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Examination of Theory of Planned Behaviour (TPB) and Its Synthesis with Time Geography for the Low Traffic Neighbourhood (LTN) Design

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Öz

This article presents an evaluation of the contribution of the synthesis of the Theory of Planned Behaviour (TPB) with Time Geography to the Low Traffic Neighbourhood (LTN) design stages. In the LTN design scheme, the evaluation of the human factor has importance at all stages of the design. However, the LTN design is currently based on stakeholder meetings, verbal statements and maps created with stakeholders in general. Social psychology, which includes concepts and theories to understand complex human behaviour, has been used in many transportation studies. TPB, one of the most well-known theories on this subject, its contributions to transportation studies and its primary deficiencies were identified within the article. It has been evaluated that the lack of spatial and temporal scope, one of these primary deficiencies, can be eliminated by synthesizing the Time Geography approach. As a result, this synthesis has the potential to increase the effects of the LTN design by integrating TPB, which has the potential to provide a basis for guiding people's behaviour, and Time Geography, which can reflect its spatial and temporal projection, in each of the stages of LTN design namely street classification, determination of neighbourhood boundaries, prioritization of neighbourhoods and determination of measures.

Anahtar Kelimeler: *Low traffic neighbourhood design, theory of planned behaviour, time geography.*

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Düşük Trafikli Mahalle Tasarımı İçin Planlanmış Davranış Teorisi'nin ve Zaman Coğrafyası ile Sentezinin İncelenmesi

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Abstract

Bu makale Planlanmış Davranış Teorisi'nin (PDT) ve Zaman Coğrafyası ile sentezinin Düşük Trafikli Mahalle tasarımı aşamalarına sağlayabileceği katkılara dair bir değerlendirme sunmaktadır. Trafik hacimlerindeki olumsuzluğu gidermek amacıyla geliştirilmiş olan Düşük Trafikli Mahalle tasarım şemasında insan faktörünün değerlendirilmesi tasarımın tüm aşamalarında öneme sahiptir. Ancak güncel durumda Düşük Trafikli Mahalle tasarımı genel olarak paydaşlarla yapılan toplantılar, sözel bildirimler ve paydaşlarla beraber oluşturulan haritalara dayanmaktadır. İnsanların karmaşık davranışlarını anlamaya yönelik kavram ve teorileri içeren sosyal psikoloji ise birçok ulaşım çalışmasında kullanılmıştır. Makale kapsamında bu konudaki en bilindik teorilerden olan PDT'nin özellikleri, ulaşım çalışmalarına yaptığı katkılar ve temel eksiklikleri belirlenmiştir. Bu temel eksikliklerin başında yer alan mekânsal ve zamansal kapsam eksikliğinin ise Zaman Coğrafyası yaklaşımı ile yapılan sentezle ne düzeyde giderilebileceği değerlendirilmiştir. Sonuç olarak Düşük Trafikli Mahalle tasarımının geleneksel aşamaları olan sokak sınıflandırması, mahalle sınırlarının belirlenmesi, mahallelerin önceliklendirilmesi ve önlemlerin belirlenmesi aşamalarının her birine insanların davranışlarını yönlendirmeye yönelik altlık sağlama potansiyeli olan PDT ve bunun mekânsal ve zamansal izdüşümünü yansıtabilecek Zaman Coğrafyası'nın entegre edilmesi ile tasarımın etkilerinin artırılma potansiyeli olduğuna ulaşılmıştır.

Keywords: *Düşük trafikli mahalle tasarımı, zaman coğrafyası, planlanmış davranış teorisi.*

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Introduction

For years, studies have been carried out to increase sustainable transportation by increasing the use of active modes, reducing air pollution, reducing emissions, and ensuring the correct use of resources (Zhao, Ke, Zuo, Xiong and Wu, 2020). Low Traffic Neighbourhood (LTN) is one of the new urban concepts that emerged to minimize transportation-related problems and maximize sustainable transportation (Nieuwenhuijsen, 2021). This concept, which gained importance especially in the UK during Covid-19, has a design scheme that includes modal filters such as one-way streets, bollards, bus gates, and banned turns to reduce motor vehicle traffic in neighbourhoods (Aldred, Verlinghieri, Sharkey, Itova and Goodman, 2021). It is based on the main idea of increasing the car-free use rates of neighbourhoods by providing a more suitable environment for active travel and also protecting motor vehicle access (Aldred and Goodman, 2021). It has an ease of implementation compared to other new models in order to achieve this by making specific small filters and restrictions at the neighbourhood scale (Nieuwenhuijsen, 2021).

In the LTN design principles published and adopted in this direction, the evaluation of existing roads, determination of the sizes and locations of neighbourhoods, prioritization of neighbourhoods, selection of modal filters, defining rules for neighbourhood boundaries, and evaluation of impacts have great importance (London Cycling Campaign and London Living Streets, 2018; Sustrans, 2021). However, in this context, data other than existing data during the Covid-19 period were not used in the LTN design, and this caused some criticism (The Guardian, 2020). The data used in making these evaluations should not be limited to traditional transportation surveys, and the outputs of these stages should be improved by expanding the scope and accuracy of the data used. In this direction, data containing many objects such as individual beliefs, behaviours, transportation preferences, and spatial and temporal reflections should be used in the design process.

Phycologists have aimed to understand complex human behaviour for years (Ajzen, 1991; Drury, 2020; Frey and Wilhite,2005; Narter,2007). Concepts and theories referring to behavioural dispositions have been one of the cornerstones of social psychology, which also have an essential role in transport planning. Many theories have been used over the years to understand the factors that shape an individual's travel behaviour (Dijst, Farag and

Schwanen, 2008; Koppelman and Pas, 1980). Norms and values influence people's travel behaviours, and the impact of attitudes on behaviour is most clearly evaluated in the Ajzen's (1991) Theory of Planned Behaviour (TPB), which is an expanded version of the Fishbein and Ajzen's (1977) Theory of Reasoned Action (TRA) (Gehlert, Dziekan and Gärling, 2013).

According to TPB, the basis of behaviour includes behavioural, normative, and control beliefs. However, many criticisms have been made in the literature regarding the scope of TPB, and many additional parameters have been proposed to improve this scope (Bamberg and Schmidt, 2003; Donald, Cooper and Conchie, 2014; Gehlert et al., 2013). In the evaluations for this development, time geography that shows individuals' daily activities directly draws attention. Time geography is a theoretical scope to evaluate the spatial and temporal reflections of individuals' journeys (Dijst and Kwan, 2005). It demonstrates the data obtained with location-sensitive technologies with space-time paths and prisms (Hägerstrand, 1970). However, as Miller (2005) stated, Time Geography is a non-behavioural theory individually, and its applicability is limited due to a lack of data. For this reason, synthesizing TPB with Time Geography can combine the contributions of two different theories and strengthen the results.

As mentioned above, LTN is a policy that can have power in making cities more sustainable. Therefore, refining the accuracy and scope of the realization stages is essential (Sustrans, 2021). Theories that enable the behavioural and dynamic perception of the human being, the most critical element that makes up the cities, are important in this context. For this reason, the need to synthesize the TPB and Time Geography theories, which have partial deficiencies, has emerged. Therefore, this discussion is necessary to evaluate the contribution of the combination of theories from different disciplines to urban transport policies and how the effects of policies that support the shift to sustainable transport can be improved.

Thus, the context of TPB will be explained and discussed and the possible contributions of TPB to transportation planning will be evaluated with the support of the literature. Also, the benefits of the synthesis of social psychology with time geography, and this synthesis's contribution to the Low Traffic Neighbourhoods' design, implementation, and success will be detailed within the scope of the study. This study is critical because understanding individuals' travel behaviour has the power to shape transportation policies like LTN, which improve sustainable mode usage.

Theory of Planned Behaviour (TPB)

Although transportation is considered as a derived demand according to some economic concepts, there are many social phenomena behind people's transportation preferences (Jain and Lyons, 2008). Thus, understanding and explaining social psychology has essential value for transportation policies, and many studies have been conducted on this subject, including the Theory of planned behaviour (TPB) for years (Donald et al., 2014; Fu and Juan, 2017; Mehdizadeh, Zavareh and Nordfjaern, 2022; Zao and Gao, 2022). While TRA assumes that behaviours can be controlled discretionally and people can alter this behaviour whenever they want, TPB involves perceived behavioural control (PBC) to understand the effect of people's control mechanism on behaviour (Staats, 2004). For instance, it is assumed that people can change the travel mode whenever they want within the framework of TRA, but factors such as financial and physical constraints of the person, infrastructure problems, etc. are also assumed to be effective in this decision change within the framework of TPB.

TPB examines the relationship of individuals' beliefs with their actions, intentions, and behaviours, and this paragraph elaborates the theory principle conveyed in the studies by Ajzen (1991, 2005). According to the theory, behavioural, normative and control beliefs are the basis of behaviour. These beliefs are shaped by the individual's personality, social characteristics, and knowledge. Behavioural belief refers to the individual's beliefs about the consequences of behaviour, normative beliefs represent accepted or rejected norms about behaviour, and control beliefs show the level of control over behaviour. These beliefs constitute three primary mechanisms that enable people to make decisions: attitude toward the behaviour, subjective norms and perceived behavioural control. These stages define the intentions and affect an individual's behaviour, whether positive or negative. Behavioural attitude, the first variable, involves people's thoughts, ideas, and expectations about action and is influenced by behavioural beliefs. For this variable, two different aspects can be examined as affective attitude, reflecting enjoyability and other emotional responses, and instrumental attitude, reflecting practical aspects of behaviour such as convenience, time, distance, and comfort.

On the other hand, subjective norms are shaped by normative beliefs and define the ideas and actions of an individual's immediate circle about behaviour. These norms also include injunctive norms indicating the level of support of these people and descriptive norms showing the realization or nonrealization of the activity amongst the individual's immediate circle. Perceived behavioural control (PBC), the final variable, is related to the individual's ability and confidence level and results from control beliefs. This variable can be evaluated by having sufficient skills, time, money, power, etc. As shown in Figure 1, although other mechanisms can shape behaviour by affecting intention, PBC also directly links with behaviour. All stages described are summarized in Figure 1.

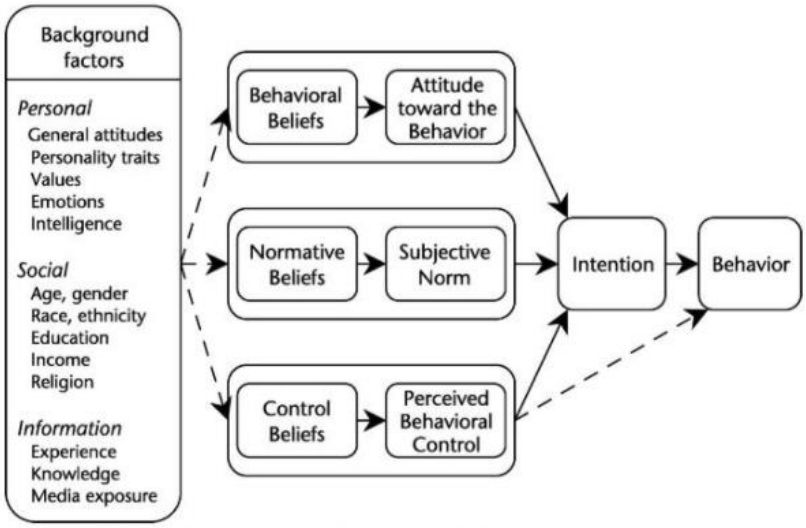

Figure 1. General structure of TPB (Ajzen, 2005).

Criticisms for TPB

It is necessary to understand an individual's travel behaviour to change people's transportation habits (Bamberg, Ajzen and Shmidt, 2003). TPB is one of the most common models used in transportation studies to examine and explain travel behaviour. In this part of the study, TPB's possible contributions to transport policies and criticisms will be evaluated. While TPB contributes to transport planning by understanding the reasons that affect people's modal preferences, being a basis for sustainable transport policies, and identifying predictors behind daily travel actions of individuals, it is negatively

criticized in terms of considering all behaviours as reasoned and having deficient parameters (habit, moral and descriptive norms, etc.) (Bamberg and Schmidt, 2003; Donald et al., 2014; Verplanken Aarts and Van Knippenberg, 1977).

Firstly, TPB has the power to direct sustainable transport policies in urban planning. It is vital first to understand the predictors of a motor vehicle and active mode uses to change travel behaviour for considering the environment, and TPB can significantly provide this requirement (Eriksson and Forward, 2011). For example, in Nayum and Nordfjaern's (2021) study, TPB is part of the modelling created to understand the public transport usage rates and the probability of involvement of university students, and the results find a strong link between TPB parameters and public transport usage. It is seen that these results have the potential to shape public transport policies in similar student cities. It has also been stated that by combining TPB with the customer satisfaction theory, in other words, by integrating satisfaction levels and perceived service quality into three components, policies to encourage people to use public transportation can be produced more accurately (Fu and Juan, 2017). In another study, car addiction on daily trips with TBP is examined, and a psychographic segmentation is created (Anable, 2005). As a result of the study, for example, although Malcontented Motorists are not satisfied with their car use and want to change, they cannot change their behaviour with the restrictions they feel from public transportation. This study demonstrates the potential of TPB to help evaluate individuals' perceptions of benefits in different modes and to help manage marketing and policies. To examine perception and beliefs about the use of active modes (Mandic et al., 2017), to describe the psychological connections between driving and driving intention (Gardner and Abraham, 2008), to understand the psychosocial reasons behind the use of bicycles in commuting travellers (Lois, Moriano and Rondinella, 2015), and the findings that provide an understanding of the relationships, changes, and current situation have provided remarkable results that will guide planning.

Regarding the criticisms, it is observed that PBC did not directly affect vehicle use, although all the relationships suggested with TPB in the study of predicting the use of cars on university routes with TPB different psychological models are confirmed (Bamberg and Schmidt, 2003). Likewise, Donald et al. (2014) also evaluated the factors affecting people's use of public transport for commuting travel, and it is seen that vehicle use can be determined by

intention and behaviour, but not by PBC, and public transport is only affected by intention. This situation causes questioning whether this parameter, which differs from the theory of TRA, is necessary for transportation studies. However, in the study of Bamberg and Schmidt (2003), it is also mentioned that the accuracy can be increased when these models work not as alternatives to each other but as supportive with different social aspects they have.

A criticism of the use of TPB in transportation studies is that the defined factors may be insufficient for this specific area and have difficulties explaining behaviour changes. (Conner and Armitage, 1998; Gehlert et al., 2013). Alongside many studies in the literature that extend theory, the most common parameters are habit, goals, moral and descriptive norms, and environmental concerns (Bird et al., 2018; de Bruijn et al., 2009; Donald et al., 2014; Hardeman et al., 2002; Jackson, Smith, and Conner, 2003; Sommer, 2011). Firstly, according to Verplanken et al. (1977), behaviours can be reasoned and unreasoned, they should not be considered just as reasoned, and when behaviour becomes a habit, these parameters will become challenging to manage. In this context, it is stated that the theory can lose its power. Also, psychologically, many studies show that modes of transportation do not consist of only one process; they will also be affected by habit, that travels are controlled by both deliberate and habitual processes, and past behaviours should be considered in this direction (Bamberg and Schmidt, 2003). For example, in Murtagh et al. (2012) study, it is calculated that the variance is 10% when transportation behaviours are calculated only with TPB, while this variance decreased to 6% with habit data. Accordingly, it has been stated that the predictive power of TPB is essential, but the habit power increases the validity of the model. However, contrary to these studies, Bamberg et al. (2003) stated that while the contribution of past behaviours and habit variables in predicting future travel behaviour is not observable, three TPB elements original antecedents of intention proposed by Ajzen (1991) are calculated as the primary source of understanding travel mode change.

Secondly, the norms defined within the scope of TPB seem insufficient to understand people's modal preferences and adding moral and descriptive norms and environmental concerns are found beneficial to add TPB because of affecting people's habits (Donald et al., 2014). On the other hand, Heath and Gifford (2006) stated that in addition to these three values in understanding modal transportation preferences, accuracy would be increased by adding perceived responsibility and awareness to TPB. However, there is also concern that it might turn into a theory that is difficult to manage and apply

by including all these elements in TPB (Conner and Armitage, 1998). Finally, another issue that the theory lacks is that it does not consider the time factor. For example, there is no difference between an individual's intention to do action within six months or in the future (Tornikoski and Maalaoui, 2019). As Trope (2012) mentioned, behaviours in the distant future are more abstract and broader, while those in the recent future are easier and more practical. The time criterion in people's decision-making seems essential in this respect (Tornikoski and Maalaoui, 2019). In addition, the environmental and psychological effects of the hours of the day on people's behaviour can be different; for example, it is seen that one of the factors that shape people's transportation behaviours during peak hours is time (Kim, Kwon, Wu and Shon, 2014). Besides, there are discussions about whether people's choice of regular travel mode is an automatic decision or a planned psychological process (Bamberg et al., 2003). In this context, it has been stated that by paying attention to erratic behaviour, it can be more accurate to understand car usage by adding the linear process of noticing and changing behaviour (Jopson, 2004). In conclusion, while it has been proven by many studies that TPB has made significant contributions to transport policies, there are many criticisms towards the development of this theory. In general, integration of the necessary variables into the main context of the TPB according to the purpose of the subject, the target to be reached, the behaviours, and the nature of the population may be more beneficial than the disruption of the main scheme of the TPB.

Synthesis of TPB and Time Geography

It has been mentioned in many studies in the literature that examining individual features are insufficient, and social network, spatial context, and built environment should also be articulated in understanding travel behaviour (Van Acker, Van Wee and Witlox, 2010). Therefore, in this part of the study, social psychology and time-geography synthesis, which are thought to contribute to this deficiency, will be evaluated.

While social psychology defines the context behind behaviours, geographical analyses determine the procedure of these behaviours (Handy, 2005). In short, these two fields are two elements that enable objective and subjective values to complement each other in evaluating behaviour thoroughly. In transport studies, daily activities such as working, shopping and going to school are spatially segregated and scattered at certain times of the day (Van et al., 2010). Therefore, although understanding non-spatial psychological

variables and factors are essential in understanding transportation behaviour, time geography, which indicates travels' spatial and temporal characteristics, is also necessary (Dijst et al., 2008). With a combination of social psychology and time geography, prioritization of individuals' travel behaviours, temporal dynamics, ways of combining urban activities, spatial representation, diversity, dependency of activities, and path-dependent behaviours can also be understood (Buliung and Kanaroglou, 2007).

When the difference between the two research areas is examined, social psychology examines people's interactions with other people, their thoughts, behaviours and the rate at which these behaviours are affected by the environment (Brehn, Kassin and Fein, 2005), while time geography, introduced by Hägerstrand (1970), defines the activities of individuals with two concept models, space-time path and space-time prism. As mentioned in the criticisms above, human behaviour can happen for a reason, or it can happen without any reason (Verplanken et al., 1997), and therefore only social-psychological evaluation may be insufficient in some cases. In transportation planning, the prioritization of activities should be determined more clearly (Buliung and Kanaroglou, 2007), and this need is another advantage that the synthesis can provide. Doherty (2000) stated that understanding individuals' detailed daily patterns is essential in understanding transportation behaviour. As stated above, TPB neglects interpersonal relationships in many studies, but time geography also contains locational and situational relations within and between communities (Thrift, 1977). As can be seen in the space-time path in Figure 2, the interaction and movements of two people during the day can be summarized with the space-time path.

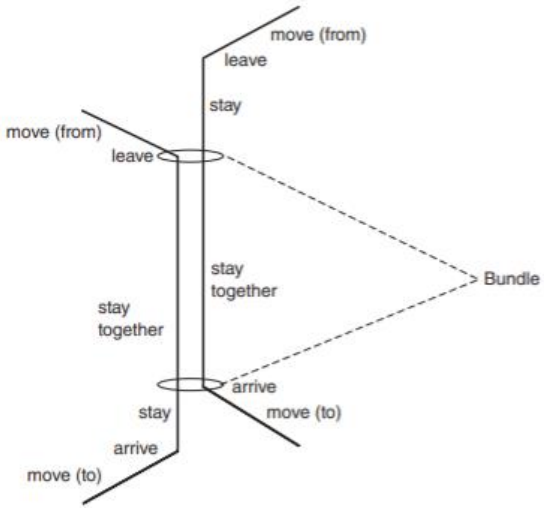

Figure 2. Relations and movements path of two individuals (Ellegård, 2018).

Time-geography has three constraints: capability, coupling, and authority (Hägerstrand, 1970). These are constraints about biological needs, people's needs (duration, space, time) for other individuals and tools, and limited access. In this context, it is necessary to understand how these theories can contribute to each other's deficiencies if the two theories work together. First, it is possible to eliminate the capability constraint with the PBC parameter in TPB. Also, although TPB helps to understand the behaviour of individuals, spatial data is needed to establish its relationship with land use. In this context, as shown in Figure 3, understanding people's travel behaviour by considering the spatial relationships of activities can help recognize individuals' living conditions, constraints, and habitats.

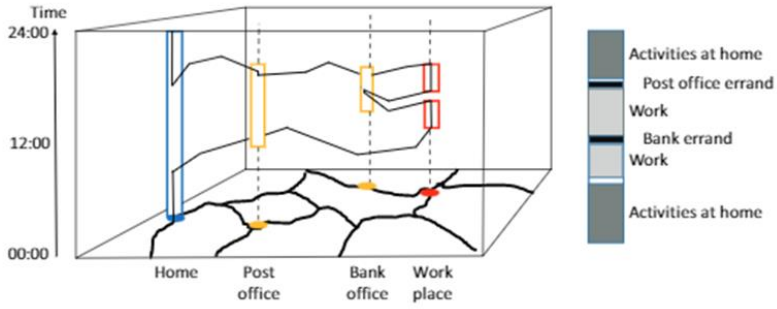

Figure 3. Individual's daily movement (Ellegård, 2018).

As seen in the transportation behaviour mechanism (Figure 4) prepared by Van et al. (2010), habits, lifestyle, and impulsiveness also affect behaviours apart from perceptions, attitudes and preferences. Also, these factors are not fixed in time, and the social and spatial environment also has an effect that should be considered. In conclusion, when social psychology and time geography are synthesized, the psychological background and mechanism of people's preferences can be understood in a temporal, spatial, and relational framework and contribute profoundly to transportation studies.

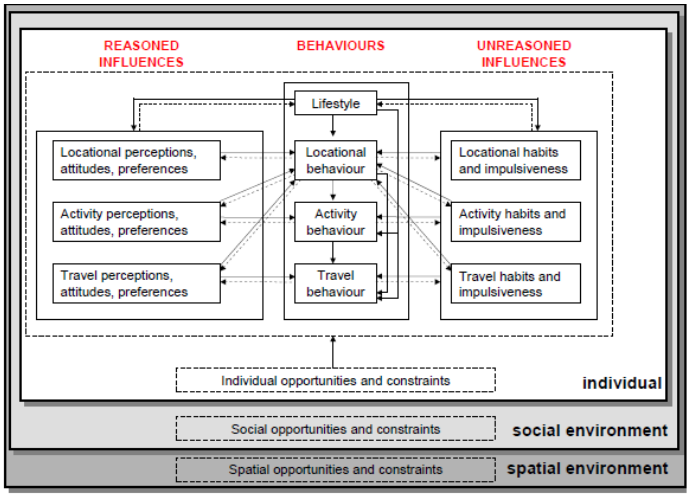

Figure 4. Cognitive scheme of travel behaviour (Van et al.,2010).

Low Traffic Neighbourhood (LTN) Design

A low-traffic neighbourhood (LTN) is developed to eliminate the problems caused by the increase in traffic volumes in the UK (Sustrans, 2020). Since 2020, it has been applied to increase sustainable modes and reduce vehicle use, especially in London (Aldred, Rachel and Goodman, 2020). In short, LTN is a design that prevents people from using residential areas as transit and makes neighbourhoods partially closed to traffic, as seen in Figure 5 (Greenpeace, 2021). While these plans and necessary actions are funded by the Department of Transport (TfL, 2020), they are carried out by the Councils (The Guardian, 2020). The size (walkable within 15 mins, surrounded by main roads, etc.) and location (close to key services and transportation points) of the neighbourhood, infrastructure system to be developed, and community involvement are critical in LTN design (Jacobs, 2020).

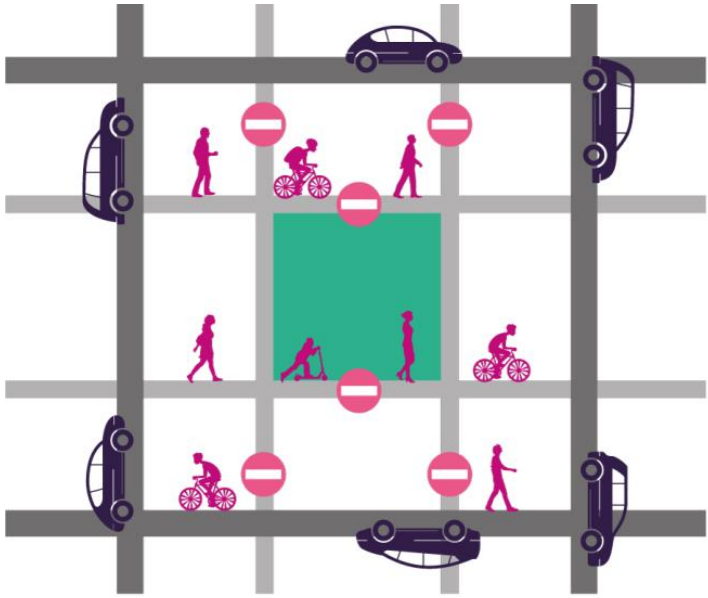

Figure 5. Conceptual design of LTN scheme (Aldred and Verlinghieri, 2020).

LTN has a scheme that includes modal filters to prevent the density of motor vehicles (especially through-traffic) on the streets, keep them away from residential areas and keep them on main roads and increase the daily usage rates and active travel of the streets (Aldred and Goodman, 2020; Cycling Embassy, 2021). Modal filters are measures such as traffic cameras, culde-sacs, and banned turns, which allow some modes of transportation (walking, cycling, PT) but prevent others (cars) (Aldred and Verlinghieri, 2020). According to Jacobs's (2020) study, the most used measures are width restrictions, bus gates, on-street parking and junction arrangements, while developments such as the creation of meeting areas, green areas and infrastructure arrangements are also offered to increase the use of space.

Although modal filters are design elements that provide achieving the goals like increasing active mode usage and use of streets and decreasing driving, it is essential to know which design will be more effective in which neighbourhood. In Aldred (2020)'s study, it was argued that making driving more difficult, expensive and accessible distracts people from using vehicles and that the increase in pedestrian and bicycle investments, especially for women and youth, increases the use of sustainable modes and it is argued that the LTN mechanism may be practical in that sense. However, the change

in psychological and spatial behaviours of individuals according to location and condition was not included in this evaluation. For this reason, the contribution level of social psychology and time-geography synthesis in LTN design, implementation, and evaluation of success will be examined in this part of the study.

Today's LTN projects have been created using existing data on potential emergency maps and data about housing, green space, deprivation and potential journeys (The Guardian, 2020). It has also been forewarned that the results of making LTN investments, which gained importance in the framework of the Covid-19 emergency, without full public participation, will not be accepted by the public (SW Londener, 2020). Considering Jacobs (2020)'s design scheme for Bath & North East Somerset (B&NES) Council, community engagement is carried out through public forums, workshops, focused conversations and community street audits. LTN designs are generally carried out this way with the traditional design scheme, adding information generated from local stakeholders through stakeholder meetings and negotiations to existing data (Aldred and Verlinghieri, 2020). The scheme followed by the Bath & North East Somerset (B&NES) Council for the LTN design is as in Figure 6.

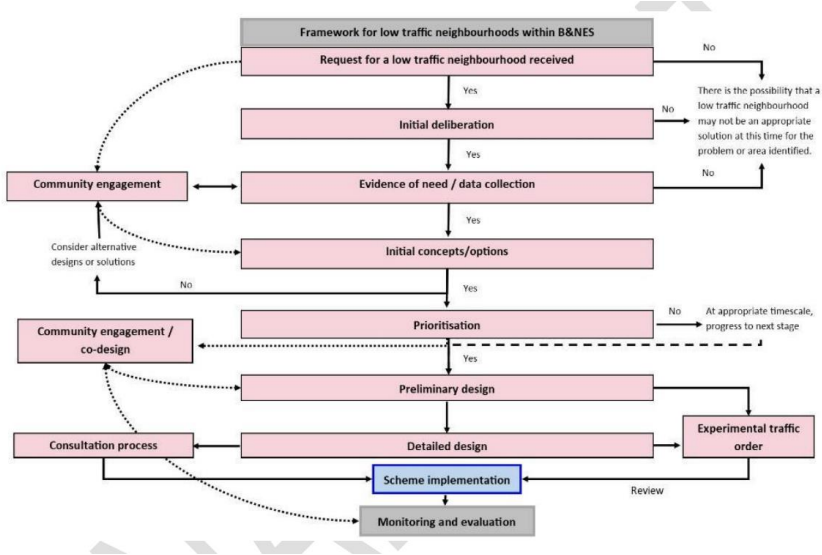

Figure 6. LTN general design flow followed by B&NES Council (Jacobs, 2020).

Street classification is the first step of LTN design, and one of the most used methods for classification is mapping created with the participation of

local residents and stakeholders and in the second stage this data used for the determination of neighbourhood's extent and boundaries (Sustrans, 2021). When one of these mapping examples is examined (Figure 7), it is seen that there is no temporal factor here, and the transport movement is restricted only spatially. With the synthesis defined with the social psychology and spatio-temporal implementations, these constraints can be eliminated, and classification accuracy can be increased with more detailed and precise data regarding psychological, temporal, and spatial contexts rather than verbal expressions.

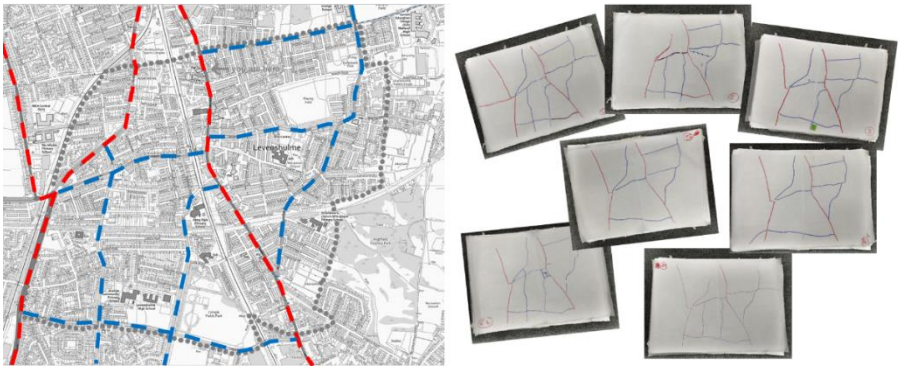

Figure 7. Community street classification exercise (Sustrans, 2021).

The third stage is prioritization according to the characteristics and needs of the neighbourhood and collected data such as social, demographic, land, and economy are crucial (Sustrans, 2021). So, it may be beneficial to integrate the habitual daily actions of people. For example, the time-geographic diary method enables the prioritization of activities according to time and gives the psychological causes and consequences of the action (Ellegård, 2018). Thus, instead of defining the modal preferences of individuals for traditional reasons, it will be possible to understand the people and their environment and how the change of these characteristics in their environment affects the person with spatio-temporal evaluation as Wang and Cheng (2010) mentioned.

Finally, measures are taken with modal filters (such as pocket parks, diagonal filters, bus gates, banned turns and one-way streets, signage enforcement, school streets and width restrictions). The most critical issue here is selecting the type of measure and their locations. These decisions made by the councils after the data collection stages are the elements that provide the effect of LTN designs (The Guardian, 2020). Modal filters include measures that

fulfil the purposes of the LTN scheme, such as camera monitoring and the use of barriers to prevent vehicular passage, as in The Lewisham and Lee Green LTN (Lewisham Council, 2021). Considering the improvement potential of the possible synthesis of theories to these measures, knowing the routes people prefer and the reasons that push them to this use, briefly understanding the psychological factors and the spatial-temporal projection of these factors, determining the selection and location of the measures accordingly will increase the accuracy. For example, school streets are time-limited filters around schools and time limits need to be well defined (Cycling Embassy, 2021). It would be possible to test the behavioural characteristics of students and shape their use of streets and add the temporal graph of the activities around the school to this analysis so that the students spend a part of their time outside of school hours under the effect of low traffic with a time limit. As another example, in the news made by SWLondener (2020), it was stated that parents living in Oval Triangle LTN had to go to work after dropping their children off at school, and therefore they could not walk to school, which is within 25-30 minutes walking distance, and return to work at a proper time. These daily actions, which people have to do, have not been defined and evaluated before, have made their lives more complex instead of benefiting society. For this reason, the outcome of the decided measures by evaluating the daily actions and behaviours of the local residents will prevent such consequences.

Another critical analysis is the possibility that the scheme may be rejected on some streets. As Aldred (2020) mentioned, while LTN provides improvements in some regions, there is a possibility that it will not be able to adapt to every place. In measuring the success of the system, it is necessary to understand the spatial change of behaviours as well as the analysis of people's psychological attitudes towards these actions. For example, in the survey involving 345 residents of LTZ in London, it is seen that 63% thought LTN improved their lives (Redfield & Wilton Strategies, 2021). It is important to understand why the remaining 37% do not think it improves, and the beliefs behind it for future policies. In understanding these beliefs and behaviours of individuals, the spatio-temporal evaluation of individuals' daily travels puts a different complexion on LTN modal filters, which are tools that only have spatial features. Also, after the program is implemented, it is essential to evaluate the impact of the plan and collect data such as general perception, travel times, changes in mobility and mode choices, and economy (Sustrans, 2021). It is

also stated that behaviour change programs are needed to increase the effectiveness of the program (Sustrans, 2021). Personalized travel planning has the potential to be realized in a highly accurate manner with the combination of time-space definition, which includes a projection of people's daily lives and their relationship with individual behaviours. For example, before and after LTN implementation, time-geography can define at what time of the day he/she goes to work, which vehicle he/she uses on his way to work, whom he/she interacts with, and her/his habitual features, and TPB can define the belief, norm, and capacity elements behind the use or not using active transport modes with defining the personal, social and informative aspects. As an example of directing LTN policies, by looking at the distribution of the daily journey of a person who is not familiar with cycling, training programs can be the basis for the development of policies such as the development of bicycle paths on that route. As a result, LTN designs, applications, and measures of success should be improved with the theories about psychology and spatial sciences.

Discussion and Conclusion

The problems that arise with the increase in vehicle usage are increasing day by day (Newman, Kosonen and Kenworthy, 2016). In this direction, policies for increasing the use of sustainable modes in cities should gain importance (Bannister, 2008). The fundamental thing to do this is to understand people, who are the cornerstones of cities (Long and Ye, 2019). Policies that try to shape and guide people without understanding them will have minimal effects. However, it will not be enough to evaluate people only psychologically or physically. In the ongoing projects today, it is observed that the concepts still consider people as a goal and most of them do not include people in the project evaluations (Zhang, Ye, Zeng and Chiaradia, 2019). People's reactions to places and individual evaluations also differ as each place's characteristics differ. Therefore, social and technical research should complement each other. The reason for considering LTN studies in this study is to evaluate the potential of this newly created policy to work more comprehensively. It is possible to develop this design policy, whose current scope deals with human actions and the psychological and spatial extensions of these actions, with theories in the literature.

In conclusion, it is necessary to define the behaviour of individuals completely to shape transportation policies because there are many reasons behind people's choices, such as psychological, economic and social. TPB, one of the theories defined within social psychology, is a method widely used in transportation studies to investigate the acceptance of society's decisions, examine their effects, and manage the decisions (Donald et al., 2014). TPB, which has a very high rate of reflecting the travel behaviours of the society, also receives criticisms such as insufficient parameters and evaluating behaviours as reasoned (Forward, 2004). When the synthesis of social psychology and time geography is examined by paying attention to these criticisms, the combination of social psychology, which reveals the factors behind people's behaviour, with time geography, which helps define the daily activities' mechanisms, seems remarkably useful. With the evaluation of the spatial-temporal dimension, the accuracy rates of social analyses can increase. As a result of reviewing LTN designs within the scope of this synthesis, it is seen that travel behaviour synthesis can be effective in classification, border determination, selection of modal filters, and prioritization stages. Monitoring the changes in people's activities and behaviours after LTN applications can summarize the success, and it is advantageous for identifying psychological and spatial characteristics with similar characteristics during the re-application of the application in other areas. These studies, which were evaluated, examined, and criticized within the scope of this study, are of high importance for transportation policies. As SW Londoner (2020) mentioned, the benefits of LTN such as reducing carbon emissions (TfL, 2020), reducing traffic volumes and increasing active transportation (Aldred and Verlinghieri, 2020) and increasing the use of streets (Sustrans, 2020) can be further increased in this way.

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