

Active commuting as a form of sustainable urban mobility: The case of the Brno Metropolitan Area

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Abstract

Environmentally friendly alternatives to motorised transport have recently become a topic of discussion among political representatives. To achieve sustainable urban mobility objectives, political discussions have focused on promoting cycling, walking and using public transport in cities. These modes of transportation are attractive ways of commuting to and from work for a portion of the population. In the literature, there is a growing interest in the phenomenon of active commuting. This paper examines the spatio-temporal patterns and practices of active commuting and evaluates their significance in the context of sustainable urban mobility. The empirical research is based on data obtained from a questionnaire survey and semistructured interviews conducted in 2023 in the Brno Metropolitan Area. Based on the data, three categories of active commuting were identified, namely pragmatic active commuting, physical active commuting, and combined active commuting, which differ in the implementation of different spatio-temporal practices. For the development of sustainable transport in the city, it is necessary to promote the construction of pedestrian and bicycle infrastructure, with the aim of making movement for pedestrians and cyclists more straightforward, efficient, and safer, including paying attention to actions leading to the embedding of this mode of transport in the wider societal context.

Keywords: Active commuting, spatio-temporal practices, urban mobility, transport mode, Brno Metropolitan Area, physical activity

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1. Introduction

In recent years, interest in environmentally friendly alternatives to motor transport has been growing. The current policies in many cities can be described as restricting car use and promoting public transport, cycling and walking (Buehler et al., 2017). This trend also applies to Brno (Czech Republic). Discussions at the level of political representation in Brno municipality are centred around promoting walking and cycling. To improve the transport accessibility of various locations in the city, the importance of public transport is also discussed. Strategy 2050 for Brno aims to increase the attractiveness and usage of sustainable modes of transport, thereby mitigating the adverse effects of transportation on urban life in the context of the entire Brno Metropolitan Area (StrategyForBrno, 2024).

One of the important components of urban mobility is commuting for work. The mode of transportation by which individuals get to work by walking, running, or cycling is most commonly referred to as 'active commuting' (Jones & Ogilvie, 2012, p. 22). Some researchers use the term 'active travel' (Saelens & Handy, 2008; Freeman et al., 2013) or 'active form of transport' (Shannon et al., 2006, p. 1) to express a type of movement involving walking, cycling and using public transport in combination with walking and cycling. Other studies label this movement as non-motorised transport (Rietveld, 2000; Saelens & Handy, 2008). The common

element of these modes is the inclusion of physical activity during the journey and positive contribution to the natural environment. Active commuting can often be the most efficient mode of transport (Hansen & Nielsen, 2014).

The discourse surrounding sustainable urban transportation is also becoming increasingly prominent. Black (1996, p. 151) defined sustainable transportation as "satisfying current transport and mobility needs without compromising the ability of future generations to meet these needs". In this article, satisfying mobility needs can be understood as efficient movements from one place to another within an urban environment. Sustainability, in this meaning, balances the economic, social and environmental pillars (Litman, 2007; Silva et al., 2010). Sustainable transport contributes positively to the economic and social state without harming human health and the environment (Silva et al., 2010), where also the protection of natural resources belongs to one of the basic principles (Gudmundsson & Hojer, 1996). In addition to the term 'sustainable transport', the term 'sustainable mobility' is used to denote a wider understanding of mobility practices. Banister (2008) states that the sustainable mobility approach aims to reduce travel needs, encourage modal shift through the promotion of walking and cycling, shorten trip lengths, and encourage transport system efficiency. Sustainable mobility is related to a diverse transport system that offers travellers various modes, locations

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and pricing options. The various components of such transport system are well integrated, such as pedestrian and cycling access to transit (Litman, 2007). Walking, cycling, ridesharing, public transport, car-sharing and teleworking, as well as the creation of more walkable and transit-oriented communities, are all parts of improving the diversity of the transport system (Litman, 2007). Sustainable mobility characterises that all modes of transportation are considered in a hierarchy, with pedestrians and cyclists at the top and car users at the bottom (Banister, 2008).

To comprehend the significance of active commuting and functional sustainable planning in the urban environment, it is crucial to understand the spatio-temporal practices of individuals who actively transport themselves to and from work. This research employs a practice-based approach to examine the implementation of these practices. Its main objective is to provide answers to the following questions:

- What spatio-temporal practices are associated with active commuting?
- What are the implications of these existing spatio-temporal practices for sustainable urban mobility in the context of a practice-based approach?

This paper presents a comprehensive spatio-temporal analysis of active commuting in a selected area, identifying three distinct categories of active commuters based on semi-structured interviews. The results are contextualised within the framework of the objective to facilitate active commuting in the Brno Metropolitan Area. In the discussion, the article points out the key elements that are important to these efforts.

2. Theoretical background

2.1 Contextualising active mobility and active commuting

Active mobility encompasses various forms of walking, and as a result, a number of terms are used in the literature – destination walking (Alfonzo, 2005), purposive walking (Matos Wunderlich, 2008), utility walking (Pooley et al., 2014), destination-oriented walking and utilitarian walking (Saelens & Handy, 2008), active-transport walking (Millward et al., 2013). The meanings of these notions are distinct, as walking is a fundamental activity for humans and is not necessarily applicable to commuting. For the purposes of this article, it is essential to be aware of the concept of walking, which characterises movement from destination A to destination B, i.e. with the intention of reaching a specific destination. Previous research indicates that walking is done over very short distances. Millward et al. (2013) indicate the most common distance in the range of 0,2–0,4 km. These results are consistent with the findings of Scheiner (2010), Larsen et al. (2010); and also Rubin et al. (2015), who found that 90% of respondents who use active transportation to work walk within 30 minutes. Walking can be employed in a number of ways, independently or in conjunction with alternative modes of transport (Jones & Ogilvie, 2012). Sarker et al. (2020) showed that the shortest walk is connected with the way to the bus stop. Previous research demonstrated that the most prevalent walking distance to a bus stop is within a ten-minute radius (Sarker et al., 2020; Besser & Dannenberg, 2005; Lachapelle & Noland, 2012). A number of previous studies (Cerin et al., 2007; Wener & Evans, 2007; Villanueva et al., 2008; and Lachapelle & Noland, 2012) have shown an association between the use of public transport and an increased frequency of walking trips or higher levels of physical activity.

When considering a route, individuals often choose the most direct and shortest route (Tight et al., 2004), a decision partly influenced by limited in the amount of time they can spend moving from one place to another within a day (Marchetti, 1994). Many

individuals see walking as a daily routine, often without conscious recognition of this activity. Seamon (1979), Wood et al. (2005), and Pooley et al. (2014) provide deeper insight into the habitual nature of walking, especially in conjunction with walking to work. An important factor that affects the decision to walk for transportation purposes is also the accessibility to the destination, which includes proximity of destinations (workplace), spatial distribution and land use mix within the given area (Saelens et al., 2003; Alfonzo, 2005; Cerin et al., 2007). Nevertheless, Hatamzadeh (2019) emphasises the role of the individual's experience and the individual's attitude toward walking. An individual's positive attitude towards walking increases their desire to walk. Desire to walk more means "whether a person wishes to increase his/her walking or not and could be considered as an intention for changing the travel behaviour in to a commute pattern in which the amount of walking would be more" (Hatamzadeh, 2019, p. 351). The choice of a walking route is also influenced by whether the route is part of a wider transport network providing good connections, crossing points, access to services, and fits the desires of individuals (Tight et al., 2004; Saelens et al., 2003).

The category of active mobility encompasses running. Despite its huge potential, running to work has received little attention so far. When authors incorporate running into their research, they often categorise it as a subfield of walking, such as Song et al. (2013). However, this topic is addressed in greater detail in the research of Cook (2021). His findings revealed that run-commuting is seasonal in nature, with the majority of individuals engaging in this practice one to two times per week. The average run time was found to be between 40 and 49 minutes. Another area of active commuting is cycling. In Poland, approximately 10% of respondents use cycling as a mode of transportation to work (Biernat et al., 2020). They also indicate that the average cycling time is under 20 minutes. The intensity and frequency of cycling use in the transport mix and in commuting decrease with increasing distance (Dickinson et al., 2003; Pucher & Buehler, 2006; Sears et al., 2012), with increasing travel time (Heinen et al., 2011), and with each additional kilometre (Heinen et al., 2013). On the other hand, Hansen and Nielsen (2014) identified a proportion of cyclists commuting longer distances (more than 5 km) and referred to them as long-distance commuter cyclists. Most respondents who commute by bicycle report cycling to work as a regular occurrence (Biernat et al., 2020). Nevertheless, previous research suggests that cycling to work has a seasonal trend with higher frequency in summer (Heinen et al., 2011; Sears et al., 2012; Hansen & Nielsen, 2014). Bergström and Magnusson (2003) highlight the differences in cycling behaviour and distinguish between winter cyclists, summer-only cyclists and infrequent cyclists.

As evidenced by previous research, active commuting can be viewed from the viewpoint of the pragmatic mode of mobility, typically employed for shorter journeys, but some individuals who walk (see Pooley et al., 2014), run (Cook, 2021) or cycle (see Heinen et al., 2011; Biernat et al., 2020) to work extend their journeys due to physical benefits and positive impact on an individual's health (see Oja et al., 1998; Rafiemanzelat et al., 2017).

2.2 Practice theory perspective on commuting

Practice theory provides a valuable framework for understanding commuting behaviours and sustainable transportation (Iyanna et al., 2019; Scheurenbrand et al., 2018). Reckwitz (2002) defines a practice as a routinised type of behaviour that involves interconnected bodily activities, mental activities, use of objects, specific knowledge, and emotional states. Practices are, in his perception, viewed as a collective phenomenon, representing shared ways of doing and understanding within a social group. Reckwitz (2002) highlights that practices encompass not just the physical actions but also the meanings, norms, and

interpretations associated with those actions. They are embedded in broader social and cultural contexts, which provide them with specific significance and value. According to Shove et al. (2012), practices are constituted as bundles of interrelated elements. These elements include material components, competencies and meanings, which are interconnected and collectively enable the existence of a particular practice.

In this regard, commuting is a complex social practice shaped by materials, meanings, and competencies, requiring tactical negotiation of these factors (Guell et al., 2012). Iyanna et al. (2019) claim that meanings play a dominant role in shaping commuting practices, with competencies and materials integrated to address these meanings. As they demonstrated with the example of public transport, it can be associated with a social stigma that is culturally unacceptable (socio-cultural meanings). Some individuals may perceive it as a means of achieving freedom and independence (symbolic meanings), whereas others may view it as an inconvenient mode of transportation without physical discomfort (personal meanings). In the context of discussing practices, Watson (2012) posits that it is of significant importance to note the interconnected and interdependent nature of practices. This suggests that the implementation of one practice may have an impact on the outcome of another practice. Spurling et al. (2013) argue that practices are part of larger systems. In research, it is important to consider the broader system of practices, as the observed patterns of commuting behaviour may not be directly linked to transport policy but rather to the location of children's educational institutions. For that reason, Heisserer and Rau (2017) highlight the limitations of an individualistic approach to mobility research, which tends to focus on individuals, actors and their motives. They argue that commuting is linked to numerous other areas of social life and demonstrate that it is influenced by a range of factors, including material (infrastructure, availability of transport, etc.), social (the need to combine trips to get children to school, etc.) and political (laws and regulations) conditions. The practice-based approach was also used in some previous studies dealing with similar topics, Larsen (2018) outlines a practice-based approach to understanding long-distance commuter cycling in Denmark, and Cass and Faulconbridge (2016) used this approach in their study focused on the transition from automobile commuting to bus- and cycle-commuting.

3. Research design and methods

This study has been carried out in the Brno Metropolitan Area. The Brno Metropolitan Area is made up of 184 municipalities with a total population of approximately 700,000 inhabitants. Brno, as a central city, is the second largest city in the Czech Republic. The city was chosen because of its progressive, post-socialist character and the steady growth of its population. Walking and cycling in cities is becoming a more widely discussed topic in the Central European region, including Brno. Brno has a great tradition of using public transport, the use of which, in combination with walking, provides optimal conditions for research. Furthermore, it was found that there is a lack of research in this area on similar themes.

The study is based on a mixed-research design, with the analysis comprising information from a questionnaire survey and semi-structured interviews. The data obtained from the questionnaire survey provides a framework for qualitative analysis, as it reveals the fundamental characteristics of active commuting. The insights into spatio-temporal behaviour were greatly expanded by the information obtained from semi-structured interviews. The questionnaire survey was conducted electronically between September 2023 and December 2023. A total of 495 respondents (290 females and 205 males) provided responses. People were contacted through social networks (Facebook, X, Instagram, Reddit and LinkedIn) and websites related to Brno. The respondents were

provided with a unique link, which they could utilise to access the survey. In the case of Facebook and Reddit, the link was shared in the public groups of the City of Brno, the city districts and the groups of individual municipalities. Furthermore, the link was posted in thematic groups focused on cycling, for example, "Brno na kole" ("Brno on bike"). This approach was taken in order to reach as many people as possible. On the X and LinkedIn platforms, the link was used to publish on a private account with a request to reshare. With regard to the municipalities situated in the hinterland of Brno, the selection process was based on a random approach. The objective was to ensure a relatively even distribution of the selected municipalities across the metropolitan region. Around 70% of the respondents reside in Brno, while the remaining 30% live in municipalities within the Brno Metropolitan Area. The questionnaire focused on individuals who walk or cycle all the way to or from work or use a combination of these modes with public transport. Individuals who only walk or cycle part of the journey and use public transport for the rest were also included in the study. The proportion of responses from the category of individuals walking and cycling is approximately equal. More specifically, 195 respondents reported walking the entire journey to work, 210 reported cycling the entire journey to work, and 90 reported combining active commuting with public transport during the journey to work. The age range and level of education were not predetermined. The questions concerned the spatio-temporal features of work-related mobility, specifically individuals' daily movements to and from work. The questionnaire was structured into a few segments, such as the journey to work and the journey from work. In cases where public transport was used, segments were defined as journeys from home to the public transport stop, from the public transport to work, and any walking errands between public transport trips, depending on the number of transfers. This data was complemented with information on motivations, seasonality and other contextual information.

Interviews with communication partners were performed simultaneously during this research period. The interviews were pre-structured, but the communication partners had the ability to alter the structure through their answers significantly. The main purpose of the semi-structured interview was to provide in-depth information on the topic that a questionnaire survey would not allow. Therefore, the specific spatio-temporal practices of individuals were investigated. Four types of communication partners were determined as an important for the qualitative analysis. The first group consisted of individuals who walked to or from work (1), the second group comprised individuals cycling to or from work (2), the third group involved runners to or from work (3), and the fourth group included individuals who combined either walking, running or cycling with public transport within the same journey to or from work (4). The individual was required to commute a few days a week using these modes of transport, but not necessarily every day. This research did not include other modes of transport, such as scooters, as part of the commute to work. Our analysis and local surveys showed that these modes are almost negligible in this region. To address the research question, a total of 22 semistructured interviews were included in the analysis (Tab. 1). The number of interviews conducted corresponds to the theoretical saturation in each of the four groups studied. Communication partners were recruited via social networks and various online groups that bring together runners, cyclists, walkers and platforms such as BrnoNaKole and others. A post was inserted into these groups, offering the opportunity for individuals to participate in research that specified the criteria for their involvement. Individuals who expressed interest were then randomly approached. The snowball method was also partly used.

The sample consists of 16 out of 22 communication partners residing in Brno. The youngest interviewee is 22 years old, and the oldest is 55. All interviews were recorded, transcribed and further analysed. All recordings were made with the consent of

Nickname (gender)	Age	Place of residence	Place of employment	Mode of transport
Martin (M)	29	Brno	Brno	walking
Tereza (F)	25	Brno	Brno	walking
Adéla (F)	55	Brno	Brno	walking
Jakub (M)	42	Brno	Brno	walking
Kateřina (F)	38	Kuřim	Brno	walking
Tomáš (M)	48	Brno	Brno	walking
Aneta (F)	41	Zbýšov	Brno	cycling
Hana (F)	45	Brno	Brno	cycling
Radoslav (M)	33	Brno	Brno	cycling
Miroslav (M)	38	Brno	Brno	cycling
Otakar (M)	42	Tišnov	Brno	cycling
Luboř (M)	36	Česká	Brno	cycling
Daniel (M)	22	Brno	Brno	cycling
David (M)	23	Brno	Brno	cycling
Pavel (M)	38	Rajhrad	Brno	walking/public transport
Eliška (F)	30	Brno	Brno	walking/public transport
Jan (M)	28	Brno	Brno	walking/public transport
Kamila (F)	44	Brno	Brno	walking/public transport
Robert (M)	26	Brno	Brno	walking/public transport
Lucie (F)	25	Brno	Brno	running
Radim (M)	36	Šlapanice	Brno	running
Markéta (F)	51	Brno	Brno	running

Tab. 1: An overview of communication partners
Source: Author's survey

the participants. The average length of the interviews is 48 min. A qualitative analysis was performed using a coding technique. Coding was carried out in successive stages, involving three levels of coding: open, axial and selective (according to the methodology of Hendl (2005)). Open coding consisted of the initial labelling of words, sentences, and parts of texts in conversations. This was followed by axial coding, which entailed further reading and searching for motives, strategies, and reasons in relation to the theory. The process of selective coding was characterised by the definition of supporting themes in which certain codes are always grouped. To illustrate, during the open coding stage, a number of codes were generated, including 'simplicity', 'directness', 'shortest path', and 'fastest'. These were subsequently categorised as "simple movement A → B" following further reading and analysis, which included the use of various tools such as the Code Co-Occurrence Table and Networks. This led to the creation of the pragmatic way of active commuting. In the final stage of the analysis, three categories of active commuting subsequently emerged from the dozens of codes: pragmatic, physical active and combined active commuting. Each category can be assigned a number of specific codes that are typical for them. The typical range of such codes is between 20 and 40 per category.

4. Statistical data on active commuting

4.1 Time perspective of active commuting

The act of walking to work can be classified into two principal categories: either as the sole mode of transportation for the entire journey or in conjunction with the utilisation of public transportation. Walking data shows that the shortest walking trips are those to a public station. Of those who walk directly, four-fifths of respondents take up to 10 minutes to get from home to the public station, adding that two-fifths take up to 5 minutes. The journey may take longer if any other activities are related to the journey from home to the public station. The most commonly reported intervals were 6 to 10 minutes or 11 to 15 minutes. The walking time interval for the subsequent segment, from the public station to work, was found to be the same. Walking the entire journey to work is characterised by slightly longer distances. Over three-fifths of participants typically walk to work within a 15-minute timeframe, with more than half of this group reporting a commuting time of between 5 and 10 minutes. Additionally, 10%

of respondents reported a commuting time of over 25 minutes (see Fig. 1). Obviously, the time duration of walking on the way to work observed in this study is consistent with the findings of previous research conducted by Scheiner (2010), Larsen et al. (2010), and Millward et al. (2013), although they reported the distance in metric units. Cycling to work is typical over longer distances. In the case of using a bicycle to work, three-quarters of individuals commute to work for a duration ranging from 11 to 30 minutes. Almost 20% of those questioned reported a commute longer than 30 minutes, and 3% reported a commute longer than an hour. These values are slightly higher than those found in a previous study conducted in Poland by Biernat et al. (2020).

The results indicate that the commute to work is typically shorter than the commute from work, regardless of whether it involves walking, cycling or a combination of these modes of transportation. Regarding combination walking with public transport, the travel times are higher by 5 minutes for those making a direct journey from work. If individuals engage in additional activities on their way home from work, their journeys become significantly longer. In such a situation, two-fifths of people take more than 20 minutes to travel from work to their first public station. On the final segment of the journey from the public station to home, walking times are shorter but also higher. According to our results, commuters mostly complete this segment within 15 minutes. For respondents who walk the entire journey home, approximately one-third of individuals take up to 10 minutes, while another one-third take more than 20 minutes for a direct journey. If additional activities are included, the journey takes longer, with over 50% of respondents taking more than 30 minutes. In relation to cycling, more than 50% of the respondents indicated that their commute from work to home takes between 31 and 60 minutes. Furthermore, nearly a quarter of the respondents have a commute from work to home that takes over an hour if it is not a direct route (see Fig. 2). It can be concluded that cycling is associated with the longest commuting times, both when travelling to and from work. The observed commuting times values for these types of active commuting to and from work correspond to the times reported in the research by Rubín et al. (2015).

4.2 The structure of journeys

In addition to the observation of longer journeys on the way home, certain similarities were also discovered. The morning commute is typically direct for all forms of active commuting

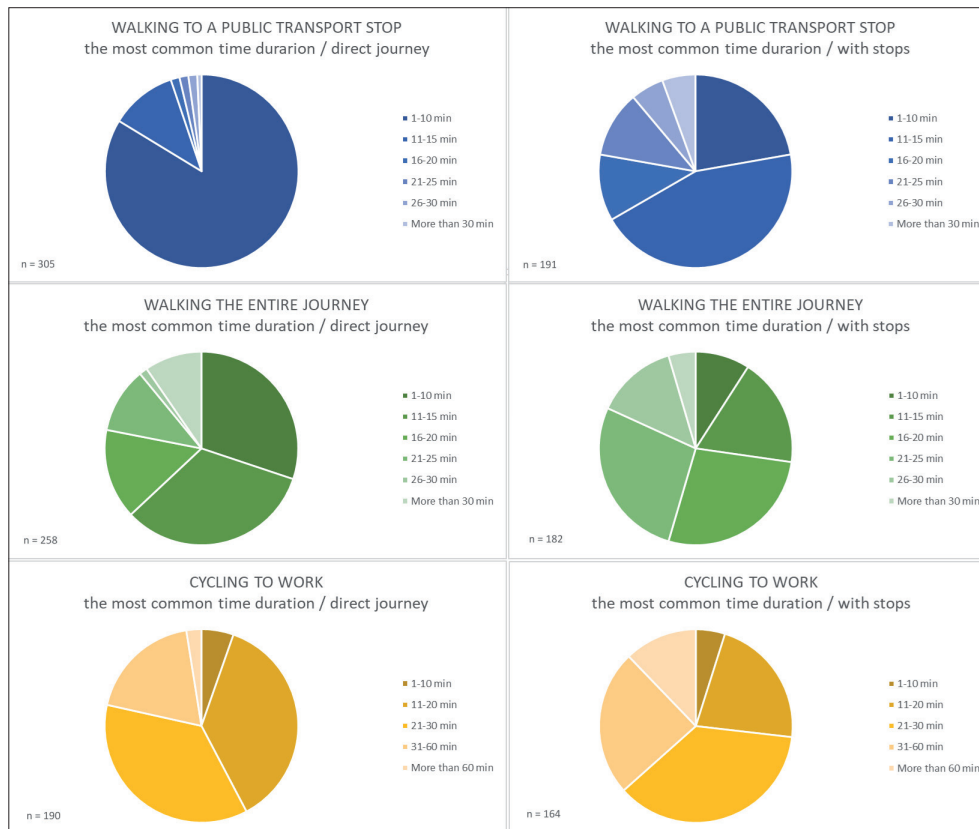


Fig. 1: Commuting time of active form of transport to work in case of direct journey (left) and in case of journey with stops (right). Even if some individuals typically (most often) complete a journey in a direct manner, if they undertake a journey with intermediate stops in at least some instances, they were also queried about the time taken
Source: Author's survey

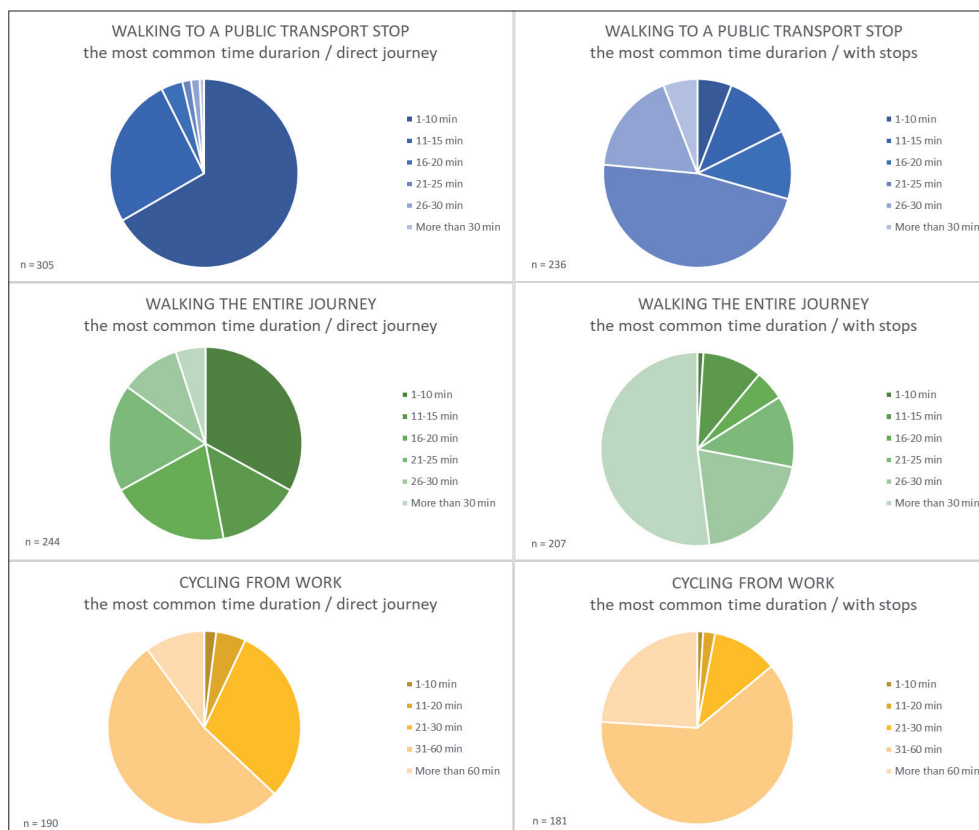


Fig. 2: Commuting time of active form of transport from work in case of direct journey (left) and in case of journey with stops (right). Even if some individuals typically (most often) complete a journey in a direct manner, if they undertake a journey with intermediate stops in at least some instances, they were also queried about the time taken
Source: Author's survey

explored. In the case of a combination of walking with public transport, 90% of individuals walk directly from their homes to the public station and then continue directly to work. Of those who include other activities in these trip segments (home → work), 80% stop at stores for refreshments. The remaining percentage consists of stops at schools or daycares with children or leisure stops related to sports, such as going to the gym. The results are not significantly divergent from those observed for walking and cycling. However, the greatest dominance of direct journeys to work was observed among cyclists.

4.3 Daily, weekly and annual pattern

Walking and cycling have been observed to have some seasonality. Increased intensity was registered during the summer period, with peaks occurring in May and June. Subsequently, there is a decrease in commuting frequency in July and August, followed by an increase in September. Conversely, a higher decrease during the winter period was registered, especially for cycling. On the other hand, combining walking with public transportation during one journey appears to be a year-round activity. Differences in the frequency of commuting within the week were also identified. Walking and cycling to/from work is only registered on certain commuting days. The most commonly cited reasons for switching to an alternative mode of transportation to/from work were adverse weather, other obligations in private or professional life (such as a meeting or session) incompatible with walking or cycling, or actual mood. One-third of individuals who engage in cycling to work travel to work only every second or third journey. The frequency of using walking to work is slightly higher. Furthermore, it is important to note that differences exist within the year. One-fifth of the respondents reported walking entirely to work in only one direction on some days, either to work or home from work. Combining walking with public transport during one journey is typically used regularly on workdays with no clearly identifiable distribution across days.

The results of the questionnaires indicated that respondents who combined walking with public transport during one journey exhibited a distinct behavioural pattern with regard to departure time strategy. The time at which individuals leave their homes for work is influenced not only by factors such as working hours but also by the public transport system. Approximately half of the respondents stated that they set off at a specific time to catch the same public transport service that runs at the same time every day. Regarding the afternoon commute, the public transport system is less influential as a pacemaker when more than three-quarters of individuals leave work at a different time each day, making this spatio-temporal behaviour similar to individuals with characteristic physical active commuting. This makes the journey from work much more flexible in terms of time.

4.4 Spatial perspective of active commuting

It is also important to note the significant spatial fragmentation involved in walking the route home from work. The results of the questionnaire survey indicate that 60% of individuals do not follow the same route daily. It hints that journeys from work have become much more complicated and varied. An even lower percentage was observed for individuals who cycle to work, with as many as 45% of cyclists taking different routes on their return journey. This discrepancy is also because each way of active commuting is associated with specific motivations. For almost 80% of respondents, cycling to work is a form of physical activity. Additionally, 90% of the participants reported that it provides mental relaxation and rest. Individuals who choose this type of commuting often intentionally extend their journey from work and seek out new routes to take each time.

5. Specific commuting practices of active commuting

The analysis of the semi-structured interviews reveals the existence of three distinct categories of active commuting: pragmatic, physical active, and combined (Fig. 3). From the perspective of spatio-temporal analysis, it is significant to note that the three categories of commuting entail the utilisation of distinct spatio-temporal practices by individuals. All three types of active commuting represent certain specific behaviours in time and space and may occur simultaneously in the same individual but in different situations and contexts.

5.1 Pragmatic active commuting

One type of active commuting is pragmatic active commuting. The category of pragmatic commuting comprises practices that can be framed as 'efficient daily walking over short distances' and 'efficient destination cycling'. A fundamental attribute of pragmatic active commuting is a mode of transportation based on the motivation to reach the destination as easily and quickly as possible. One frequent explanation mentioned by communication partners for this spatio-temporal behaviour is the limited amount of time available for commuting. The basic principle of pragmatic active commuting is to get from point A (individual's home) to point B (individual's workplace) and vice versa.

5.1.1 Efficient daily walking over short distances

This spatio-temporal practice was observed in Martin, Adéla, Tereza, Jakub and Kateřina, whose walking journey to and from work can be labelled straightforward. As Martin says: "There is no reason to stop anywhere in the morning". Besides the individual motivation of commuters, the reduced frequency of stops for commuters walking to their destination may be attributed to the fact that these walking routes often pass through parks and housing estates, which are not conventional service locations. Therefore, those walking have limited opportunities to stop somewhere. The statements of the communication partners indicate that if commuting to work involves a stop, it is done in close proximity to the daily route. For instance, Adéla and Jakub mentioned rare stops at a bakery, small grocery store or café. However, these stops are typically en route. Therefore, communication partners do not significantly deviate from their planned route. This practice is carried out along the same, predefined, learned routes. All communication partners confirmed that their current walking route results from evolution and previous experience with other alternatives. The current route gives attributes such as most efficient, most pleasant, shortest, and only possible. Adéla stressed that "the important factor is the time". In addition to spatial characteristics, temporal consistency was also found. For the individuals interviewed, a consistent time of day of departure is typical. However, there were variations in arrival and departure times among the individuals studied. Adéla departs home as early as 6:30 AM and returns at 3:00 PM, while Tomáš heads home after 5:30 PM. These findings align with the temporal fragmentation of commuting (see Gorný, 2024).

The category of pragmatic commuting includes walking the entire journey. From the semi-structured interviews, it can be concluded that this type of active commuting is chosen as a mode of transport when individuals need to travel from home to work on a route that is not covered by public transport and where using public transport would result in increased travel time or a detour. This study validates previous research findings on the impact of environment on walking characteristics, albeit in a marginally distinct context:

"If I was to take the tram from Zoologická to Svratecká (...) It takes 5 minutes to get to the next stop and 3 minutes to wait for the tram. So that would take 8 minutes, then the tram ride would

take 4 minutes. The journey to the office would take 16 minutes compared to 20 minutes on foot. The difference is too small. I rather walk.” (Martin)

5.1.2 Efficient destination cycling

Another spatio-temporal practice that falls under the category of pragmatic active commuting is ‘destination cycling’. This practice can be characterised as a quick and straightforward commute, similar to walking, but over longer distances. In this study, communication partners, such as Aneta, Hana, Miroslav, Luboš and Radoslav, implement this particular type of commuting behaviour in the morning as they travel to their place of work. The rationale provided is that there is no compelling reason for them to extend the journey; they simply commute to their place of work:

“When I started, I used to ride along the river because that route is nicer, but when you go to work, it’s a few extra kilometres. So if you can go that way, if you’re coming from work and want to go for a ride, you can go any way you want, but I take the shortest route for the vast majority of my morning rides.” (Luboš)

Pragmatic active commutes can thus be characterised by the following spatio-temporal patterns: place of home → place of work and place of work → place of home.

5.2 Physical active commuting

An additional category of active commuting may be defined as physical active commuting, whereby the journey to work is undertaken with the intention of engaging in sporting activity. This type of commuting involves spatio-temporal practices such as ‘after-work cycling’ and ‘run-commuting’.

5.2.1 After-work cycling

The rationale behind the delineation of after-work cycling is that the journey from the workplace often comprises a longer period of travel than is necessary. Communication partners who realise this spatio-temporal practice mentioned the longest trip durations in the context of journeys that are part of commuting. Some active commuters take their journeys from work as an opportunity for sport and physical exercise for the body. The aim of such motivated individuals is to implement the longest routes possible, depending on the time available to them. For instance, according to Hana and Aneta, such a journey takes them more than 5–6 hours in the longest cases. These findings are in contradiction with the pragmatic active commuting discussed above:

“If possible, I take a longer route through Adamov, Kuřim, or other villages near Brno (...) It takes around 4 hours. So I leave the faculty at 3:00 PM and return at 8:00 or 9:00 PM. However, this requires extra time. So this year, I only did it for 2–3 hours, covering a distance of maybe 30–40 km.” (Hana)

However, the length of the journey is affected by the season, with the biggest factor being the length of daylight. During winter, when daylight hours are shorter, communication partners reported shorter journeys compared to summer. In a semi-structured interview, Aneta stated that she rides up to 15 different routes. Similar commuting behaviour with multiple route options was mentioned by Radoslav, Miroslav, Otakar, Luboš, Hana, David and Daniel. Especially Daniel exhibits remarkable spatio-temporal behaviour. Despite living only a few minutes away from work, he drives along the surrounding streets on his way home to get some exercise. The time it takes is indifferent to him:

“I can actually go back and forth between Antonínská–Semilasso [tram stations] with the fact that my favourite section in Brno is Slovanské náměstí – it’s the biggest roundabout in Brno and I can do as many circuits as I want.” (Daniel)

The findings from this research are in line with Hansen and Nielsen (2014), who concluded that the main motive for commuting

a long distance on a bicycle is physical exercise and stress relief. These reasons were repeated across the interviews we conducted. At the same time, all communication partners who implemented this spatio-temporal pattern expressed a positive attitude towards cycling, even in their free time. Chen and Chen (2013) and Heesch et al. (2015) found that individuals who cycle for leisure prefer cycling routes with attractions along the way, whereas those who cycle for transportation choose the shortest route. Our research has shown that there is a hybrid, i.e. individuals who behave as if they are cycling for leisure when travelling from work to home.

5.2.2 Run-commuting

A further spatio-temporal pattern that has been documented in our study is the phenomenon of running to or from the workplace. This process has previously been designated as ‘run commuting’ (Cook, 2021). In our research, running to or from work concerns Lucie, Radim and Markéta. Amongst these communication partners, the shared element of the ‘run-commuting’ practice is the running of routes with the specific goal of achieving a certain level of athletic performance. Lucie is engaged in a training regimen for a half marathon, which results in a variable running routine on a daily basis. The duration, velocity, and terrain of her runs, as well as the routes she traverses, exhibit considerable variation. On some days, she runs a basic route without timing, simply for the pleasure of the activity. On other days, she attempts to run the same route at a specific time. On occasion, she stops at the athletic stadium to engage in interval training. Markéta also referenced comparable spatio-temporal behaviour, noting that, as part of her training regimen, she occasionally diverges from her established route to incorporate hilly terrain:

“On Monday, I run the core route; on Tuesday and Thursday, I take it as training, so on Tuesday, I run through the athletics stadium and on Thursday, I run circles in Lužánky Park.” (Lucie)

While Lucie and Markéta run only in the direction from work to home, Radim runs only to work. This is a consequence of the other activities and responsibilities that they undertake, for example, Radim is required to spend the afternoon with his son. However, their statements agree that incorporating running into their daily commute enables the integration of two activities into one and thus affords them more leisure time after they get home from work. The statements of the communication partners also demonstrate that run-commuting is not a daily occurrence. Lucie runs once a week, Radim and Markéta three times a week, with all of them emphasising the significance of rest days.

To sum up, using the example of run-commuting practices, we can thus confirm the results of Larsen (2018), indicating that commuting can be an effective form of training. In such circumstances, the route taken by communication partners between their place of employment and their place of work is not the shortest available option. Rather, it is extended for a number of reasons, which is the essence of physical active commuting.

5.3 Combined active commuting

In addition to the pragmatic and physical active commuting, the statements of communication partners also suggest the existence of another form of active commuting, which may be referred to as combined active commuting. From the semi-structured interviews, three basic spatio-temporal patterns have been identified in the context of combined active commuting. The first spatio-temporal practice represents simple combined commuting, the second includes walking between two journeys made by public transport during commuting from work, which has been labelled as ‘in-between walking on the journey home’. The third spatio-temporal practice that arose from the semi-structured interviews has been denoted as ‘walking errands before getting on public transport’.

5.3.1 Simple combined commuting

Simple commuting refers to commuting behaviour characterised by walking to a public transport stop without making any stops, then taking transport and walking again to the destination without making any stops. This spatio-temporal practice is carried out with varying frequency by all communication partners who stated that they sometimes use public transport when travelling. This spatial practice was observed both on the way to work and on the way home.

5.3.2 In-between walking

In-between walking is a characteristic feature of Kamila and Eliška's commute. It should be noted that this walking errand is not a regular daily journey for these communication partners. A characteristic feature of this walking segment is its irregularity within the week. Eliška implements this type of walking into her commuting twice a week. Moreover, she states that the form of such walking has several variations, with the main distinction being in its length. Even for Kamila, this spatio-temporal behaviour is not an everyday occurrence. Semi-structured interviews indicate that in-between walking is performed due to the necessity of arranging or purchasing something. Frequent stops on this journey include shops, mail-order houses, restaurants, and offices. Thus, one form of spatio-temporal pattern typical for combined active commuting can be described as follows: being at work → riding public transport → in-between-walking → riding public transport → walking home.

5.3.3 Walking errands before getting on public transport

The second spatio-temporal pattern can be denoted as “walking errands before getting on public transport”. It has been found that some communication partners carry out walking errands during the first segment of the journey home from work, which means immediately when they get off work. This spatio-temporal pattern, mentioned by Kamila, Jan, Pavel and Robert, is also characterised by irregularity and does not occur daily. For Jan, this walking journey, in combination with time in the shop, takes one to two hours, which means he usually arrives home between 6 and 7 PM. Pavel adjusts his work schedule accordingly. If he needs to run errands in town, he finishes work early to catch the next bus. However, if he has plans to do an activity with friends later in the day, he stays at work longer and this pattern is then observed in the later hours. The responses of the communication partners showed that during the final segment of the journey, i.e. from the last public transport stop towards home, none of the communication partners mentioned any stops; the aim is always to get home as quickly as possible, which is in line with the results of the questionnaire survey. Thus, the second significant observed spatio-temporal pattern of this type of active commuting takes the form of being at work → walking in the city → riding public transport → walking home.

The two spatio-temporal patterns are linked to a common element – the variability in the selection of public transport stops. In relation to commuting from work, it was observed that communication partners do not arrive at the same public transport stop after their walking errands. Individuals mentioned various options for continuing their journey home and pointed to the option of choosing the public transport stops they needed to reach. Therefore, the length of these walking errands and their positioning in space can vary greatly:

“But if I want to go to another shop, I take a different bus to a different station, and there I walk a little bit; I don't take the 12 anymore, but I go straight to the 4 to the main station.” (Eliška)

5.4 Common features of pragmatic and physical active commuting

Although the various forms of active commuting differ from each other, some similarities can be found between pragmatic and physical active commuting. These two types of commuting

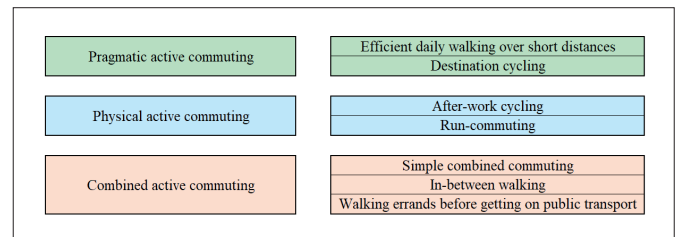


Fig. 3: Types of active commuting (left) and its corresponding spatio-temporal practices (right)

Source: Author's conceptualisation

are characterised by seasonal rhythm. Using the example of communication partners, it can be noted that Tereza and Jakub, who typically walk the entire route to work, alter their mode of transportation during the winter period due to the darkness because of passing their route through unilluminated areas. Jakub does not want to walk through the fields and forests on the outskirts of the town. Tereza avoids poorly lit corners near her place of work. Both of them replace walking with utilising public transport:

“During winter, I like taking the tram because there is less daylight. On Videňská Street, there is a square where some people with drug addiction can be found. It's not recommended to go there alone, especially in the early evening when there are no lights.” (Tereza)

The connection between the environment and weather is another crucial aspect that demands attention. Communication partners have a tendency to refrain from walking the entire journey due to muddy terrain caused by rainy weather. This is an example of Jakub's situation, who walks on partially unpaved roads when commuting to work and resorts to public transportation in rainy weather. On the contrary, in the case of combined active commuting, communication partners were unable to express any seasonal rhythm.

6. Discussion

This research pointed out that transport planners should take into consideration the existence of more forms of active commuting, which vary in terms of the implementation of different spatio-temporal practices by individuals. In other words, it differs in temporal and spatial features of the journeys to and from work. On the one hand, some forms of active commuting involve simple and straightforward movement, while on the other hand, some forms of active commuting involve intentionally prolonging journeys (Fig. 4). With regard to these results, this study contributes to the aforementioned existing literature by demonstrating that active commuting encompasses more than merely 'short-distance commuting'. Spatio-temporal practices that typify physical active commuting are defined by longer journeys. It can be concluded that they are comparable in length to car journeys (e.g. Schwanen et al., 2003). These journeys are intentionally extended, with typical durations exceeding 30 minutes, regardless of whether they are undertaken on a bicycle or in the form of a run. In exceptional cases, the duration of physical active commuting in the form of after-work cycling or run-commuting may extend to an hour or more. Both individuals who use bicycles and those who run to work extend their commuting journey due to the efficiency gained from combining transportation and physical activity into a one-time slot. For cyclists, an increase in time was observed solely on the return journey from work. In contrast, for runners, the increase was noted on both the outward and return journeys.

From a spatial perspective, the journeys made from workplaces are more diverse than those made to workplaces. In a significant number of cases, the route taken from the workplace does not coincide with the route taken on the previous journey, nor is it the

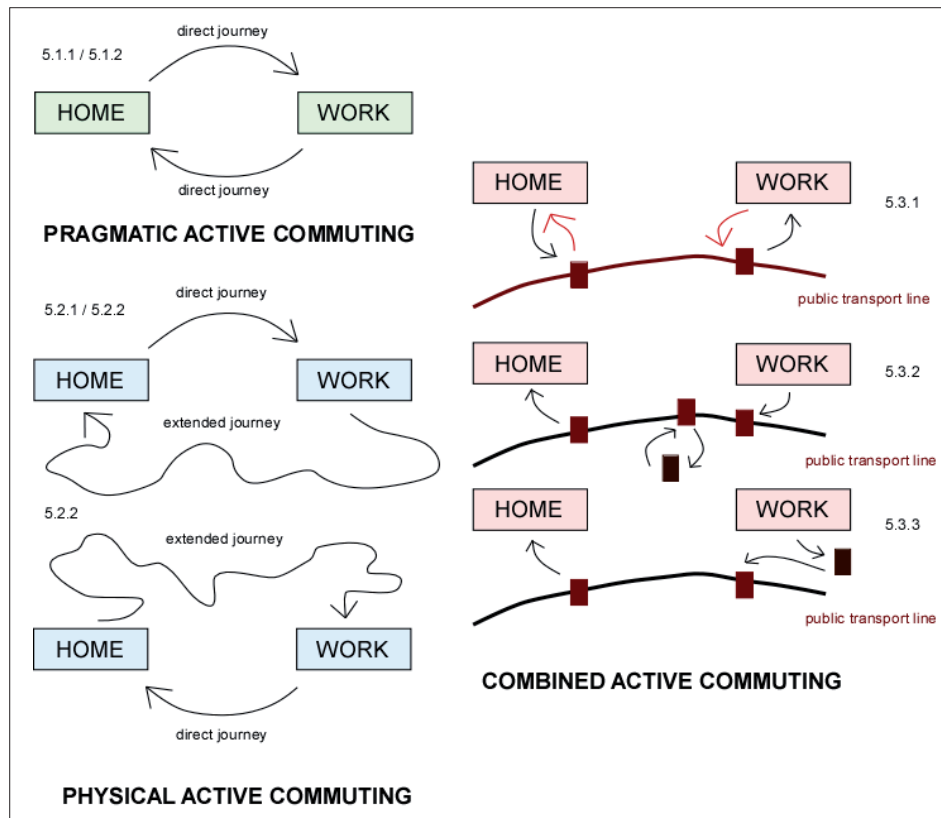


Fig. 4: Visualisation of observed spatio-temporal practices
Source: Author's conceptualisation

same route in the morning. It should be noted, however, that in the physically active commuting category, a higher proportion of respondents implemented a variety of options in their journeys.

Consistent with previous research (Humpel et al., 2002; Lee & Moudon, 2004), it has been confirmed that paying attention to accessibility, in this case, accessibility to work, is crucial. The efficiency of the journey taken from home to work determines whether one decides to walk or bike to work. The accessibility also refers to the accessibility of public transport stations and the overall efficiency of the public transport system in the city. An important supporting factor is the speed of travel compared to alternative transport options. Thus, the time efficiency of each mode of transport must be considered. If walking (or cycling) the entire journey is more time-efficient than combining walking with public transport, the individual would rather walk the whole journey. Our results are in line with Rietveld (2000), which emphasises the greater potential for the use of non-motorised modes where competing modes of transportation are slower. In this regard, the impact of land use on active commuting, or more broadly on the selection of transportation modes, is evident. Prior research has demonstrated the influence of density, diversity and design on travel demand (Cervero & Kockelman, 1997). Subsequent research has extended this to encompass destination accessibility and distance to transit (Ewing & Cervero, 2010). Badland and Schofield (2005) highlighted the existence of positive correlations between physical activity levels and mixed land use, density, and street connectivity. Based on the interviews, it is evident that street connectivity, destination accessibility, and distance to transit should be given particular emphasis to increase active commuting. Consequently, the priority for policy implementation should be the construction of convenient and safe sidewalks and bicycle paths that effectively connect residential areas of cities to employment locations.

The integration of active commuting into the city's intermodal transportation system appears to be a complex issue as there was

observed a contradictory relationship between types of active commuting and public transport. While walking is combined with public transport in a single journey, the same cannot be said for cycling and running to work. Although Kosmidis and Müller-Eie (2024) demonstrated that the bike-transit combination is used as a mode of transportation in countries such as the Netherlands and China, our research came up with different results. We found that when individuals choose to cycle to work, they cycle the entire journey. This finding is, on the contrary, consistent with Kaplan et al. (2016). The main reason lies in the inefficiency of a journey that would be made partly by bicycle and partly by public transport. The same incompatibility with public transport applies to the use of private bicycles, and also to the use of shared bicycles (van Marsbergen et al., 2022). It should be added that in the case of the Brno Metropolitan Area, 'public transport' means mainly using tram, bus and trolleybus. Research conducted by Martens (2004) found that faster modes of public transport, such as trains, are more closely linked to the cycle-transport mix. Therefore, results from individual regions can vary quite significantly.

However, our research has shown that some individuals integrate walking with public transport during the same journey, as well as alternating between walking and public transport on different days. Combining walking with public transport is also important for those who prefer to walk the entire journey, e.g. in case of bad weather, important meetings, or time pressure, and also for runners who only run one way. Therefore, the other priority for policy implementation should be ensuring efficient public transport.

We agree with Scheurenbrand et al. (2018) that policy interventions need to take a holistic, practice-based approach that addresses the alignment of materials, competencies, and meanings across the bundle of related practices. While intervention in material elements (e.g. investment in infrastructure) is necessary, it is also crucial to consider changing cultural meanings and social

norms (Watson, 2012). Besides public institutions, it is also an incentive for the private sector and companies, e.g. to encourage more sporting challenges in commuting. However, as Cass and Faulconbridge (2016) have observed, it is necessary to consider the broader social structures that shape these activities, including the location of shops, health centres, and the increasingly complex spatio-temporal patterns of youth leisure activities, as these activities are also sequenced with commuting.

7. Conclusions

Active commuting encompasses different modes of transportation. This research focused in detail on spatio-temporal practices of active commuting as an important aspect of sustainable urban mobility. The study revealed the significance of distinguishing between three types of active commuting: pragmatic active, physical active and combined active commuting. Each type has unique characteristics and spatio-temporal practices that should be considered.

Combined active commuting is characterised by shortest distances and year-round implementation. The journey to work is generally direct, with more frequent stops on the journey home. Typical spatio-temporal practices include ‘simple combined commuting’, ‘in-between-walking’ and ‘walking errands before getting on transport’. It can also be described by the commuting patterns taking the forms of being at work → walking in the city → riding public transport → walking home and being at work → riding public transport → in-between-walking → riding public transport → walking home. Timing to public transport departures is a particular feature used by half of the respondents. Pragmatic active commuting represents straightforward, short, uncomplicated and direct journeys in order to get from point A to point B, as maximum time efficiency and effectiveness are the main decision-making variables for the commute. Within pragmatic active commuting, spatio-temporal practices named ‘efficient walking over short distances’ and ‘destination cycling’ have been observed. In other words, this type of active commuting characterises commuting patterns taking the forms of place of home → place of work and place of work → place of home. Physical active commuting is represented by longer journeys, which are motivated by the implementation of sports activity into the commute. Our analysis identified two spatio-temporal practices that were particularly prevalent within physical active commuting: ‘after-work cycling’ and ‘run-commuting’. These practices exhibit considerable variation, which gives rise to a range of spatial movements on a daily basis. As with pragmatic active commuting, it is typical of physical active commuting for there to be seasonal patterns with a peak in the summer months. It is important to note that the observed commuting practices are highly context-specific. This research presents results from the Brno Metropolitan Area. It does not preclude the existence of other practices that may coexist within these three types of active commuting, and which did not occur in this area due to infrastructural, cultural or other differences.

All of these types of active commuting can be categorised as a form of sustainable urban mobility. To enhance its relevance, measures should be taken to facilitate the implementation of these three forms of active transportation. Further research should focus on opportunities to use other active commuting alternatives, such as scooters and shared bikes, and assess the differences that may arise within the metropolitan area or smaller cities. At the same time, the issue of run-commuting, which represents a relatively under-researched area within the field of active commuting, is deserving of further attention. Support for urban running infrastructure is dependent on accurate data on commuting intensity and the spatio-temporal behaviour of runners.

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