifts, and (3) sharing practices.

Absolute reductions refer to those behaviors that directly reduce the level of consumption. In tourism mobility, these behaviors may include choosing closer tourism destinations and traveling shorter distances, increasing the length of stay at a single destination rather than visiting multiple destinations on one trip, taking fewer trips, and shortening the duration of trips.

Modal shifts refer to behaviors that transition existing consumption patterns to more sustainable ones. In tourism mobility, these behaviors may include taking sustainable transport modes (public transportation, cycling, walking, jogging, train, bus), taking electrified vehicles (electric cars, bikes, and scooters) and, using multimodal travel (multi-trip transportation) options including shuttle bus.

Sharing practices refer to behaviors that increase the usage intensity of products and services by the activities of sharing. In tourism mobility, these behaviors may include using shared mobility services including car sharing, bike sharing, e-bike sharing, and using electric car rental services.

Please read the following statements and questions about absolute reduction behaviors and select the response that best reflects your opinion ranging from strongly disagree to strongly agree or never to always.

As a reminder, absolute reductions refer to those behaviors that directly reduce the level of consumption. In tourism mobility, these behaviors may include choosing closer tourism destinations and traveling shorter distances, increasing the length of stay at a single destination rather than visiting multiple destinations on one trip, taking fewer trips, and shortening the duration of trips.

AR	**Items** Strength items (D. Liu et al., 2017)	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
AR1	I intend to adopt absolute reductions in my tourism transportation behaviors.							
AR2	As far as possible, I will choose to apply absolute reductions in my tourism transportation behaviors in the coming year.							
AR3	I will encourage the members of my family and friends to adopt absolute reductions in tourism transportation behaviors.							

Please read the following statements and question about modal shift behaviors and select the response that best reflects your opinion ranging from strongly disagree to strongly agree or never to always.

As a reminder, **modal shifts** refer to behaviors that transition existing consumption patterns to more sustainable ones. In tourism mobility, these behaviors may include taking sustainable transport modes (public transportation, cycling, walking, jogging, train, coach), taking electrified vehicles (electric cars, bikes, and scooters) and, using multimodal travel (multi-trip transportation) options including shuttle bus.

MS	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
MS1	I intend to adopt modal shifts in my tourism transportation behaviors.							
MS2	As far as possible, I will choose to apply modal shifts in my tourism transportation behaviors in the coming year.							
MS3	I will encourage the members of my family and friends to adopt modal shifts in tourism transportation behaviors.							

Please read the following statements and questions about sharing practice behaviors and select the response that best reflects your opinion ranging from strongly disagree to strongly agree or never to always.

As a reminder, **sharing practices** refer to behaviors that increase the usage intensity of products and services by the activities of sharing. In tourism mobility, these behaviors may include using shared mobility services including car sharing, bike sharing, e-bike sharing, and using (electric) car rental services.

SP	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
SP1	I intend to adopt sharing practices in my tourism transportation behaviors.							
SP2	As far as possible, I will choose to apply sharing practices in my tourism transportation behaviors in the coming year.							
SP3	I will encourage my family members and friends to adopt sharing practices in tourism transportation behaviors.							

Appendix A: Online Questionnaire

Independent variables

Please read the following statements and select the response that best reflects your opinion on the following items, ranging from strongly disagree to strongly agree.

ATT	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
ATT1	I think adopting behaviors that prioritize sufficiency in tourism transportation is wise.							
ATT2	I think adopting behaviors that prioritize sufficiency in tourism transportation is good.							
ATT3	I think adopting behaviors that prioritize sufficiency in tourism transportation is worthwhile.							
ATT4	I think adopting behaviors that prioritize sufficiency in tourism transportation is beneficial.							

PBC	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
PBC1	I believe I have the ability to adopt sufficiency behaviors in tourism transportation.							
PBC2	If it were entirely up to me, I am confident that I will adopt sufficiency behaviors in tourism transportation.							
PBC3	If you are reading this statement, please select 6 “AGREE).							
PBC4	I have resources, time and willingness to adopt sufficiency behaviors in tourism transportation.							
PBC5	Sufficiency transport options are generally available to me when I go for tourism transportation.							

SN	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
SN1	Most people who are important to me think I should adopt sufficiency behaviors in tourism transportation.							
SN2	Most people who are important to me would want me to adopt sufficiency behaviors in tourism transportation.							
SN3	People whose opinions I value would prefer that I adopt sufficiency behaviors in tourism transportation.							
SN4	My friend’s positive opinion influences me to adopt sufficiency behaviors in tourism transportation.							

Please read the following statements and select the response that best reflects your opinion on the following items, ranging from strongly disagree to strongly agree.

PN	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
PN1	I feel a moral obligation to adopt sufficiency behaviors in tourism transportation.							
PN2	I feel that I should adopt sufficiency behaviors in tourism transportation.							
PN3	I feel it is important that people in general adopt sufficiency behaviors in tourism transportation.							
PN4	I would feel guilty when I don’t adopt sufficiency behaviors in tourism transportation.							

HAB	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
HAB1	I adopt sufficiency behaviors in tourism transportation frequently.							
HAB2	I adopt sufficiency behaviors in tourism transportation automatically.							
HAB3	I adopt sufficiency behaviors in tourism transportation without having to consciously remember.							
HAB4	It makes me feel weird if I do not adopt sufficiency behaviors in tourism transportation.							

EC	**Items**	1: Strongly Disagree	2: Disagree	3: Somewhat Disagree	4: Neither Agree nor Disagree	5: Somewhat Agree	6: Agree	7: Strongly Agree
EC1	For me, the financial cost of adopting sufficiency behaviors in tourism transportation is high.							
EC2	For me, the time cost of adopting sufficiency behaviors in tourism transportation is high.							
EC3	For me, the overall effort required to adopt sufficiency behaviors in tourism transportation is high.							

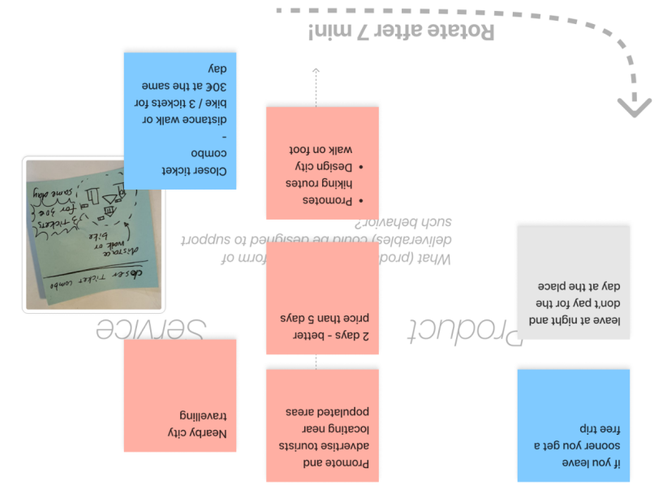
Demographic variables

Please answer the following question:

	Demographic variables						
D1	What is your age?	Text input					
D2	What is your gender?	Male	Female	Other	Prefer not to say		
D3	What is your highest education level?	Secondary school	Diploma	Bachelor’s degree	Master’s degree	PhD	Other
D4	What is your personal monthly after-tax income level?	Below 1500€	1500-2500€	2500-3500€	3500-4500€	Above 4500€	

In-destination travel
Absolute Reduction

Shortening the duration of trips (while choosing closer destinations)



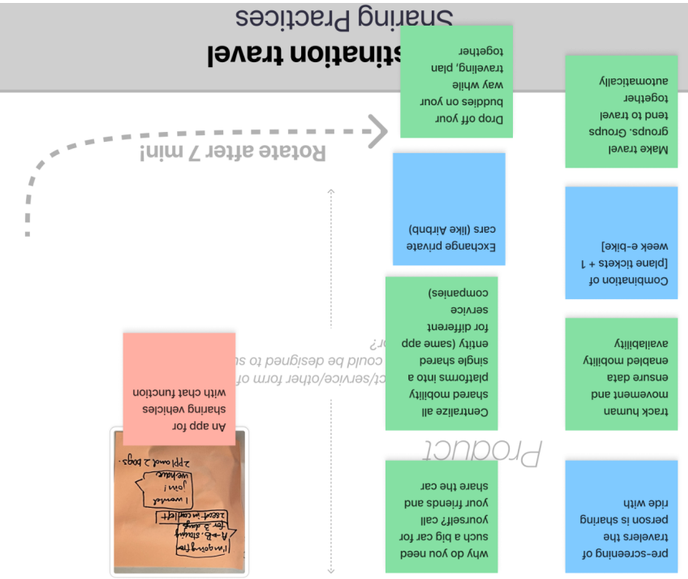
In-destination travel
Modal Shift

Taking electrified vehicles (electric cars, bikes, and scooters)



In-destination travel
Sharing Practices

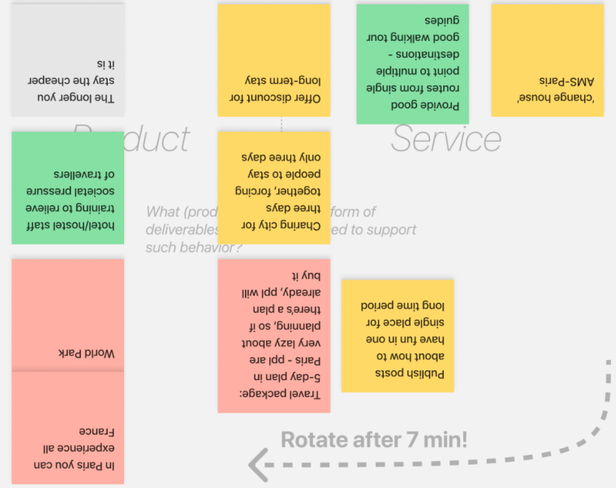
Using shared mobility services
(car sharing, bike sharing, e-bike sharing, and using electric car rental services)



Appendix B: Co-creation session results

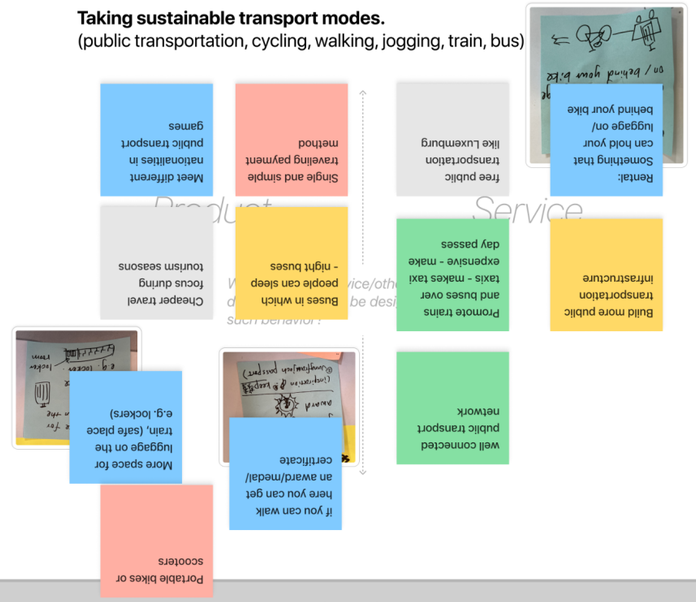
In-destination travel
Absolute Reduction

Increasing the length of stay at a single destination rather than visiting multiple destinations on one trip



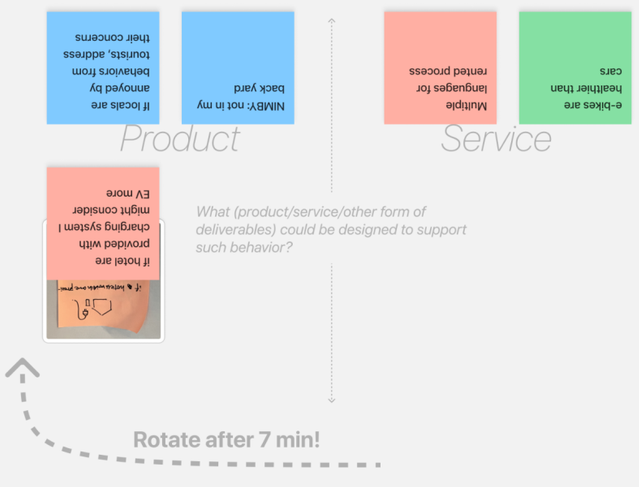
In-destination travel
Modal Shift

Taking sustainable transport modes.
(public transportation, cycling, walking, jogging, train, bus)

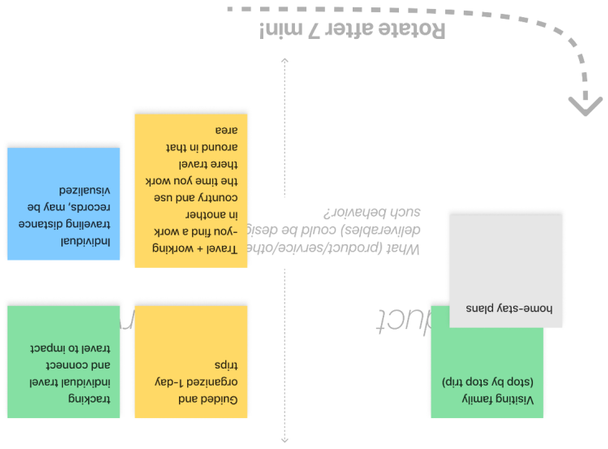


In-destination travel
Sharing Practices

Using shared mobility services
(car sharing, bike sharing, e-bike sharing, and using electric car rental services)



Travel from home to destination
Absolute Reduction

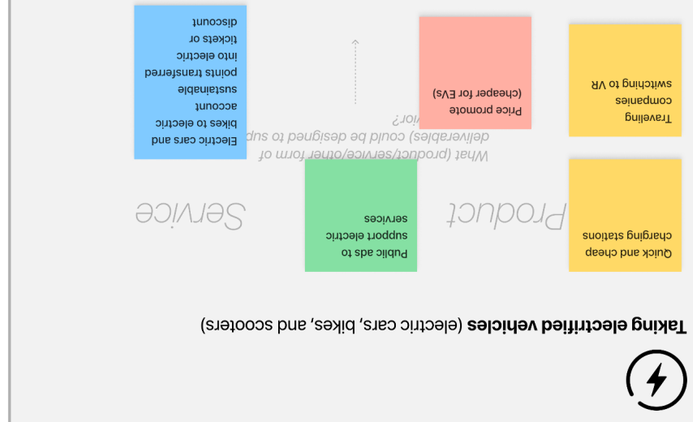


Choosing closer tourism destinations and traveling shorter distances
(during the trips)

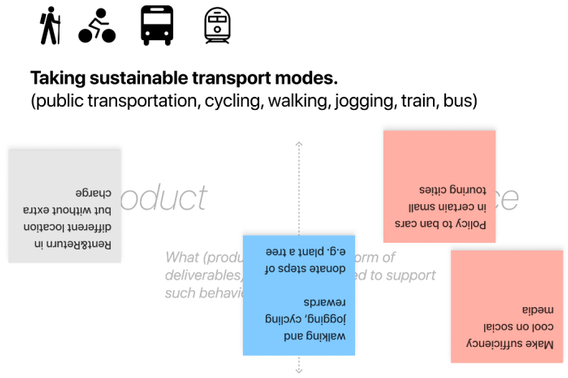




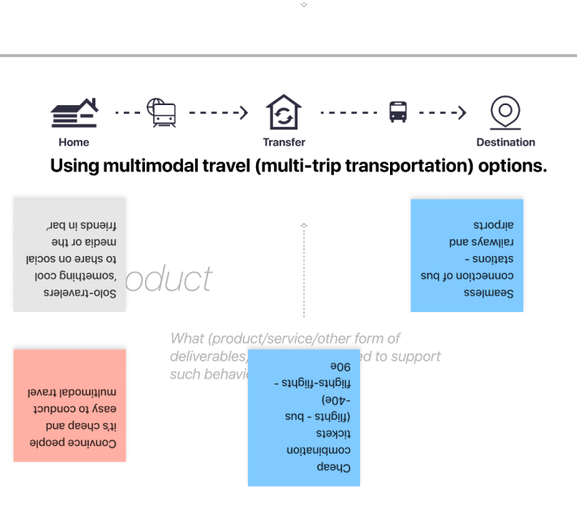
Travel from home to destination
Modal Shift



Taking electrified vehicles (electric cars, bikes, and scooters)



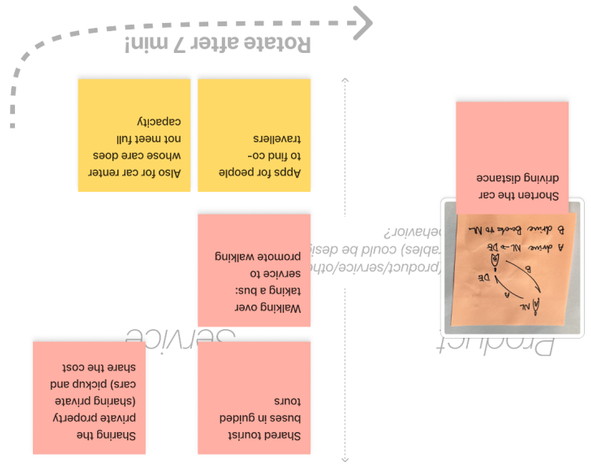
Taking sustainable transport modes.
(public transportation, cycling, walking, jogging, train, bus)



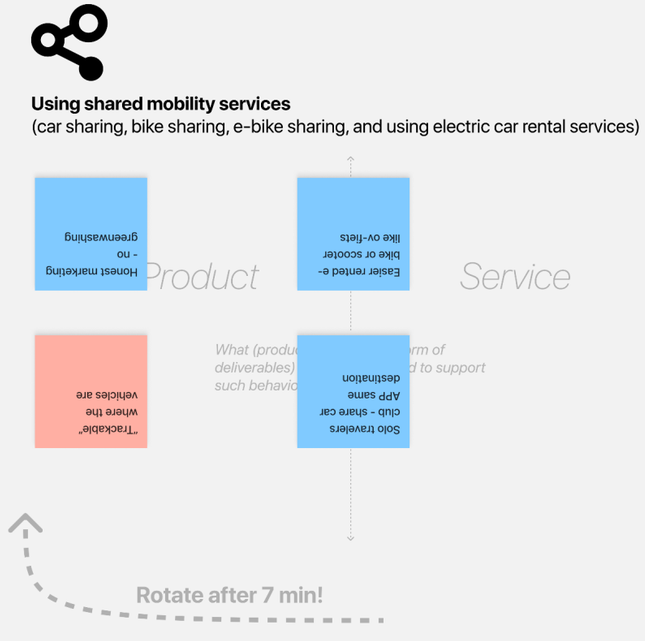
Travel from home to destination
Absolute Reduction

Travel from home to destination
Modal Shift

Travel from home to destination
Sharing Practices



Using shared mobility services
(car sharing, bike sharing, e-bike sharing, and using electric car rental services)



Travel from home to destination
Sharing Practices

Appendix B: Co-creation session results

Appendix B: Co-creation session results

OG



Appendix C: Toolkit prototype for pilot test

Step 0: Understand Sufficiency in Tourism Mobility

Step 0 serves as a warm-up session. Depending on the circumstances, energizers can be added to boost creativity. The main goal of Step 0 is to ensure all participants share a common understanding of sufficiency and sufficient tourism mobility behaviors. This step takes about 10 minutes.

Participants will start by reading an introductory material that explains the definition of sufficiency and describes tourists' sufficient behaviors in the context of tourism mobility. After the reading, they will reflect on the concepts and identified behaviors, considering perspectives such as a sustainable future, related design practices, and stakeholders.

Step 1: Scoping the Project

Step 1 focuses on setting goals for the overall session. It begins with defining the features of the (potential) design project and concludes with a written design goal related to the targeted sufficient tourism mobility behaviors. This step also takes about 10 minutes.

Participants will determine the focus of their deliverables step by step, based on a (fictional) project brief and, if applicable, previous user research results. Although ideally combined with user research insights, for the pilot and formal user tests, a fictional project brief is provided. Participants can pretend they have conducted user research based on their travel experiences and knowledge.

Step 2: Ideation on Features and Functions

The goal of Step 2 is to generate possible solutions that address the design goals or context, and behaviors identified in Step 1. Ideation in this step is approached from two aspects: 'Forcing' and 'Offering,' as discussed in previous sections. This step takes about 20 minutes.

Participants will use the provided sticky notes, each listing a specific strategy topic, to ideate systematically. Blank sticky notes are also available for ideas that don't fit easily into predefined categories. To maintain energy and creativity, techniques like rotation (where participants rotate materials and build on each other's ideas), and short energizers can be incorporated. However, facilitators should be mindful of not distracting participants from their tasks.

Step 3: Idea Selection by Constructs

In Step 3, psychological constructs identified and studied in the previous research activities (online survey and PLS-SEM) are introduced. The objective is to refine and converge the ideas generated in Step 2 by evaluating them based on these influential constructs. This step is located at the bottom part of the template and is interconnected based on the earlier study. Step 3 also takes about 20 minutes.

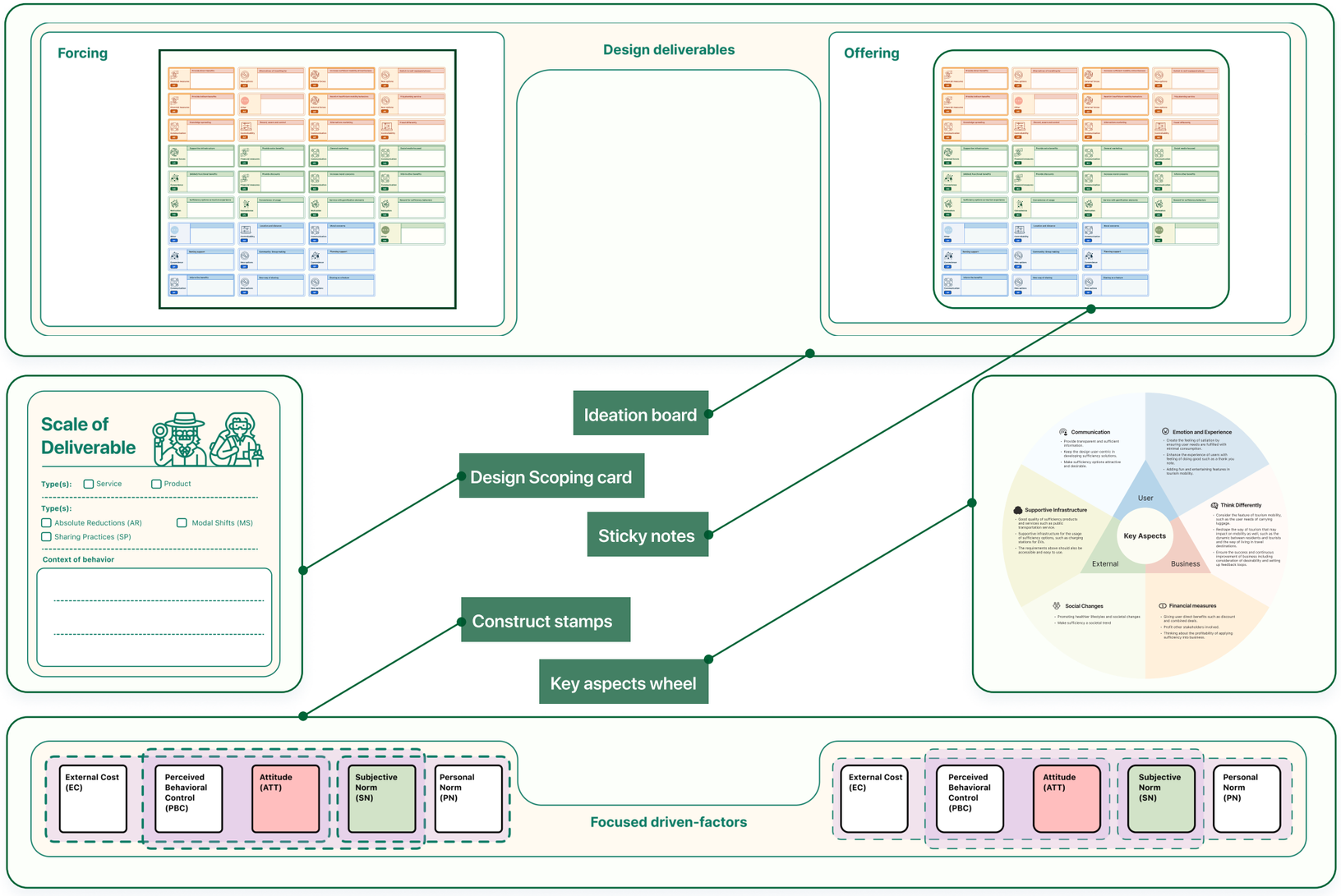
Participants begin by reading a brief introduction to each construct and its impact level on INT. Then, they mark their ideas according to these constructs. Finally, they select and integrate their ideas based on the results.design criteria.

Step 4: Mapping Ideas on the Key Aspects Wheel

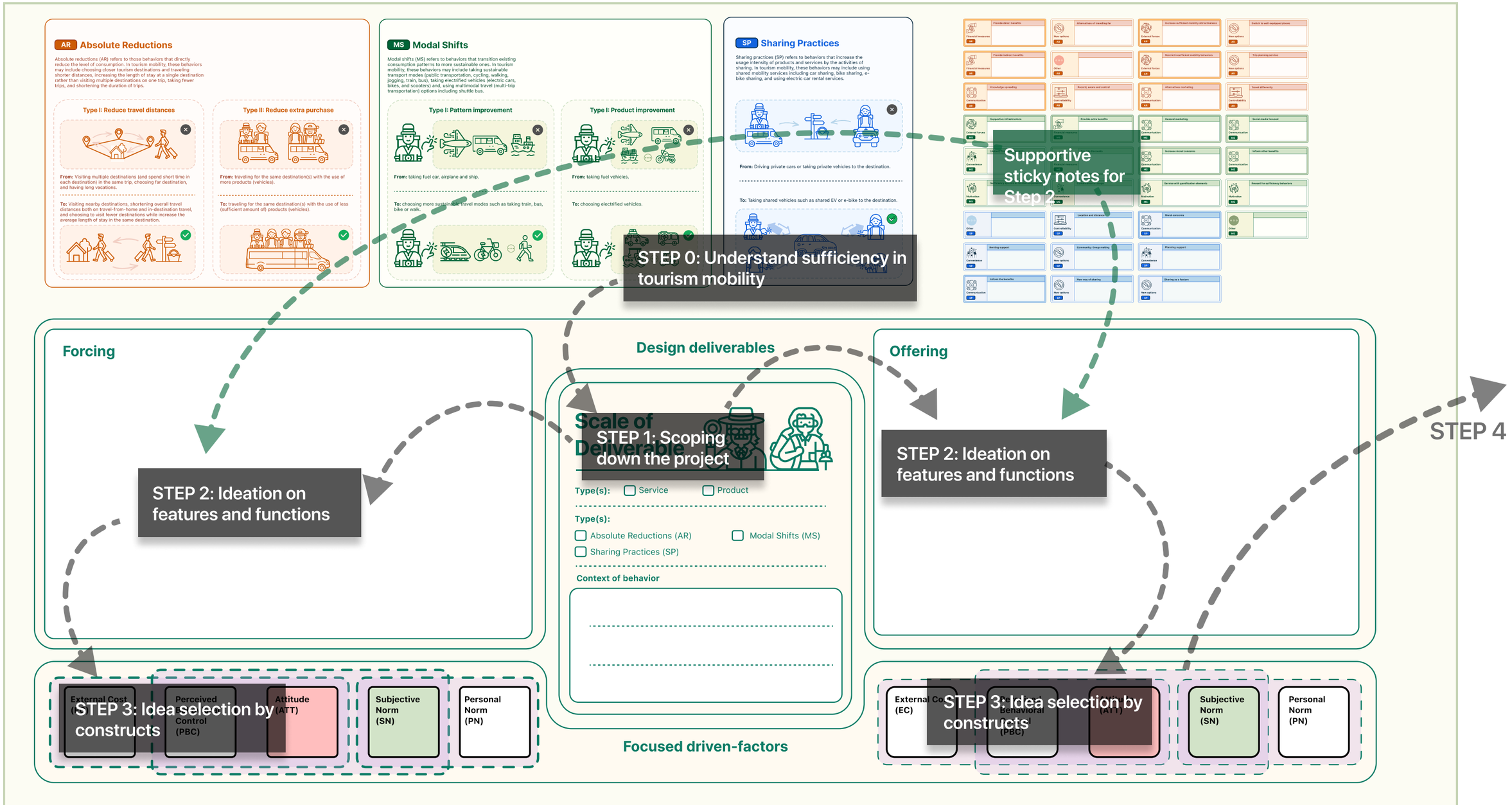
Step 4 introduces the final component of the co-creation session results. The goal is to evaluate how the outcomes of Step 3 align with the key aspects wheel and determine which aspects are most important. This step takes about 10 minutes, with an additional 15 minutes for reflection and commentary.

Participants map their selected or integrated ideas onto the wheel according to the definitions of each segment. They then reflect on the results and discuss potential

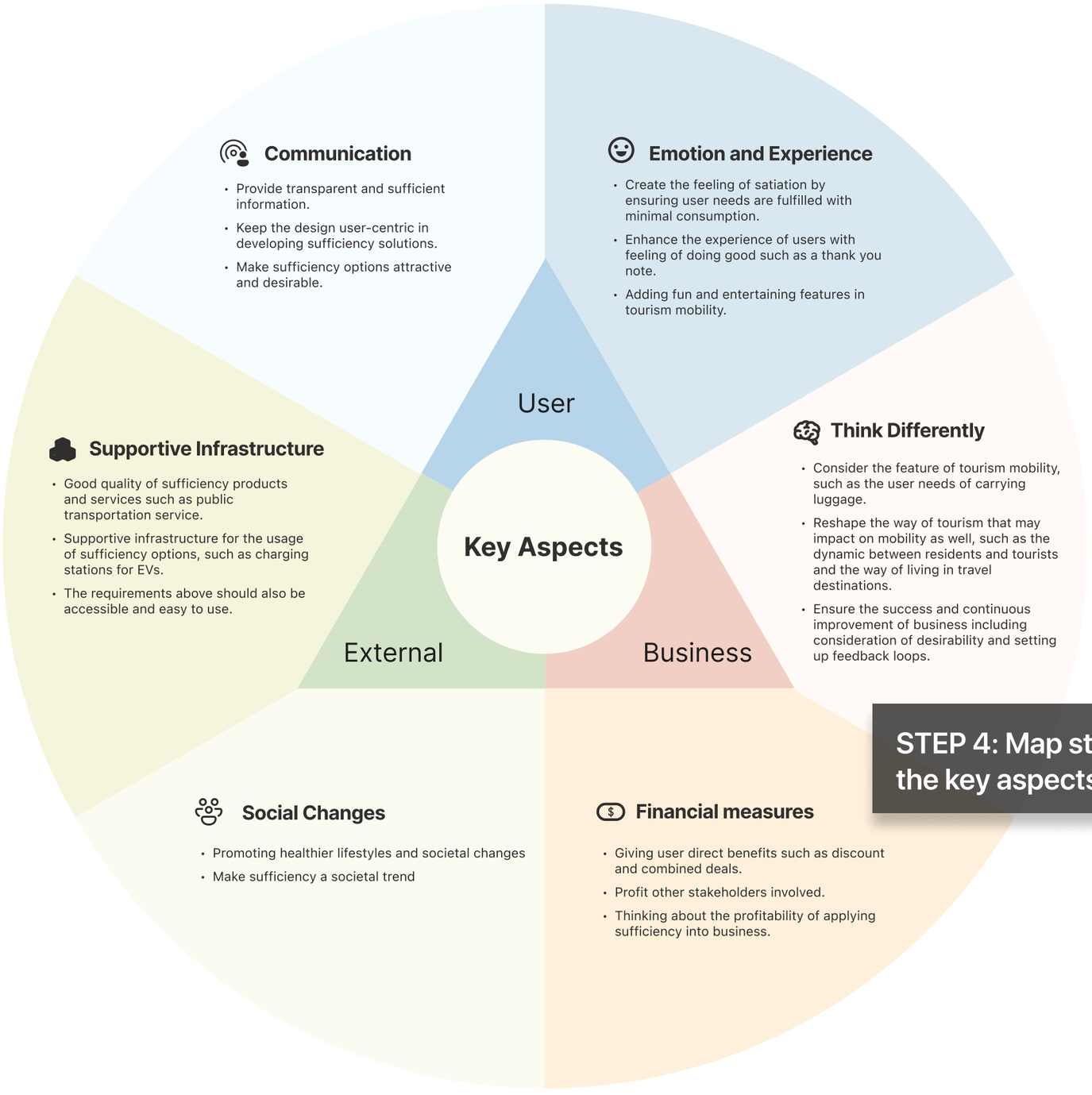
Appendix C: Toolkit prototype for pilot test



Appendix C: Toolkit prototype for pilot test



Appendix C: Toolkit prototype for pilot test



STEP 4: Map sticky notes on the key aspects wheel

Appendix D: Second version of the toolkit

Step 0: Understand Sufficiency in Tourism Mobility

Step 0 is the exact same as prototype of the first version

Step 1: Scoping the Project

Step 1 focuses on setting goals for the overall session. It begins with defining the features of the (potential) design project and concludes with a written design goal related to the targeted sufficient tourism mobility behaviors. This step also takes about 10 minutes.

Participants will determine the focus of their deliverables step by step, based on a (fictional) project brief and, if applicable, previous user research results. Although ideally combined with user research insights, for the pilot and formal user tests, a fictional project brief is provided. Participants can pretend they have conducted user research based on their travel experiences and knowledge.

Step 2: Ideation on Features and Functions

The goal of Step 2 is to generate possible solutions that address the design goals or context, and behaviors identified in Step 1. Ideation in this step is approached from two aspects: 'Forcing' and 'Offering,' as discussed in previous sections. This step takes about 20 minutes.

Participants will use the provided sticky notes, each listing a specific strategy topic, to ideate systematically. Blank sticky notes are also available for ideas that don't fit easily into predefined categories. To maintain energy and creativity, techniques like rotation (where participants rotate materials and build on each other's ideas), and short energizers can be incorporated. However, facilitators should be mindful of not distracting participants from their tasks.

Step 3: Idea Selection by Constructs

In Step 3, psychological constructs identified and studied in the previous research activities (online survey and PLS-SEM) are introduced. The objective is to refine and converge the ideas generated in Step 2 by evaluating them based on these influential constructs. This step is located at the bottom part of the template and is interconnected based on the earlier study. Step 3 also takes about 20 minutes.

Participants begin by reading a brief introduction to each construct and its impact level on INT. Then, they mark their ideas according to these constructs. Finally, they select and integrate their ideas based on the results.

Step 4: Mapping Ideas on the Key Aspects Wheel

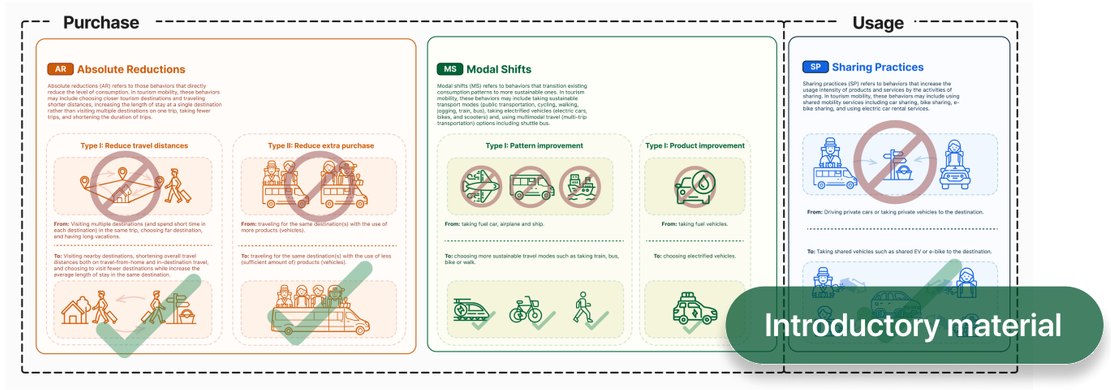
Step 4 introduces the final component of the co-creation session results. The goal is to evaluate how the outcomes of Step 3 align with the key aspects wheel and determine which aspects are most important. This step takes about 10 minutes, with an additional 15 minutes for reflection and commentary.

Participants map their selected or integrated ideas onto the wheel according to the definitions of each segment. They then reflect on the results and discuss potential design criteria.

Appendix D: Second version of the toolkit

Step 0: 10 min

Understand sufficiency in tourism mobility



Step 1: 10 min

Define the scope of project

- Multi-select the boxes if applicable.
- Define the context of the project and certain behaviors to enhance if applicable.



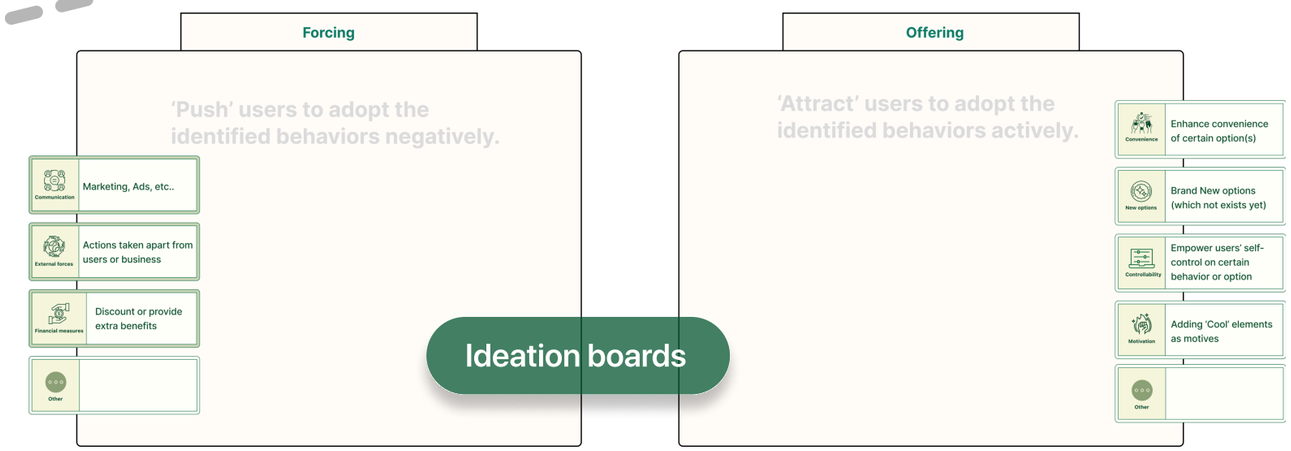
Adding energizers depends on the energy of participants.

Step 3

Step 2: 25 min

Determine the features of deliverable and related strategies

- Ideate the possible features of design outcomes from the aspect ‘forcing’ and aspect ‘offering’.
- You can use the sticky notes with a given theme. If not applicable, you could use template ‘other’.
- Use stamp ‘AR’, ‘MS’ and ‘SP’ to differentiate the sticky notes.

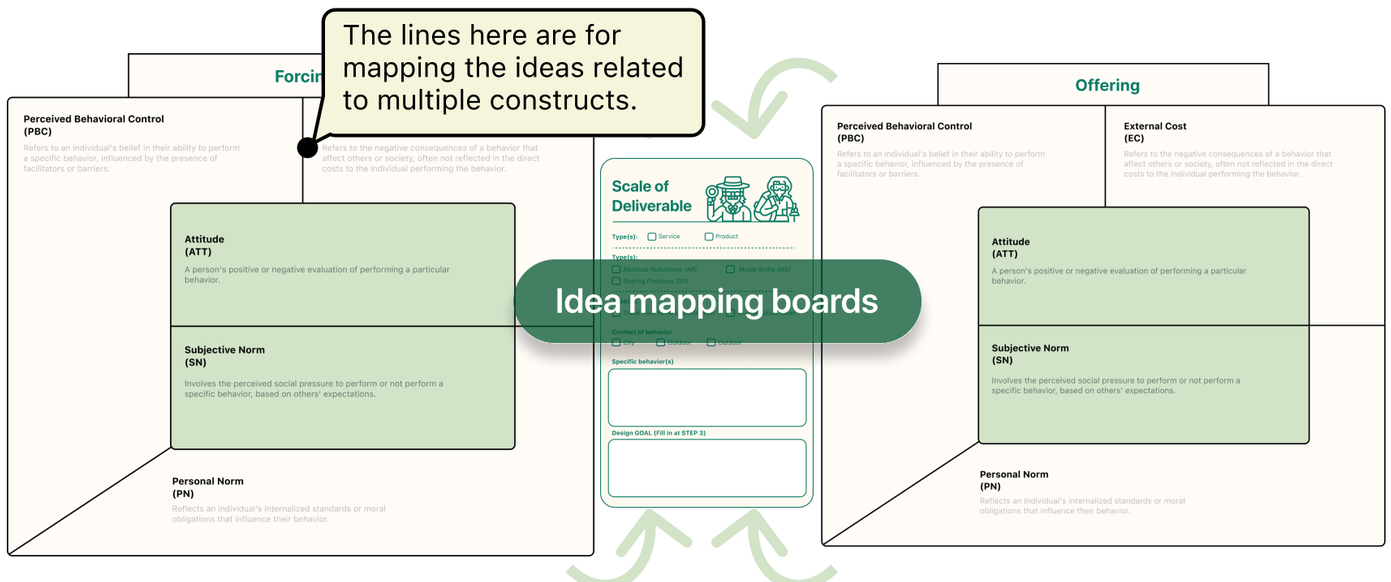


Appendix D: Second version of the toolkit

Step 3: 10 min

Select the key features based on factors

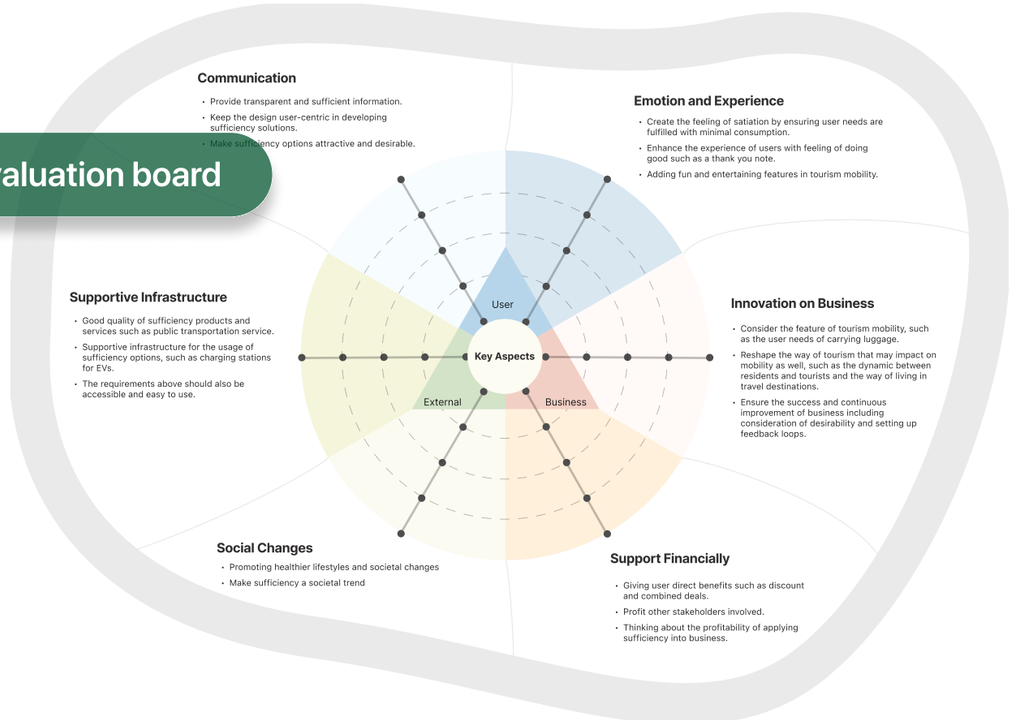
- Map the sticky notes based on the definition of psychological variables.
- Sticky notes located at the green block at the center are more likely to connected with users' sufficient behaviors.
- Reflect on the behaviors identified in STEP 1, screen the ideas, and formulate a design objective based on the content.



Step 4: 10 min

Reflect and evaluation

- Based on the formulated design objective from STEP 3, rate foreseeable design deliverable from the aspects of 'user', 'external' and 'business' on the five-point axis.
- Draw a radar map based on the rating.
- Reflect on the radar results, and point out the key criteria from the out side of the content.



Appendix D: Second version of the toolkit

AR Absolute Reductions

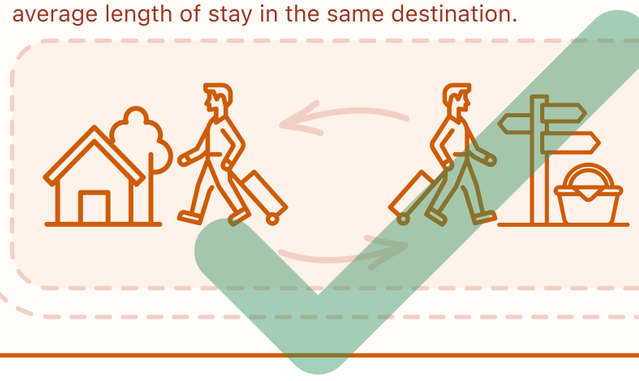
Absolute reductions (AR) refers to those behaviors that directly reduce the level of consumption. In tourism mobility, these behaviors may include choosing closer tourism destinations and traveling shorter distances, increasing the length of stay at a single destination rather than visiting multiple destinations on one trip, taking fewer trips, and shortening the duration of trips.

Type I: Reduce travel distances



From: Visiting multiple destinations (and spend short time in each destination) in the same trip, choosing far destination, and having long vacations.

To: Visiting nearby destinations, shortening overall travel distances both on travel-from-home and in-destination travel, and choosing to visit fewer destinations while increase the average length of stay in the same destination.

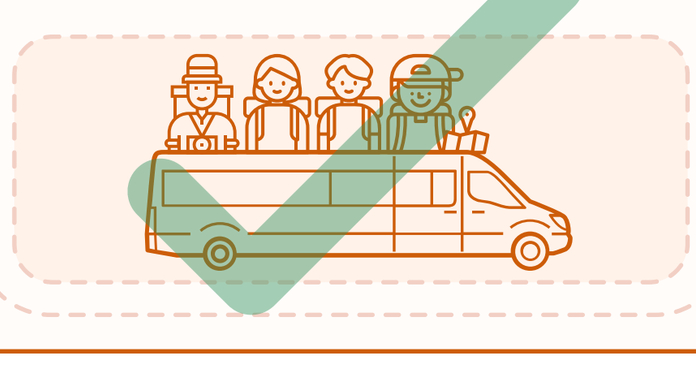


Type II: Reduce extra purchase



From: traveling for the same destination(s) with the use of more products (vehicles).

To: traveling for the same destination(s) with the use of less (sufficient amount of) products (vehicles).



Appendix D: Second version of the toolkit

MS Modal Shifts

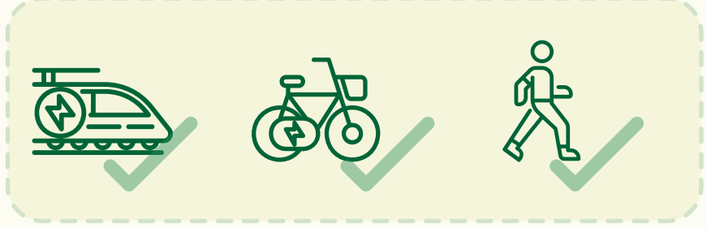
Modal shifts (MS) refers to behaviors that transition existing consumption patterns to more sustainable ones. In tourism mobility, these behaviors may include taking sustainable transport modes (public transportation, cycling, walking, jogging, train, bus), taking electrified vehicles (electric cars, bikes, and scooters) and, using multimodal travel (multi-trip transportation) options including shuttle bus.

Type I: Pattern improvement



From: taking fuel car, airplane and ship.

To: choosing more sustainable travel modes such as taking train, bus, bike or walk.



Type I: Product improvement



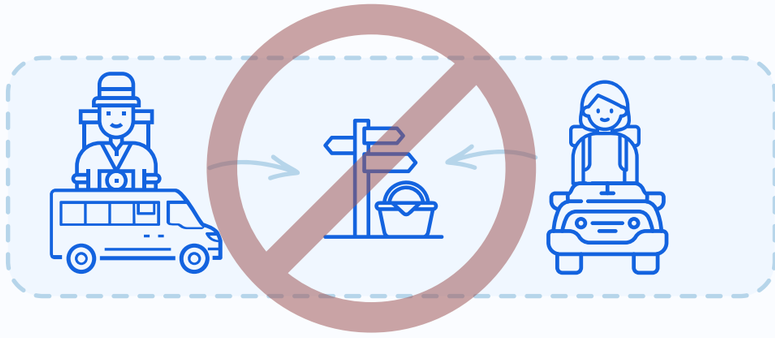
From: taking fuel vehicles.

To: choosing electrified vehicles.



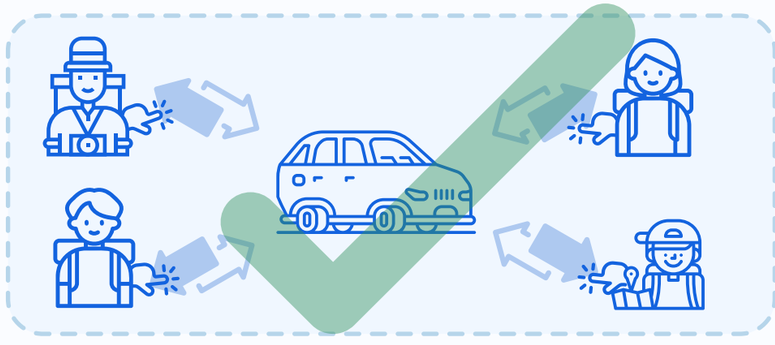
SP Sharing Practices

Sharing practices (SP) refers to behaviors that increase the usage intensity of products and services by the activities of sharing. In tourism mobility, these behaviors may include using shared mobility services including car sharing, bike sharing, e-bike sharing, and using electric car rental services.



From: Driving private cars or taking private vehicles to the destination.

To: Taking shared vehicles such as shared EV or e-bike to the destination.



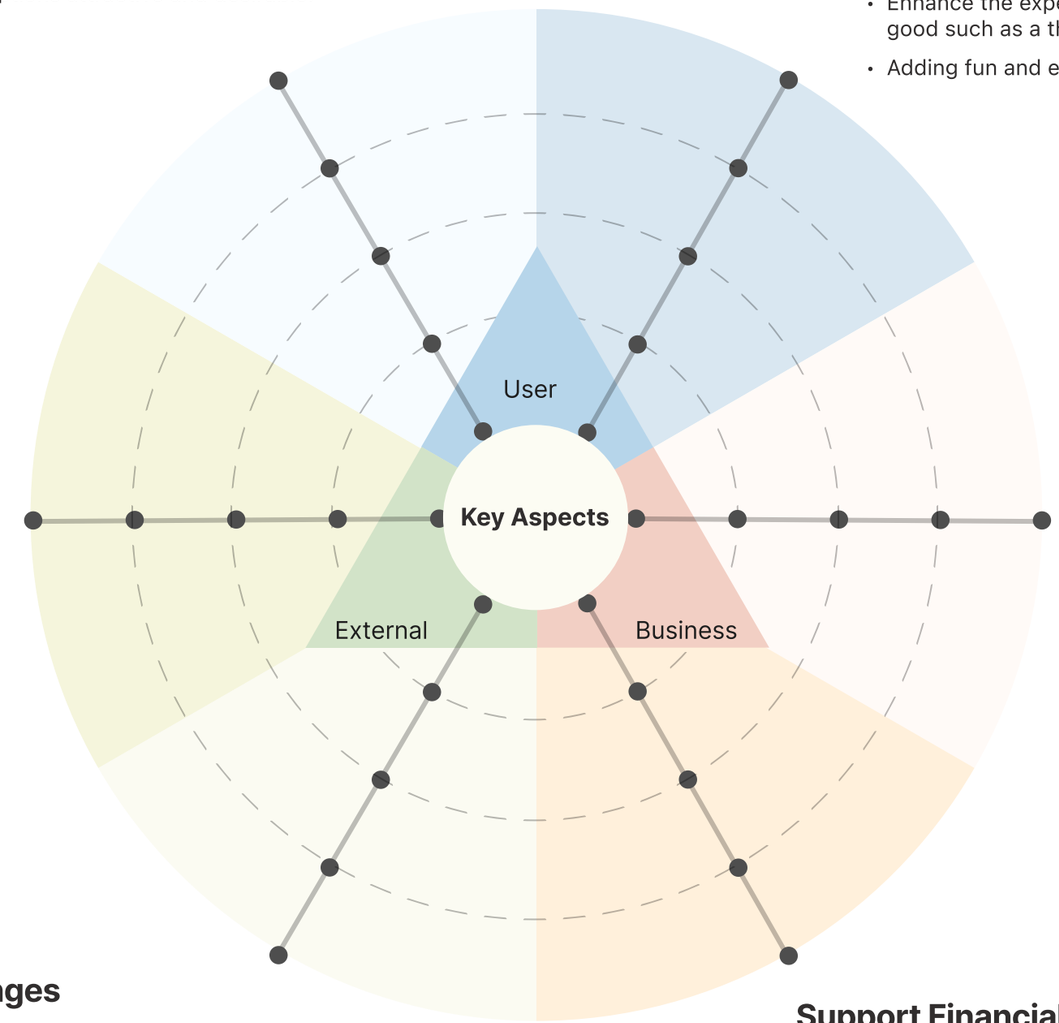
Appendix D: Second version of the toolkit

Communication

- Provide transparent and sufficient information.
- Keep the design user-centric in developing sufficiency solutions.
- Make sufficiency options attractive and desirable.

Emotion and Experience

- Create the feeling of satiation by ensuring user needs are fulfilled with minimal consumption.
- Enhance the experience of users with feeling of doing good such as a thank you note.
- Adding fun and entertaining features in tourism mobility.



Supportive Infrastructure

- Good quality of sufficiency products and services such as public transportation service.
- Supportive infrastructure for the usage of sufficiency options, such as charging stations for EVs.
- The requirements above should also be accessible and easy to use.

Innovation on Business

- Consider the feature of tourism mobility, such as the user needs of carrying luggage.
- Reshape the way of tourism that may impact on mobility as well, such as the dynamic between residents and tourists and the way of living in travel destinations.
- Ensure the success and continuous improvement of business including consideration of desirability and setting up feedback loops.

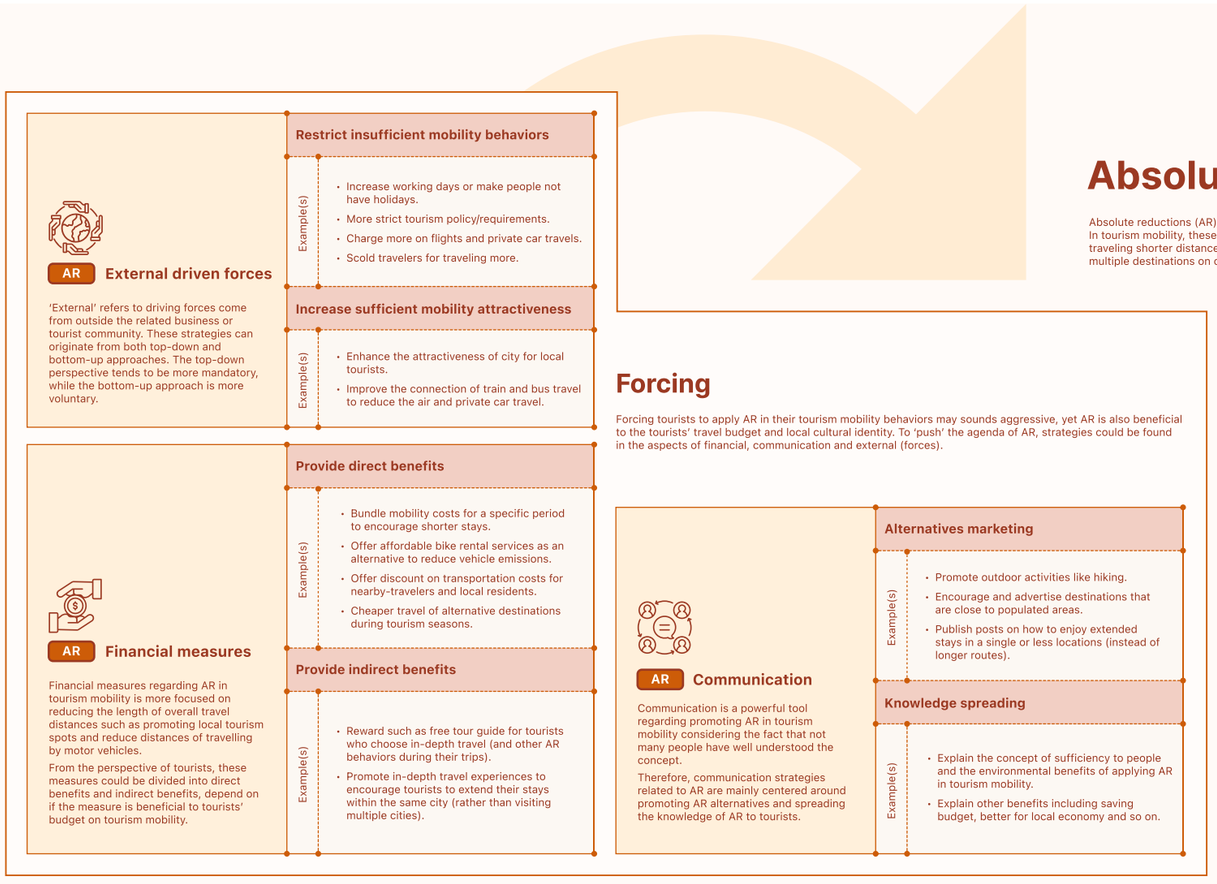
Social Changes

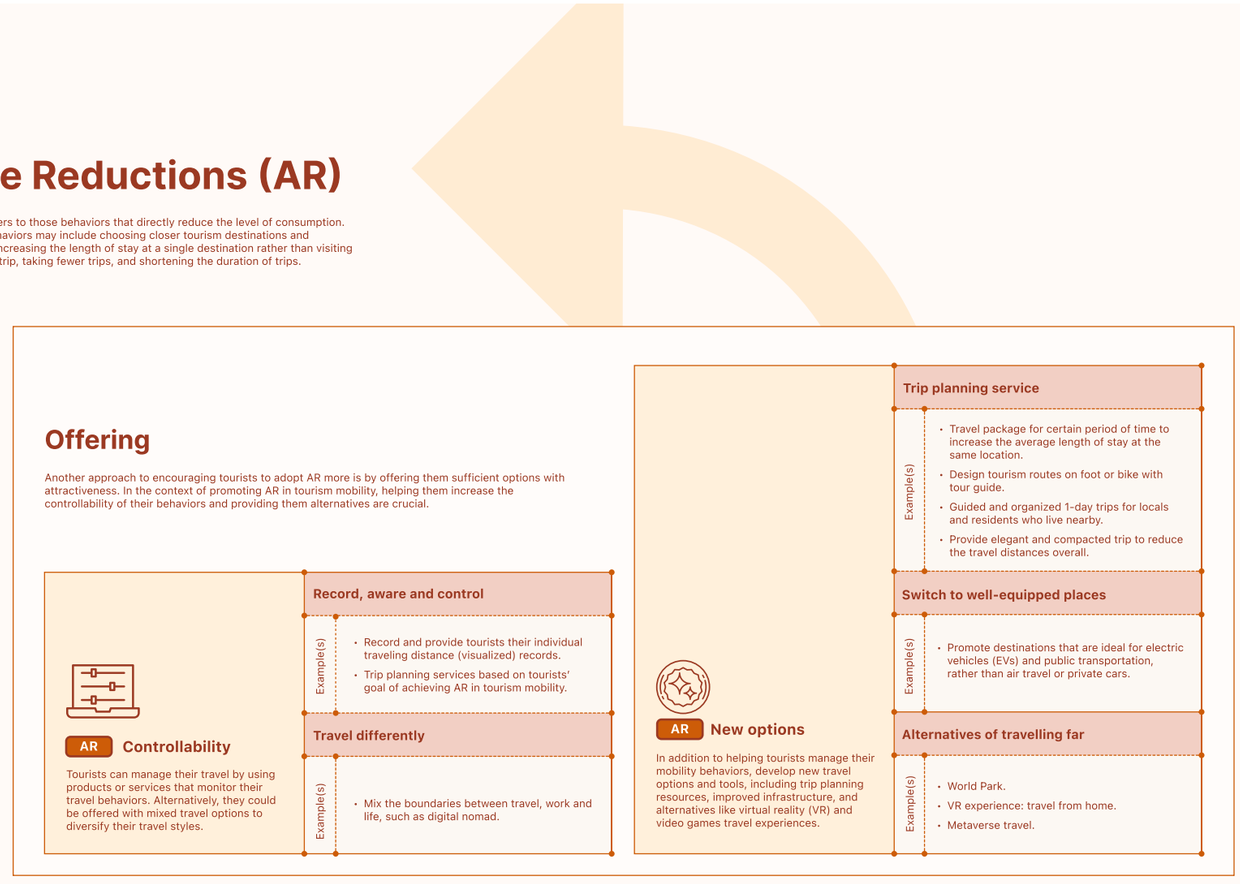
- Promoting healthier lifestyles and societal changes
- Make sufficiency a societal trend

Support Financially

- Giving user direct benefits such as discount and combined deals.
- Profit other stakeholders involved.
- Thinking about the profitability of applying sufficiency into business.

Appendix E: Frist version design strategies for sufficient behaviors in tourism mobility

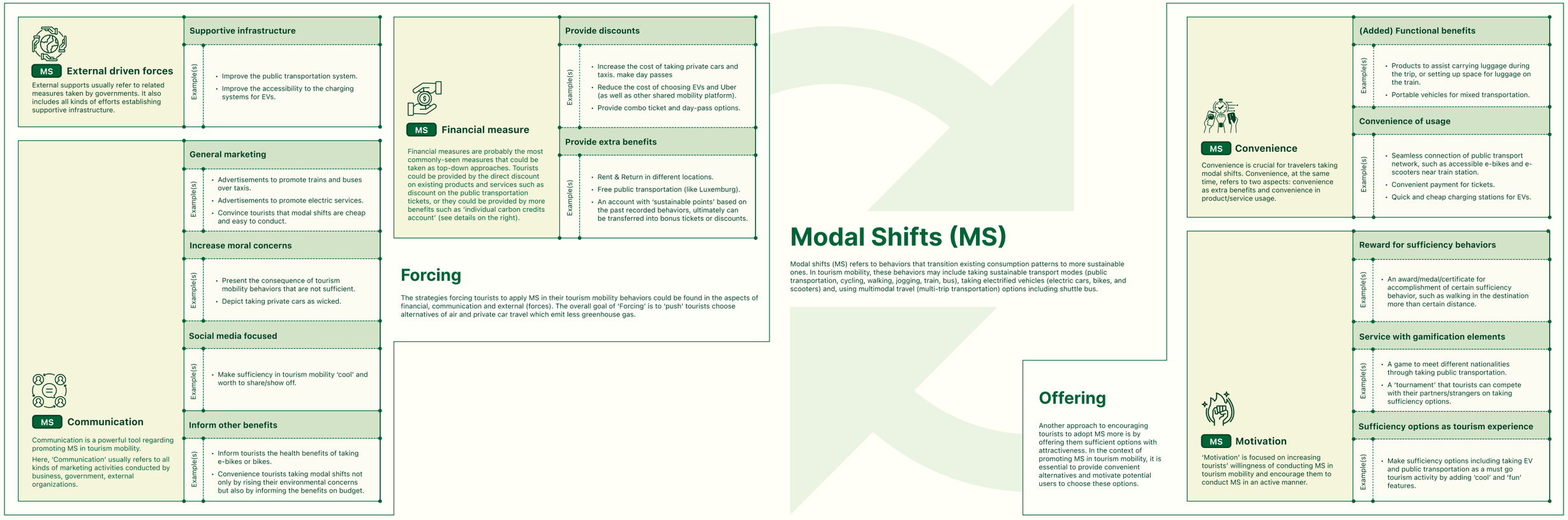




Note

The following maps visually represent the design strategies generated from the co-creation session. These strategies were initially summarized in this format, then refined and organized into tables under the heading "Design strategies for supporting absolute reductions regarding tourism mobility behaviors." after receiving the feedbacks in pilot and user tests.

Appendix E: Frist version design strategies for sufficient behaviors in tourism mobility



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Appendix E: Frist version design strategies for sufficient behaviors in tourism mobility



Note

The following maps visually represent the design strategies generated from the co-creation session. These strategies were initially summarized in this format, then refined and organized into tables under the heading "Design strategies for supporting absolute reductions regarding tourism mobility behaviors." after receiving the feedbacks in pilot and user tests.

Appendix F: Final toolkit



Figure i: Toolkit guide - A4

Appendix F: Final toolkit

A TOOLKIT GUIDE OF

Design for sufficient tourism mobility behaviors

FAQ:

What is sufficiency?

Sufficiency refers to the concept of using only what is necessary to meet needs, avoiding overconsumption and excess. It emphasizes optimizing resources to achieve a balance between sustainability and quality of life.

In context of tourism mobility, sufficiency encourages three types of behaviors, “Absolute reductions”, “Modal Shifts” and “Sharing Practices”. You can check the details of these activities on the back side of this toolkit guide.

Who are using this toolkit?

If you are in the ideation phase of a project related to sufficiency in tourism mobility, and you have conducted the front end research and had a clear view of your target users as well as the context, and you are about to dive in to the ideation and concept development phase, then you are the target user of this toolkit!

Why should I use this toolkit?

The toolkit provides you with a easier way to select and evaluate each of your ideas from the perspectives of behavioral intervention strategies and the driven factors of consumer behaviors. It also helps with your ideation efficiency for sure!

What will I gain from the toolkit?

It will help you formulate a design goal as well as some of the potential solutions or concepts. In the end you will get a clearer expected design outcome.

What do I need to prepare?

To use this toolkit, you will need:

- **2 - 4 participants** (if participants are from the same background, then this is an ideation session, if not, then you could see it as an co-creation session)
- **A facilitator** to hold the session with this toolkit guidebook
- **Color markers**
- **Sticky notes**
- **A timer**
- **Templates of each steps**, physically or digitally in Figma Jam

How long is the session?

It takes about 90 minutes to conduct, and it may takes a few minutes more for facilitator to get to know the process.

Figure ii: Toolkit guide - A4

Appendix F: Final toolkit

AR Absolute Reductions

In tourism mobility, absolute reductions refers to behaviors that reduce the distances of travelling and consumption levels, including:

- **Choosing closer tourism destinations,**
- **Traveling shorter distances**,
- **Increasing the length of stay at a single destination** rather than visiting multiple destinations on one trip,
- **Taking fewer trips**,
- **Shortening the duration of trips**.

Sufficient tourism mobility behaviors

SP Sharing Practices

In tourism mobility, sharing practices refers to the behaviors of:

- **Using shared mobility services** including car sharing, bike sharing, e-bike sharing, and using electric car rental services.

IDENTIFIED SUFFICIENT TOURISM MOBILITY BEHAVIORS

MS Modal Shifts

Modal shifts refers to tourism mobility behaviors that choosing more sustainable travel modes instead of unsustainable ones, including:

- **Taking sustainable transport modes** (public transportation, cycling, walking, jogging, train, bus),
- **Taking electrified vehicles** (electric cars, bikes, and scooters) and,
- **Using multimodal travel** (e.g. shuttle buses) options.

Figure iii: Toolkit guide - A4

Appendix F: Final toolkit

BEFORE STEP 2

Refer to the wheel on the right, which emphasizes key aspects of the design. Can you identify how your design goal and thoughts align with the information presented in the graph?

Use the wheel as a source of inspiration for **developing design ideas in Step 2** and **establishing evaluation criteria in Step 3**, and engage in discussions with others to assess your design outcomes.

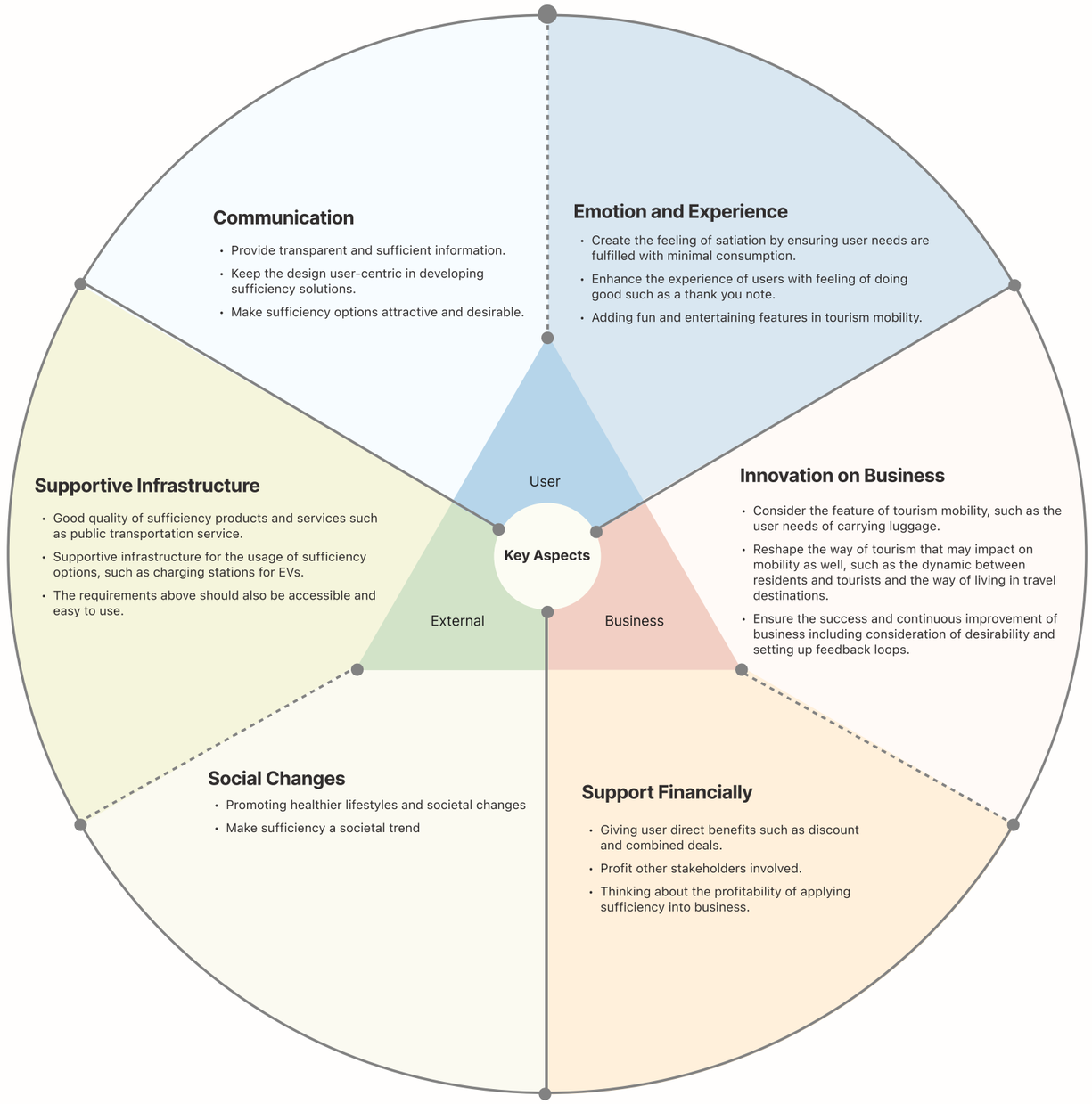

Figure iv: Toolkit guide - A4

Appendix F: Final toolkit

Explanation Of Influential Factors (Step 4)

Subjective Norm (SN) Involves the perceived social pressure to perform or not perform a specific behavior, based on others' expectations.	**Example** My parents and close friends would want me to do...	**Significance** Has a significant impact on intentions of absolute reductions, modal shifts and sharing practices.
Attitude (ATT) A person's positive or negative evaluation of performing a particular behavior.	**Example** I feel the behavior is beneficial/good/ worthwhile...	**Significance** Has a significant impact on intentions of absolute reductions and modal shifts.
Perceived Behavioral Control (PBC) Refers to an individual's belief in their ability to perform a specific behavior, influenced by the presence of facilitators or barriers.	**Example** I can easily manage to...	**Significance** Theoretically has a significant impact on intentions of sufficient tourism mobility behaviors.
Personal Norm (PN) Reflects an individual's internalized standards or moral obligations that influence their behavior.	**Example** I feel moral obligated to...	**Significance** Theoretically has a significant impact on intentions of sufficient tourism mobility behaviors.
External Cost (EC) Refers to the negative consequences of a behavior that affect others or society, often not reflected in the direct costs to the individual performing the behavior.	**Example** The time, money and overall effort to...	**Significance** Theoretically has a significant impact on intentions of sufficient tourism mobility behaviors.

Figure v: Toolkit guide - A4

Appendix F: Final toolkit

INSTRUCTIONS & TIPS

To the facilitators:

Please read the following instructions for using the toolkit, and ensure that you have color markers and sticky notes available nearby. If you're using the Figma Jam version, kindly check that all the participants have logged in before proceeding.

Step 0

Understand sufficiency in tourism mobility and sufficient tourism mobility behaviors

To do

- Read the introduction to sufficiency provided on the cover page and the sufficient tourism mobility behaviors listed on the back of the paper.
- Take a moment to reflect on sufficiency as a sustainability concept and the identified behaviors with your partners.

Tips

The goal of Step 0 is to ensure that all participants develop a broad and shared understanding of sufficiency in tourism mobility. Additionally, this step involves reflecting the findings from prior desk research and user research.

Step 1

Formulate the design goal

Recommended duration: 10 min

To do

- Ask participants to discuss with each others and define the features of the (potential) design project.
- Formulate the design goal based on the discussion.

Tips

The goal of Step 1 is to define the design goal based on the prior work completed before the session and reframe the issues. During this step, the facilitator should encourage participants to actively reflect on their expectations for the design and the potential outcomes, fostering a thoughtful discussion.

Step 2

Ideation on Features and Functions

Recommended duration: 20 min

To do

- Participants use sticky notes to create the ideas freely as many as possible.
- Rotate the template among participants and ideate based on each others' thoughts.
- Make sure the ideas are specific enough like the given samples on the template.

Tips

The goal of Step 2 is to ideate potential design concepts, focusing on the design goal established in Step 1. During the ideation activities, the facilitator should be mindful of the creative flow and introduce energizer activities if needed. It's essential to remind participants that this step is about generating specific ideas, rather than general design directions. Encourage them to use the provided wording samples to articulate their concepts clearly.

Figure vi: Toolkit guide - A4

Appendix F: Final toolkit

INSTRUCTIONS & TIPS

Step 3

Cluster and select the concepts based on intervention level

Recommended duration: 20 min

To do

- Move the sticky notes on template Step 2 to template Step 3 and map the ideas based on the intervention levels given on the template.
- Label the sticky notes under each category with the corresponding tag on the left, or use color marker with numbers.
- Discuss the outcome with each other, on which level are clusters targeted at? And do they match the design goal?
- Select ideas based on the mapping with dots.

Tips

The goal of Step 3 is to evaluate how well the concepts align with the design goal and expected behaviors from the view of behavior interventions. The higher the number on the left, the stronger the level of intervention. The team can decide the level of intervention they wish to encourage for behavioral change. For example, interventions in the upper part suggest that the concepts allow more freedom in users' choices, while those in the lower part indicate that businesses may provide incentives or impose restrictions on users.

Step 4

Idea Selection by Constructs

Recommended duration: 15 min

To do

- Look at the template and read the definition of each construct.
- Map the chosen ideas from Step 3 on the template according to the constructs.
- Select the concepts based on the mapping results, keeping in mind that the closer the ideas are to the center, the more likely they are to influence the desired behaviors.

Tips

The goal of Step 4 is to select ideas based on internal driving forces, specifically the psychological factors that influence sufficient tourism mobility behaviors. In contrast, Step 3 focused on evaluating concepts from the perspective of external interventions. The facilitator should explain this distinction to participants to prevent any confusion between the two selection processes.

Step 5

Formulate and visualize the design outcome

Recommended duration: 15 min

To do

- Reflect on the selected ideas in Step 4 and integrate them to a expected design outcome.
- Write the design outcome on the template of Step 5, and make a poster by collage and illustration.

Tips

The goal of Step 5 is to integrate the selected concepts into a single, specific design outcome. Participants can refer to the provided sample in the template to help frame the wording of the design outcome effectively.

Figure vii: Toolkit guide - A4

Define the project



Design outcome (Multi-select): ☐ Service ☐ Product

Types of behavior (Multi-select):

☐ Absolute Reductions (AR) ☐ Modal Shifts (MS)

☐ Sharing Practices (SP)

Context of behavior (Multi-select):

☐ Travel from home to destination ☐ In-destination travel

Context of behavior (Multi-select):

☐ City ☐ Outdoor

Specific behavior(s)

Figure viii: Step 1 Template - A4

Appendix F: Final toolkit

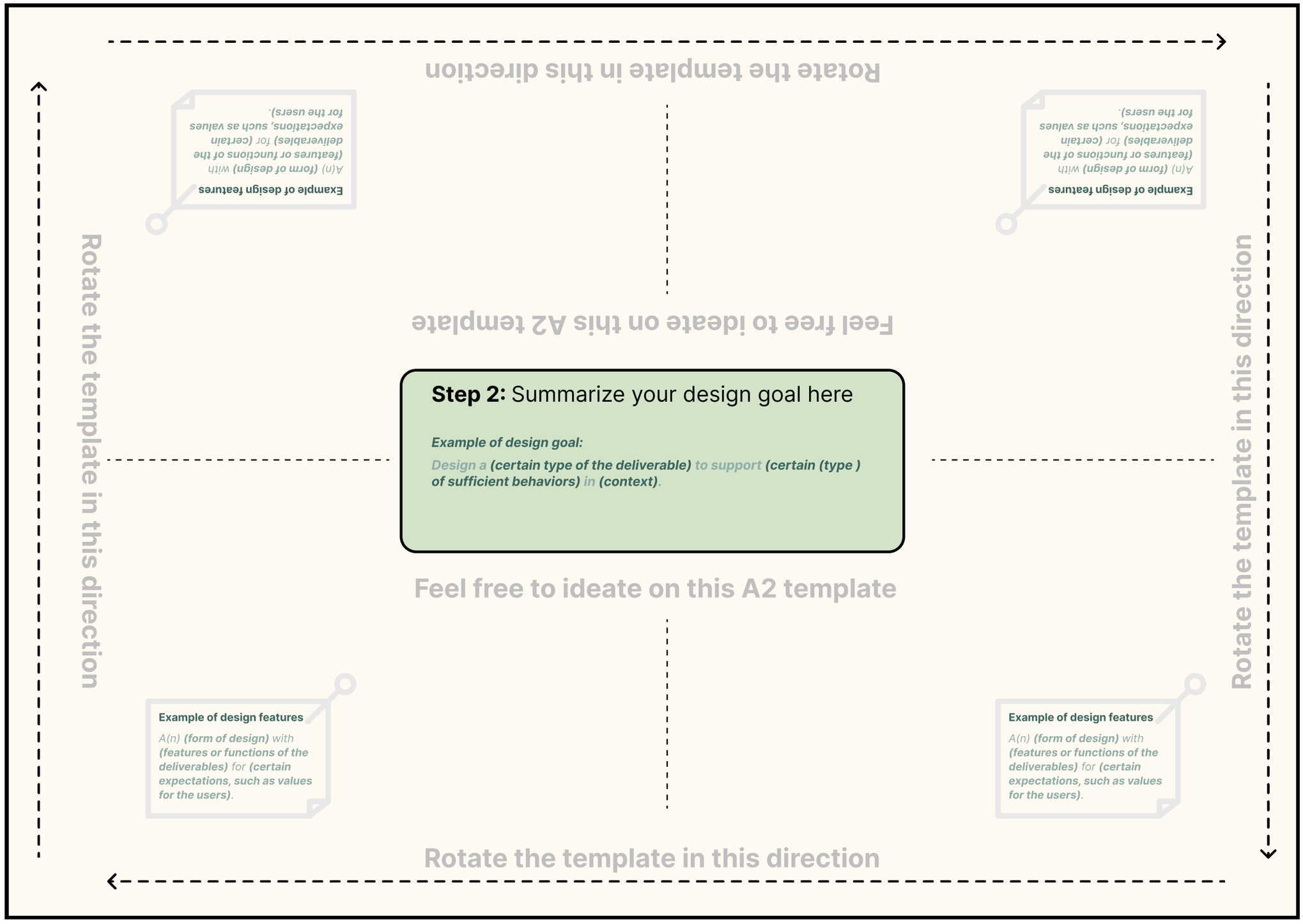

Figure ix: Step 2 Template - A2

0 Other

1
Provide trip planning service to make sufficient options visible
Make sufficient options visible and accessible to tourists.

2
Provide sufficient alternatives
Provide tourists with sufficient alternatives.

3
Advertise sufficient alternatives
Encourage tourists to think positively on sufficient tourism mobility behaviors.

4
Spread the knowledge of sufficiency.
Encourage tourists to reflect upon their behaviors and furtherly adopt sufficient behaviors in tourism mobility.

Guide the change to sufficient tourism mobility

Make sufficient options visible to tourists and encourage them to see sufficient tourism mobility behaviors positively.

Step 3: Write down your design goal
↓

Catalyze the change to sufficient tourism mobility

Make sufficient options favorable to tourists and encourage them to adopt sufficient tourism mobility behaviors actively.

5
Inspire and encourage tourists to choose sufficient options.
Inspire users to adopt sufficient tourism mobility behaviors through providing rewardings and 'prompts'.

6
Improve the attractiveness of sufficient options.
Attract users to adopt sufficient tourism mobility behaviors through increasing the attractiveness and experience of sufficient options.

7
Provide sufficient options with lower cost
Facilitate users to adopt sufficient tourism mobility behaviors through lowering the time, effort and financial cost of sufficient options.

8
Restrict insufficient mobility behaviors
Restrain insufficient behaviors and to persuade tourists behaviors by putting restrictions.

0 Other

Figure x: Step 3 Template - A2

Appendix F: Final toolkit

Appendix F: Final toolkit

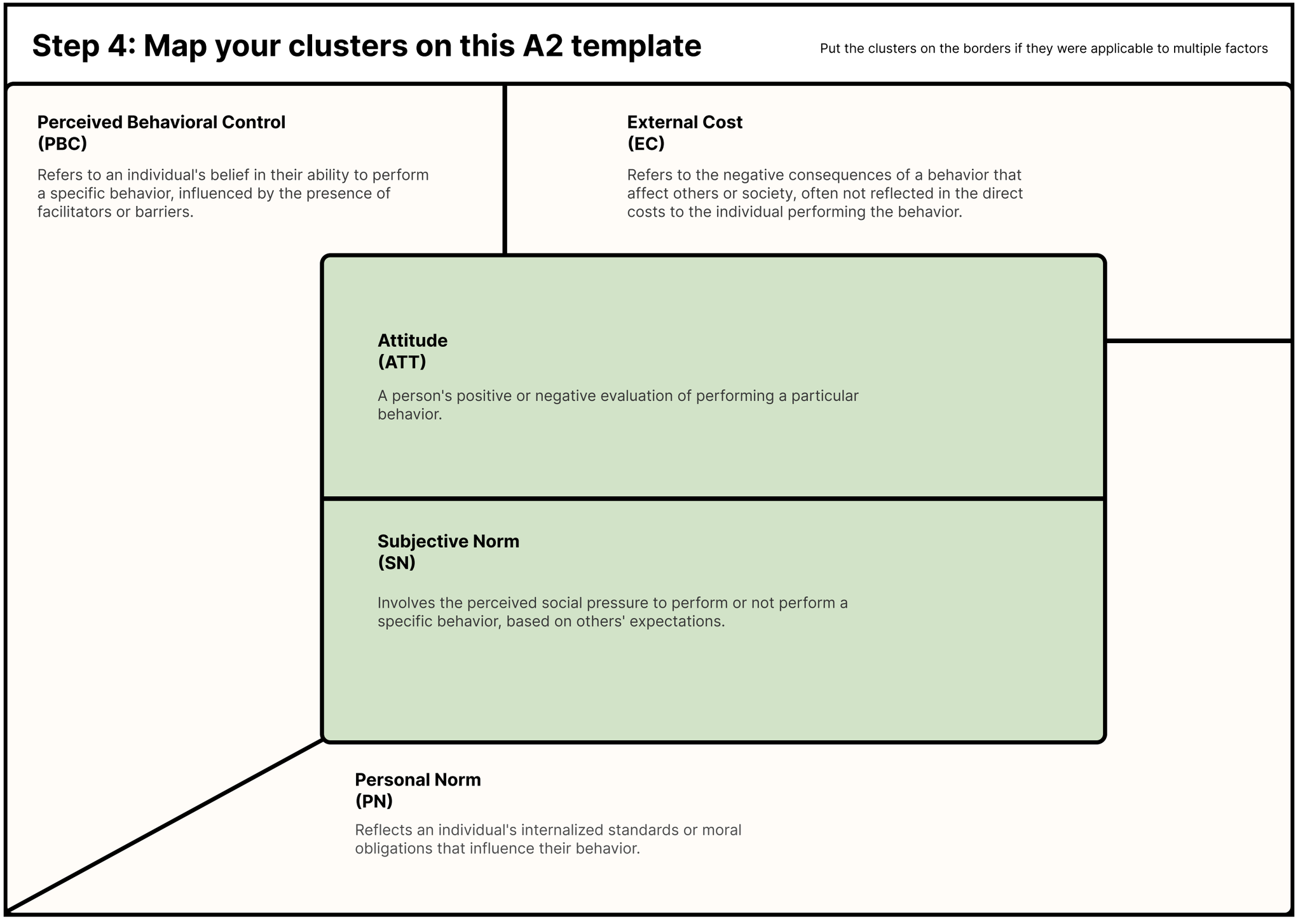

Figure xi: Step 4 Template - A2

Step 5: Formulate and visualize the design outcome

Try to visualize the features of your design outcome with illustrations and collage below.

Summarize your design outcome here:

Example of design outcome:

Design a (certain type of the deliverable) to support (certain (type) of sufficient behaviors) in (context) with (design features or functions) for (users) to (expected results of usage, such as bring values for the community).

Figure xii: Step 5 Template - A3

IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME

Complete all fields and indicate which master(s) you are in

Family name	Geng 7033
Initials	R
Given name	Ruihong
Student number	5759544

IDE master(s)	IPD ☐ DfI ☐ SPD ✔
2nd non-IDE master	
Individual programme *(date of approval)*	
Medisign	☐
HPM	☐

SUPERVISORY TEAM

Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair	Lise Magnier	dept./section	DOS
mentor	Shahrokh Nikou	dept./section	DOS
2nd mentor			
client:			
city:		country:	
optional comments	While both supervisors belong to the same department, Lise Magnier specializes in consumer behavior, whereas Shahrokh Nikou's expertise lies more in the field of sustainability within organizations.		

! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.

! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.

! 2nd mentor only applies when a client is involved.

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in **by the Chair** of the supervisory team

Sign for approval (Chair)

Lise Magnier

Digitally signed by Lise Magnier
Date: 2024.02.15 14:27:14 +01'00'

Name Lise Magnier Date 15 Feb 2024 Signature

CHECK ON STUDY PROGRESS

To be filled in **by SSC E&SA** (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total _____ EC

Of which, taking conditional requirements into account, can be part of the exam programme _____ EC

★	**YES**	all 1st year master courses passed
	NO	missing 1st year courses

Comments:

Sign for approval (SSC E&SA)

Robin den Braber

Digitaal ondertekend door Robin den Braber
Datum: 2024.03.04 11:49:46 +01'00'

Name Robin den Braber Date 4 mrt 2023 Signature

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

YES	★	Supervisory Team approved
NO		Supervisory Team not approved

Comments:

Based on study progress, students is …

★	**ALLOWED** to start the graduation project
	NOT allowed to start the graduation project

Comments:

Sign for approval (BoEx)

Monique von Morgen

Digitally signed by Monique von Morgen
Date: 2024.03.07 10:32:44 +01'00'

Name Monique von Morgen Date 7 Mar 2024 Signature

Personal Project Brief – IDE Master Graduation Project

Name student Ruihong Geng **Student number** 5,759,544

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title Design for individual sufficiency in leisure mobility

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

The existing human ecological footprint surpasses the Earth's regenerative capacity by approximately 1.6 times (WWF, 2022), underscoring the imperative for strategies aligned with environmental sustainability to meet the objectives delineated in the Paris Agreement. This suggests a shift in consumption patterns towards more sustainable practices (Lorek & Fuchs, 2013). Sufficiency, as an interdisciplinary concept (Wiese et al., 2022), endeavors to establish balance in human activities within ecosystems, serving both as an end and a means for fostering sustainable consumption and production.

Mobility is a significant aspect of sustainability, constituting an average of 20% of the carbon footprint and 23% of total energy consumption within households (UNEP, 2010). It stands out in discussions concerning sufficiency due to its substantial impact on individual environmental footprints and the availability of various alternatives. Four types of behaviors have been identified: (1) Absolute reductions, (2) Modal shifts, (3) Product longevity, and (4) Sharing practices (Sandberg, 2021). Opting not to use private cars or airplanes is recognized as a promising strategy for absolute reductions, with shared mobility also demonstrating potential in modal shifts.

Despite its potential contribution to sustainability, a research gap exists in the operationalization of sufficiency in mobility, characterized by the absence of comprehensive design guidelines. Moreover, there are opportunities to enhance consumer awareness of their mobility behaviors in relation to sufficiency and to offer alternative options that contribute to sufficiency in travel consumption.

➔ *space available for images / figures on next page*

introduction (continued): space for images

image / figure 1

image / figure 2

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

In current sufficiency studies, the concept of "sufficiency" still lacks of clear definition and criteria of evaluation o Regarding design practice, there is a lack of explicit guidelines to help designers contribute to sufficiency. Given that mobility accounts for around 23% of the global emissions, the inquiry into enhancing the sufficiency of consumption in mobility emerges as a focal problem. Consumers may put less effort for sustainable alternatives in tourism than they do for everyday travel, making it an ideal starting point for research.
Research question: "How can design support sufficiency-oriented consumption in the context of transportation in tourism/leisure? "
Sub-questions include:
- What does sufficiency mean in the domain of leisure mobility?
- How do consumers perceive the sufficiency options regarding leisure mobility?
- How can designers support the behavior change towards sufficiency in leisure mobility?

- How can designers make use of boundaries such as 2T CO2 emission and 1.5 **°C** as a criterion to evaluate the sufficiency of design (in leisure mobility) from both business and consumers perspectives?

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Investigate the potential measures towards sufficiency in mobility consumption and how they are perceived by consumers, create design guidelines for consumer sufficiency in mobility, and design a toolkit for designers to increase consumer awareness of sufficiency in mobility and furtherly support behavior change.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

Phase 1: understand the context & conceptualization Duration: approx. 12 weeks
- Literature review of sufficiency consumption and related indicators of leisure mobility. Determining the theoretical model for later quantitative analysis.
- Questionnaire for analyzing the factors which have impact on the consumer behaviors to sufficiency regarding leisure travel
Phase 1 should be closed with a summarized guideline regarding design for sufficiency.

Phase 2: concept development. Duration: approx. 8 weeks
- Visualize the guidelines identified in the Phase 1.
- Design a toolkit for designers regarding sufficiency consumption in mobility based on the identified guidelines.
- One iteration with usability test (toolkit).
- Evaluate the sufficiency impact with certain indicators.

Project planning and key moments

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	6 Feb 2024
Mid-term evaluation	10 Apr 2024
Green light meeting	11 Jun 2024
Graduation ceremony	9 Jul 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	
For how many project weeks	
Number of project days per week	

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

I have had a sustained interest in sustainability because it serves as both the means and the goal for achieving a desirable long-term living status. My engagement in sustainable design projects during both my undergraduate (medication packaging) and master's (stroller consumption) studies has enabled me with a more comprehensive understanding of sustainability.

In this graduation project, I am enthusiastic about exploring strategic possibilities that aid individuals in transitioning towards sustainable lifestyles. I have gained a lot of experience in qualitative studies in my previous research & design practice, and now I am eager to explore quantitative research skills. Incorporating both methods into my master's thesis is an interesting prospect for me.

My two ambitions for graduation are (1) to integrate knowledge, introducing innovative possibilities into future design practices, and (2) to empower consumers—potentially all of us—with the ability to shape the future through a sustainable mindset.