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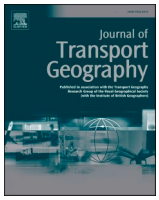

Critical review

Intra-household decisions and the impact of the built environment on activity-travel behavior: A review of the literature

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ABSTRACT

Featuring the most direct and closest social relationships, the household plays a crucial role in influencing an individual's wants, needs, and behavior. However, the role of intra-household decisions in the connection between the built environment and activity-travel behavior has not been systematically analyzed. This paper adds to the literature by: (1) proposing a conceptual framework explaining how intra-household decisions are related to activity-travel behavior, the built environment, and attitudes; (2) synthesizing the current literature on this topic; and (3) identifying gaps in the literature and suggesting avenues for future research. In particular, we focus on the relationships between intra-household decisions and (changes in) travel attitudes, residential self-selection, and residential dissonance. Based on the results of the literature review, we found that very few studies have explored the extent to which the residential built environment meets and satisfies the travel needs and preferences of different household members, and how these contribute to different activity-travel behaviors. As attitudes may vary over time, capturing changes in attitudes and activity-travel behavior of different members of a household during and after residential relocation is recommended for future research to understand the role of intra-household decisions in the relationship between attitudes, built environment, and activity-travel behavior.

1. Introduction

Most activity and travel behavior studies consider the individual as the unit of analysis. However, individual activity-travel behavior may also be the result of a group decision, especially within a household. Most people live in a multiple-member household in most stages of life, and household members tend to jointly schedule and distribute various activities among each other (Bhat and Pendyala, 2005; Ho and Mulley, 2015b; Kroesen, 2014). In addition, residential location decisions, which have an important impact on travel behavior, are taken at the household level. This suggests that the factors that impact individual activity-travel behavior are related to intra-household decisions—an outcome of the joint decisions of multiple household members. We define intra-household activity-travel decisions as all decisions on location and activity choices and travel behavior made at the household level.

However, the impact of intra-household decisions has been largely overlooked in studies on the relationship between the built environment and travel behavior. Here, built environment refers to the human-made environment such as the land use and transportation systems where people carry out daily activities (Frank et al., 2003; Handy et al., 2002). The classic Five Ds—density, diversity, design, distance to transit, and destination accessibility—have been used to measure the built environment (Cervero and Kockelman, 1997; Ewing and Cervero, 2010). It has been widely acknowledged that residents in neighborhoods with higher density, more mixed land uses, and shorter distances to public transport drive less and tend to walk, cycle, and use public transport more frequently (Ewing and Cervero, 2001, 2010). However, as household members share the same residential location, but are under different spatial and temporal constraints (Ho and Mulley, 2015b), they may be differently affected by the built environment.

An indirect way in which the built environment influences travel is through residential self-selection which is the "tendency of people to choose locations based on their travel abilities, needs, and preferences" (Litman, 2005, p. 5). Residential self-selection occurs when individuals with certain attitudes self-select their preferred residential built environment so that they can use their preferred travel mode more frequently (Kitamura et al., 1997; Næss, 2009; Van Wee, 2009). This suggests that part of a built environment's impact on travel may arise

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from attitude-induced self-selection. Hence, such self-selection should be controlled for, otherwise the impact of the built environment may be overestimated (Mokhtarian and Cao, 2008). However, an underestimation is also possible, especially if the built environment leads to changes in attitude (Kroesen et al., 2017). Moreover, the impact of the built environment on travel behavior through residential self-selection has mostly been investigated at the individual level despite the fact that decisions about where to live and how to allocate household tasks and resources are made at the household level. In particular, in a multiple-member household where members have different attitudes but share the same neighborhood environment, residential location decisions may suggest different degrees of residential self-selection for different members.

Since the 1980s, intra-household travel behavior has received increasing interest, leading to one literature review paper (Ho and Mulley, 2015b) and three special issues: two in the journal "Transportation" (Auld and Zhang, 2013; Bhat and Pendyala, 2005) and one in the journal "Transportation Research Part B" (Timmermans and Zhang, 2009). The accumulated literature has, however, hardly addressed the importance of intra-household decisions related to the impact of the built environment on travel behavior and even less in the context of residential self-selection.

This review aims to connect intra-household travel research and the impact of the built environment on travel behavior by departing from an a priori conceptual framework. In particular, we focus on how intra-household decisions are made regarding residential location choice and activity and travel behavior, in the context of individual travel attitudes. Some important issues such as residential self-selection, residential dissonance, and changing attitudes are discussed at the household level. Consequently, this paper adds to the literature by: (1) proposing a conceptual framework explaining how intra-household decisions are related to activity-travel behavior, the built environment, and attitudes; (2) synthesizing the current literature on this topic; and (3) identifying gaps in the literature and suggesting avenues for future research.

The rest of this paper is organized as follows. Section 2 presents the key concepts that are relevant to this study while Section 3 describes the literature search strategy and gives an overview of the papers used for the literature review. Section 4 then summarizes the empirical findings, identifies gaps, and proposes avenues for future research based on an a priori conceptual framework. Finally, Section 5 presents some concluding remarks.

2. Key concepts

2.1. Intra-household decisions

Intra-household decisions refer to household members communicating with or reacting to each other regarding outcomes or values that affect them all. In our review, intra-household decisions include: (1) joint structural decisions, for example, important decisions about location, such as those regarding residential, work or school locations (Guan and Wang, 2019b; Ho and Mulley, 2015b; Zhang and Fujiwara, 2009); (2) car ownership and the allocation of household resources (e.g., cars), tasks and activities (Ettema and van der Lippe, 2009; Roorda et al., 2009; Schwanen et al., 2007); and finally (3) the transfer of norms from one household member to another which influences travel attitudes and behavior (Barnett et al., 2013; Mao and Wang, 2020; Reid et al., 2010). As these three aspects are somewhat broad, we mainly focus on their links to activity-travel behavior. Here, activity behavior refers to various kinds of activities that people carry out at different places such as working, childcare, and leisure activities. For travel behavior, we mainly focus on mode choice for various trips.

2.2. Attitudes, built environment and travel behavior

2.2.1. Residential consonance and dissonance

Residential self-selection assumes a consonance between the actual residential location and the preferred residential location based on travel attitudes (i.e., residential consonance). However, there may be a mismatch between travel attitudes and actual residential built environment, which is defined as residential dissonance. For instance, people who like driving a car but actually reside in a high-density urban area are considered to be residential dissonants. Residential dissonance arises from the complicated process of the residential location decision. People cannot always fulfill their wants and needs regarding their residential location due to constraints, such as the availability of properties in the housing market, housing prices, and personal finances (Guan et al., 2020; Van Wee and Cao, 2020). Nevertheless, even without such constraints, people might have other considerations—such as the aesthetics of available housing or neighborhood safety—so attitudes might not be prioritized in the final location decision (Ettema and Nieuwenhuis, 2017; Næss, 2009). In addition, a change in attitudes can also result in residential dissonance (De Vos et al., 2012), for instance, when urban residents develop a preference for car use. Such attitude changes may be triggered by a life event, such as childbirth. Moreover, a changing built environment with unchanged attitudes may also contribute to such dissonance.

While accessibility is likely a better concept than the built environment to explore the relationships between activity-travel patterns and location, it is comprised of more than land use and the transport system (Geurs and Van Wee, 2004), which may further complicate the links of the framework we propose. We use the concept of "built environment" in this paper—classified into "urban" and "suburban/rural" areas—to facilitate understanding. Furthermore, the concept can be interpreted as "built environment/accessibility" where accessibility is limited to the land use and transport system, excluding the individual and temporal component as addressed by Geurs and Van Wee (2004). It is assumed that urban areas tend to be high-density with mixed land uses, and suitable for walking, cycling, and public transport use while suburban/rural areas are low-density and feature wider roads suitable for car use. Based on one's travel preference and actual residential location, consonance and dissonance between attitudes and built environment could emerge as indicated in Table 1.

2.2.2. Changing attitudes

People with certain attitudes can self-select themselves into their preferred built environment but can also change attitudes when influenced by the built environment. In fact, several recent studies have shown that residents can adjust their attitudes due to exposure to a new environment (De Vos et al., 2018; Wang and Lin, 2019). Such attitude changes can result from cognitive, behavioral, and affective processes (Van Wee et al., 2019). Cognitive processes suggest that people gain new knowledge about the built environment, and therefore renew cognition and change attitudes. The behavioral process implies that a change in the built environment may result in a change in behavior, which in turn leads to a change in attitudes. These attitude changes may arise because people tend to align their attitudes with their behavior to reduce

Table 1
Consonance and dissonance.

	Pro-urban[1]	Pro-suburban/rural[2]
Urban area	Urban consonant	Urban dissonant
Suburban/rural area	Suburban/rural dissonant	Suburban/rural consonant

[1] Pro-urban refers to a preference for an urban lifestyle in a high-density environment with compact land use and a preference for walking, cycling, and public transport use.

[2] Pro-suburban/rural refers to a preference for a suburban/rural lifestyle in a low-density environment and a preference for car use.

cognitive dissonance (Festinger, 1957; Heider, 1982; see also Section 4.3). The affective process implies that travel in a favorable environment leads to positive emotions and high satisfaction, which enhances positive attitudes towards that built environment and travel mode. In addition, attitudes can change for other reasons, such as the influence of other people and the social environment.

3. Literature review

3.1. Search strategy

We used the Scopus database with search strings within the title[1] including "household" AND "travel" (OR "commuting" OR "commute" OR "activity" OR "activities" OR "allocation" OR "self-selection" OR "interaction"); source type was set as "Journal" while the subject area was restricted to "Social Science" which includes the following relevant sub-fields: "Geography, Planning, and Development," "Transportation," "Gender Studies" and "Urban Studies." The search, conducted on 15 August 2022, resulted in 634 publications.

We screened papers in the following three steps (Fig. 1): (1) non-English language studies and papers unrelated to residential location decision, activity participation, and travel behavior were excluded; (2) studies that did not involve intra-household decisions, intra-household travel studies without empirical findings, and other papers unrelated to the topic of this research were excluded; and (3) based on this, we used both backward and forward snowballing methods to replenish the original database. As we focus on empirical findings, editorials and literature reviews were excluded before forming the final dataset.

3.2. Results

After screening, 87 papers were kept for the literature review (Appendix 1). Studies covered a range of themes and focused on intra-household transport research. Most concentrated on two topics: 1) car use and allocation in the household; and 2) activity distribution among household members. A few studies focused on the residential location decision, which is another important aspect of intra-household decisions. However, some research implicitly explored the residential location choice through a comparative analysis of commute distance differences between partners. About half of the studies included the built environment in the analysis, while only eight studies included travel attitudes in the analysis.

4. Conceptual framework for the role of intra-household decisions: The impact of the built environment on activity-travel behavior

The literature acquired in Section 3 was analyzed based on an a priori conceptual framework (Fig. 2). It extends the relationships between the built environment, travel attitudes, and activity-travel behavior from the individual level to the household level by including intra-household decisions. The proposed conceptual framework describes how intra-household decisions play a role in two relationships: (1) the connection between the built environment and travel attitudes, which includes self-selection, residential dissonance, and changing attitudes; and (2) the impact of the built environment on activity and travel behavior. For intra-household decisions, we focus on the three aspects defined in Section 2.1 (i.e., joint structural decisions, transfer of norms, and allocation decisions). Based on the proposed conceptual framework, we summarize empirical findings to identify gaps and propose avenues for future research. However, as very limited literature explicitly explores the role of intra-household decisions in the relationship between the built environment and travel attitudes as well as the impact of the built environment on travel behavior, we did not make categories for "Empirical evidence" and "Discussion and research suggestions" in Sections 4.4 and 4.5. Relevant findings that explicitly or implicitly addressed the arrows in the conceptual framework are listed in Appendix 1.

4.1. Relationship between intra-household decisions and the built environment

4.1.1. Empirical evidence

Important location decisions such as the residential, work, and school locations as well as holiday destinations are important household decisions wherein household members negotiate to reach a consensus (Arrow 1a). Among these, residential location decisions, as one of the most important joint structural decisions within households, are widely explored. The role of intra-household decisions in residential location choice has been explored by Timmermans and colleagues since the 1990s (Borgers and Timmermans, 1993; Timmermans et al., 1992); they found that household members' opinions weigh differently in their joint residential location decision regarding housing and transport facilities. Using data from a stated preference survey of couples in Hiroshima (Japan), Zhang and Fujiwara (2009) found that, in different types of built environment, wives held less decision-making power than husbands in terms of residential location.

The residential built environment influences the allocation of out-of-home household tasks and activities (Arrow 1b). Schwanen et al. (2007) found that in areas with higher population densities, male partners participated in more grocery shopping than female partners. It has also been found that land use and access to destinations (e.g., shops and workplaces) do not have much impact on the allocation of in-home household tasks and activities (Ettema and van der Lippe, 2009; Schwanen et al., 2007). Regarding household vehicles, the workplace built environment plays a key role in explaining car allocation within a household (Arrow 1b). In dual-earner households with only one vehicle for example, Maat and Timmermans (2009) found that the partner with the longest commute distance and the lowest work location density[2] is usually allocated the car. Similar results were also found in Hu et al. (2022) with a focus on commute behavior in a small Chinese city, where partners within dual-earner households tended to commute by car if the workplace was located far from the city center. Moreover, residential location also influences car use among household members (Anggraini et al., 2012; Kroesen, 2015). Yang et al. (2019) found that in China, the residential built environment does not influence the car travel behavior of the household head (i.e., the head of a household as named in the household registration book), but does have an impact on car travel behavior of other household members.

4.1.2. Discussion and research suggestions

Regarding household-level decisions, the literature we reviewed mainly focused on the residential location decision; limited attention has been paid to the decisions regarding other locations, such as work and school locations, or household holiday destinations. As these location decisions may also involve intra-household interaction, more attention is required in future research. Many intra-household transport studies include work locations together with residential locations in the analysis, but in a format of commuter distances/times (i.e., travel distances/times between residence and workplace) (e.g., Chidambaram and Scheiner, 2020; Clark et al., 2003; Deding et al., 2009; Guo et al., 2020; Hjorthol and Vågane, 2014; Jun and Kwon, 2015; Korsu, 2012; Lee et al., 2022; Mok, 2007; Picard et al., 2013; Plaut, 2006; Sermons and

[1] When we expanded the search strings to the abstract, title, and keywords, Scopus provided thousands of results. Hence, we kept the scope of search strings restricted to the title of the paper.

[2] Density refers to urban density, a composite of density regarding housing, jobs, and retail floor space.

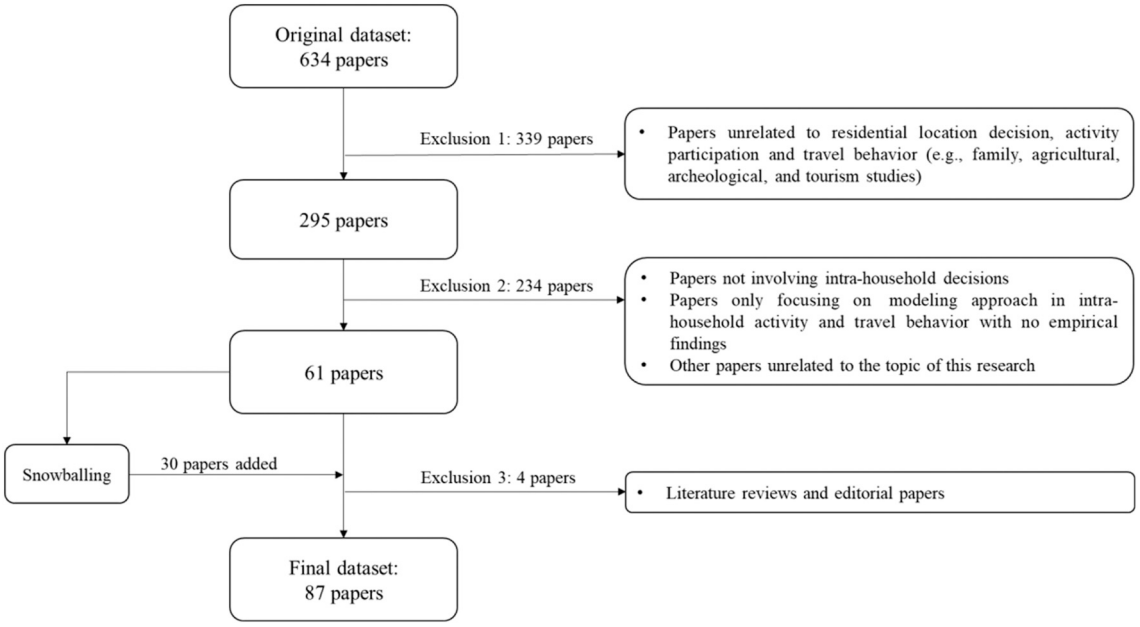

Fig. 1. Literature screening method.

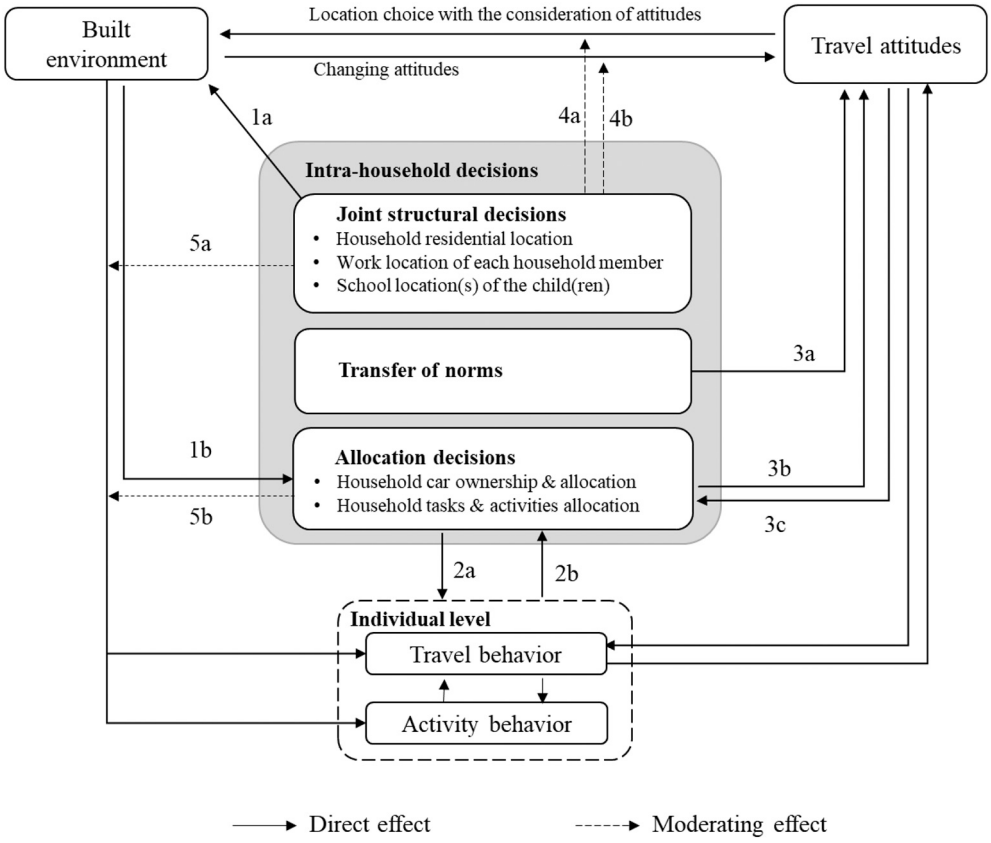

Fig. 2. A conceptual framework for dominant relationships between intra-household decisions, built environment, activity-travel behavior, and travel attitudes.

Koppelman, 2001; Singell and Lillydahl, 1986; Sultana, 2005; Surprenant-Legault et al., 2013; Wheatley, 2014); almost all found that female partners tend to commute shorter distances and times than male partners. However, except for a study by Jun and Kwon (2015), little is known about how different household members make decisions about the residential location and various work locations in coherence across geographical space. In particular, some low-income households may choose a location far from the workplace of one household member due to lower housing prices; this results in longer commute distances for that household member (Cassel et al., 2013; Zhao et al., 2020). In this situation, the other household member may choose to work closer to their residence to better organize various household maintenance activities. It is very interesting to explore how household member decisions on where to live and work are related to time use patterns, working status, wages,

and workplace accessibility by different travel modes.

In addition, Information and Communication Technology (ICT), especially telecommuting/telework, may relate to residential and work location choices. Working from home saves commuting time and costs, and is popular among residents who live far from their workplace (Kim et al., 2012; Mokhtarian et al., 2004). Because of the increased popularity of teleworking fueled by the Covid-19 pandemic, some households may move further away from work. However residential choice depends on many factors, such as housing prices, neighborhood characteristics, and access to non-work destinations such as schools (Clark and Huang, 2003; Van Ham and Clark, 2009). Consequently, the long-term effects of more teleworking on residential choice (and activity-travel patterns) are not thoroughly understood, and thus are an interesting avenue for future research.

Also, car allocation among household members is not fixed and is associated with the travel needs and built environment at user destinations. For instance, a non-frequent car user could occasionally use the household car if a place is not easily accessible by public transport or active travel modes. However, the flexibility of household car allocation has not been sufficiently analyzed. Based on the household car allocation pattern, household member car use can be classified into one of four types: (1) monomodal (a car is used for all trips); (2) multimodal (multiple travel modes are used but a car is the main travel mode); (3) occasional (a car is used occasionally for travel); and (4) non-car (a car is never used). It would be interesting to explore how the household car allocation pattern is related to the built environment around key activity locations.

4.2. Relationship between intra-household decisions and activity-travel behavior

Here, we reviewed papers that focused on how household members made decisions on task and car allocation, leading to different individual activity and travel behaviors (Arrow 2a). In turn, the household allocation decision is influenced by household members' preferred activity-travel patterns (Arrow 2b).

4.2.1. Empirical evidence

Obviously, car allocation influences one's travel behavior (Arrow 2a). How a car is allocated among household members has been widely investigated in previous studies (e.g., Roorda et al., 2009; Wen and Koppelman, 2000; Zhang et al., 2009). Many household studies have shown that, compared to male partners, female partners are less likely to use the car (Anggraini et al., 2008, 2012; Surprenant-Legault et al., 2013). Nonetheless, Habib (2014) found that female partners drive to work more than male partners in one-car households where both partners are licensed drivers. Also, the same socio-demographic attributes exert different impacts among different household members (Scheiner, 2020; Scheiner and Holz-Rau, 2012a, 2012b). Using data from the German Mobility Panel, Scheiner and Holz-Rau (2012b) found that, in households where men and women hold higher levels of education, men are more likely to drive than women. In the same study, the presence of young children in the household increases women's car use but decreases men's; this may be because women are more likely to use a car for various childcare activities, which reduces car availability for men if a car is not always available for each driver within households. In addition, household members may travel together by car. Weiss and Habib (2020) found that car-deficient households are more likely to travel together than car-sufficient households.

The relationship between task allocation and activity and travel patterns (Arrows 2a and 2b) is addressed in many studies (e.g., Bernardo et al., 2015; Golob and McNally, 1997; Kim and Parent, 2016; Kim et al., 2015; Liu et al., 2018; Sarangi and Manoj, 2021; Scott and Kanaroglou, 2002; Smart et al., 2017; Solá, 2016; Srinivasan and Athuru, 2005; Srinivasan and Bhat, 2005; Vovsha et al., 2004a, 2004b; Wang and Li, 2009; Yao et al., 2017, 2020; Yoon and Goulias, 2010; Zhang and Fujiwara, 2006; Zhang et al., 2002; Zhang et al., 2005). Within a household, females tend to carry out more maintenance responsibilities than males (Cao and Chai, 2007; Srinivasan and Bhat, 2005). In addition, the socioeconomic attributes of household members (e.g., age, level of education, income, and presence of children) influence the allocation of household tasks and activities (Cao and Chai, 2007; Chakrabarti and Joh, 2019). In the Chinese context, some studies found that hiring domestic helpers (Wang and Li, 2009) or living with the wife's mother (Feng et al., 2020) significantly changes the household task allocation pattern.

Moreover, household members tend to schedule joint activities and trips (e.g., Bradley and Vovsha, 2005; Chu, 2022; Fujii et al., 1999; Gliebe and Koppelman, 2002, 2005; Gupta and Vovsha, 2013; Kalter and Geurs, 2016; Kang and Scott, 2011; Kato and Matsumoto, 2009; Lai et al., 2019; Liu et al., 2022; Lu et al., 2022; Mosa and Esawey, 2013; Srinivasan and Bhat, 2006, 2008; Vovsha et al., 2003), and these mainly include joint leisure activities and escorting children to school (Han et al., 2019; Hsu and Saphores, 2014; Vovsha and Petersen, 2005; Yarlagadda and Srinivasan, 2008). The existence of joint activities among household members complicates the trade-off between the different types of activities (e.g., household task allocation) (Arrow 2b). For instance, Ettema et al. (2007) found that in households, female participation in leisure is negatively associated with males performing in-home tasks, as both partners probably tend to engage in joint leisure activities. In addition, joint activities increase the probability of sharing a car among household members (Ho and Mulley, 2013a, 2013b, 2015a).

4.2.2. Discussion and research suggestions

Most of the literature on household task allocation processes focuses on the Western context with a smaller part on China; evidence from other parts of the world is still limited even though household allocation decisions may vary among geographies due to cultural contexts. Some comparative studies have looked at the impact of geographical context on activity-travel behavior (Buehler, 2011; Haustein and Nielsen, 2016; Timmermans et al., 2003), but the extent to which geographical context influences household task allocation remains unknown. More comparative studies, including on non-Western countries, are required to further explore this.

Even in the same context, household allocation decisions may change over time. Typical household allocation patterns today are different from several years ago (Altintas and Sullivan, 2016), due to changing gender roles over time (Frändberg and Vilhelmson, 2014; McDonald, 2015). Many studies have explored gender-based travel trends in various parts of the world (Crane and Takahashi, 2009; Hjorthol, 2008; Kuhnimhof et al., 2012a; Kuhnimhof et al., 2012b; Susilo et al., 2019), but these studies focused on changes in activity-travel patterns at the individual level. Only a few studies have explored changes in commute distances over time between household members in the US (Kwon and Akar, 2021) and the Netherlands (Rouwendal and Rietveld, 1994). Insight is lacking into how household allocation patterns change and what factors (e.g., gender roles, environment, attitudes, lifestyles, and technology) are significantly associated with such changes over time. In particular, the biggest change over time is technology, which dramatically impacts household allocation decisions regarding activity-travel patterns. For instance, ICT applications such as for online shopping, telecommuting, and food delivery apps, significantly change individual activity-travel behavior with potential implications for task allocation patterns. Moreover, the occurrence of shared and fully autonomous vehicle use also enables a household member without car access to use a car, which may lead to re-scheduling activity-travel patterns. While knowledge regarding the impacts of innovative mobility technology on activity-travel patterns at the individual level has been summarized in recent studies (Milakis et al., 2017; Mouratidis et al., 2021), insights regarding this topic at the household level are still lacking, which requires more attention for future research.

4.3. Relationship between intra-household decisions and travel attitudes

4.3.1. Empirical evidence

In Ajzen's theory of planned behavior, a household member perceives others' expectations and as a result may adjust their intentions and behavior accordingly (Ajzen, 1991). In this way, norms and attitudes may be transferred from one household member to another (Arrow 3a). Using longitudinal data from the German Mobility Panel, Kroesen (2015) found that, after controlling for a series of individual and shared household characteristics, the travel patterns of one partner in a household influenced those of the other partner over time. This implicitly suggests that, over time, transferred social norms and attitudes may play a significant role in influencing household members' travel behavior.

The theory of cognitive dissonance (Festinger, 1957) holds that people tend to reduce inconsistency between attitudes and behavior (Heider, 1982). When a mismatch occurs between attitudes and behavior, people tend to adjust their attitudes to align with their behavior. This means that attitudes are influenced by behavior. This could potentially take place through car allocation (Arrow 3b). For instance, a household member with non-preference for car use might develop positive attitudes towards traveling by car if they are allocated and use a car more frequently. However, empirical evidence regarding this is still lacking.

In addition, the distribution of travel attitudes among household members may influence the allocation of household vehicles (Arrow 3c). The theory of planned behavior holds that an individual's attitudes influence their intention to exhibit certain behaviors (Ajzen, 1991). As such, positive attitudes towards a certain travel mode might promote the choice of that mode (Beirão and Cabral, 2007; Heinen et al., 2011), which increases the probability of securing that travel mode in the household allocation decision. Guan and Wang (2019a) found that in a couple-household, the male partner's share of travel time by car is positively affected by his positive attitudes towards driving, but negatively impacted by his partner's attitudes towards driving, which suggests that the household car allocation pattern is related to the distribution of travel attitudes among household members.

4.3.2. Discussion and research suggestions

How one household member transfers their norms and influences the travel attitudes of other members may differ between households. It is possible that one household member could easily transfer their norms for sustainable travel so that other members gain positive attitudes towards walking, cycling, and public transport, if no one has access to a car. By contrast, in a multiple-member household with only one car, it might be more difficult for household members without car access to persuade the frequent car user(s) to change their travel attitudes in favor of active travel modes. Future research could explore in which conditions the transfer of norms could influence travel attitudes, and how this effect differs between households.

Additionally, the relationship between travel attitudes and intra-household decisions has a bidirectional effect. However, it remains unknown whether a change in household car allocation is triggered by a change in the distribution of travel attitudes among household members or vice versa, although both may occur simultaneously. Longitudinal research exploring the relationship between changes in the allocation of household tasks, activities, and vehicles as well as changes in the distribution of travel attitudes among household members could reveal interesting insights.

4.4. Role of intra-household decisions: The relationship between the built environment and travel attitudes

4.4.1. Role of intra-household decisions in the residential location decision in relation to travel attitudes

Intra-household decisions influence the degree of residential self-selection and residential dissonance among different members within a household (Arrow 4a). As members of a household may have varying attitudes but share the same residential location, a neighborhood's built environment may not always suit the travel tastes and preferences of each household member. It is possible that a residential location decision aligns with one partner's attitudes (residential self-selection), but not the other, which makes the latter dissonant in terms of the built environment. Very little research has focused on the extent to which the residential location matches the travel tastes and preferences of various household members (e.g., Guan and Wang, 2019a; Guan and Wang, 2019b). In Beijing, China, Guan and Wang (2019b) found that in dual-worker households, males' travel attitudes played a larger role than those of females in residential location decisions, which indicates that males' attitudes lead self-selection processes. In principle, there can be four types of "match" or "mismatch" between the residential built environment and partner attitudes, namely: (1) partner 1: consonant, partner 2: consonant; (2) partner 1: consonant, partner 2: dissonant; (3) partner 1: dissonant, partner 2: consonant; and (4) partner 1: dissonant, partner 2: dissonant. Based on our literature search, only two recent studies have explored the extent to which the residential location decision is related to the travel attitudes of different household members (Gao et al., 2022; Janke, 2021). In Vienna, Austria, Janke (2021) found that female partners tend to be consonant more often than male partners if they reside in urban areas, while the reverse holds in suburban areas. Similar results were also in Gao et al. (2022), with a focus on the travel behavior of couples in the Netherlands. A few studies have explored the determinants of residential dissonance at the individual level (Kamruzzaman et al., 2016; Schwanen and Mokhtarian, 2004), but little is known at the household level. Future research could explore what factors lead to the different distributions of consonance and dissonance between travel attitudes and residential location within a household.

The extent to which the travel needs and preferences of various household members are prioritized in location decisions often focuses on residential location choice, while limited attention has been paid to other location decisions, such as work and school locations. This is mainly because residential location decisions are more relevant to each household member than other location decisions; decisions regarding work and school locations are especially relevant to the particular household member who works in those locations or is responsible for picking up or dropping off children at school. Nonetheless, households can self-select various locations beyond the residential location (Van Wee, 2009), which holds different implications for different household members. Among these, school location decisions require more attention. Specifically, some couples with school-age children may decide to live close to school. Such location decisions may meet and satisfy the travel needs and preferences of the household member who is responsible for dropping off and picking up their children at school, but it may make other household members dissonant if the residential location choice conflicts with their travel needs and preferences. It could be interesting to explore how different household members set different priorities in various location decisions in terms of travel needs and preferences, and how this is related to activity-travel patterns.

4.4.2. Role of intra-household decisions: The impact of the built environment on travel attitudes

The residential built environment influences the travel attitudes of each household member and this influence is different for each member of a household (Arrow 4b). In the residential relocation process, if travel attitudes are not matched with the new residential location, people may adjust their attitudes to align the built environment and travel attitudes (De Vos et al., 2018). By contrast, people who choose the residential location based on their travel attitudes are less likely to experience a change in attitudes, even though they may occasionally update their attitudes based on their experiences in the new residential location. In the residential relocation process, different household members with different degrees of residential self-selection might experience different

levels of attitude adjustment, despite being faced with the same changes in the residential built environment. However, to the best of our knowledge, no empirical research has explored this issue.

The change in attitudes makes the distribution of consonance and dissonance among household members after residential relocation different from when the residential decision was made. If we consider the match or mismatch between attitudes and the built environment at the time of residential location choice and after residential relocation, there will be 16 types of consonance and dissonance in a couple-household (four types[3] during residential relocation multiplied by four types after). Changes in the allocation of household tasks, vehicles, and activities may also occur in this process. Future research could explore how the distribution of consonance and dissonance within a household changes over time after residential relocation, and what factors (including changes in household tasks, activities, and car use) lead to different distributions of consonance and dissonance during and after residential relocation.

As people may adjust their travel attitudes, such dissonance between location and attitudes may not be lasting (De Vos et al., 2018; Kroesen et al., 2017). In particular, some relocated residents tended to adjust their travel attitudes in accordance with the new location within two years (De Vos et al., 2018; Wang and Lin, 2019). Insight is lacking into the role of other household members in travel attitude changes. Due to a partner's influence within a household, an individual who is a residential dissonant might change attitudes quickly if their partner is a residential consonant. Future research could explore the effect of a partner's attitude and level of consonance on attitude change.

A change in the built environment without residential relocation can also lead to a change in attitudes—an issue that has received only limited attention. For instance, a newly constructed metro station near a residential location might attract more residents to metro travel with more commuters gradually coming to favor the use of public transport. This usually happens in developing countries in the context of rapid urbanization and the mass construction of transport infrastructure (Wang and Zhou, 2017). However, there has only been limited research on this, most of which explored the impact on travel behavior (Hu et al., 2018). Future research could look into how a change in the built environment influences travel attitudes, as well as how the impact differs among different household members.

4.5. Role of intra-household decisions: The impact of the built environment on activity-travel behavior

The impact of the residential built environment on travel behavior is different for household members with different degrees of residential self-selection (Arrow 5a). In particular, the residential built environment may promote the use of one travel mode over another if the attitude of a person aligns with the environment. This suggests that the built environment may have a differing impact on travel behavior given one's travel attitudes. Guan and Wang (2019a, 2019b) explored the impact of the built environment on travel behavior at the household level by considering the attitude-induced self-selection effect, but insight is lacking regarding heterogeneous behavioral responses to the built environment based on travel attitudes at the household level.

Moreover, the impact of the built environment on travel behavior can also be moderated by the allocation of household tasks and activities (Arrow 5b). Built environment may exert a bigger impact on household members who have more out-of-home activities. However, findings may be different if the built environment is measured across different geographic scales, which is known as the Modifiable Areal Unit Problem (MAUP) (Fotheringham and Wong, 1991; Horner and Murray, 2002). Specifically, commuting trips are mainly influenced by the built environment at the metropolitan scale rather than at the neighborhood scale, as they are more related to the distribution of residences and workplaces across cities. In contrast, the built environment at the neighborhood level is relatively more important for non-work trips such as trips to grocery stores, schools, and other activity locations, which are often selected within a neighborhood (Handy et al., 2002; Hong et al., 2014). If this issue is explored from a household perspective, the relationship between the built environment and travel behavior of each household member can differ across different geographic scales, due to the allocation of household tasks and activities. In particular, the urban structure may play a larger role in explaining the commuting behavior of the household member who acts as the breadwinner and spends more time on work-related activities. In contrast, neighborhood characteristics may be more effective in explaining the (joint) non-work trips of household members. However, exploration of this topic at the household level is still lacking, and so requires more attention in future research.

5. Concluding remarks

An individual's behavior is influenced by their spatial environment but also by their closest social network: the household. However, the impact of intra-household decisions on the relationship between the built environment and travel behavior has not been fully addressed. This review paper aims to narrow this gap by reviewing the literature based on an a priori conceptual framework. This framework contributes to understanding how intra-household decisions are related to activity-travel behavior, the built environment, and attitudes. This relation is through different dimensions of intra-household decision-making, namely: (1) the location decision; (2) transferring norms; and (3) the distribution of household tasks, activities, and travel modes. A series of issues such as (changes in) travel attitudes, residential self-selection, and residential dissonance were explored and discussed in this framework.

By sorting through the literature, we found that most empirical research has focused on how members within a household jointly decide and distribute household activities and transportation resources (e.g., a car), and how these household allocation decisions are related to the built environments around residential and work locations. By contrast, limited attention has been paid to the role of travel attitudes; in fact, only four recent studies—two in Beijing, China (Guan and Wang, 2019a, 2019b), one in the Netherlands (Gao et al., 2022), and one in Vienna, Austria (Janke, 2021)—have explored attitudes, induced self-selection and residential dissonance within a couple-household. Guan and Wang (2019a, 2019b) found that husbands tend to lead self-selection in residential location decisions, while findings from Janke (2021) and Gao et al. (2022) suggest that self-selection led by husbands or wives depends on where they live (e.g., urban or suburban areas). Such different results may be related to differences in the measurement of attitudes and the built environment as well as the specific travel and residential mobility culture and local lifestyles. Nonetheless, more attention should be paid to the impact of intra-household decisions on the relationship between the built environment and travel behavior.

Based on the review of the empirical research, we summarize the following four knowledge gaps and propose avenues for future research:

1) For locational choice and travel attitudes, most research has focused on residential locations while limited attention has been paid to other household-level location decisions which play a role in activity-travel behavior, such as decisions regarding work, school, and household holiday locations. As these location choices may also involve a trade-off in attitudes and preferences between household members, self-selection, and its implications for activity-travel behavior, may also occur differently among different household members, which requires more attention in future research.
2) Attitudes may not always remain the same over time, especially during the residential relocation process. This could lead to a varied

[3] Four types of "match" or "mismatch" between the residential built environment and partner attitudes within a couple-household are illustrated in Section 4.4.1

Table 2
Questions recommended for a survey.

Before residential relocation	After residential relocation
Household level	
• Household income • Number of children and their ages • Car ownership and allocation • Motivation for residential relocation (only asked before residential relocation) • Occurrence of life events (e.g., the birth of the child, marriage, or move-out of the child) • School location(s) • Responsibility for dropping children off and picking up from school	
Household member level	
• Socio-demographic attributes (e.g., age, gender, education degree working status, salary) • Attitudes towards various travel modes • Residential preferences (e.g., high-density neighborhood (apartment) versus low-density (house) • Work location • Commute mode choices, distances, and times • Time use in various activities during weekdays/weekends • Frequency of travel mode use to various destinations (e.g., work location, restaurant, or stores)	

distribution of residential consonance and dissonance among household members during and after residential relocation. Insight regarding this issue is required in future research to explore the extent to which attitudes play a role in residential location decisions and travel behaviors. In particular, longitudinal data that capture the attitudes and behaviors of different members of a household during and after residential relocation over time are recommended as key to dealing with these issues.

3) The location decision process, housing systems, household allocation patterns, and activity-travel behaviors differ in different cultural, geographical, and racial contexts, which may moderate the proposed links in Fig. 2. For instance, using data collected in Ganyu (China), Hu et al. (2022) found a limited occurrence of residential self-selection in the context of small Chinese cities. In the future, more comparative studies, including on non-Western countries, are required to explore the extent to which cultural, geographical, and racial identity influence residential location decisions and household task allocation.
4) With changes in social and travel environments over time, household allocation patterns and activity-travel behaviors may also change, especially with the extensive use of ICT applications (e.g., ride-hailing, online shopping, and teleworking) and emerging autonomous vehicles. Future research could explore how current household allocation patterns and residential location decisions differ from those several decades ago, and how ICT applications and innovations in mobility technology play a role in this process.

In terms of research methods, both qualitative and quantitative approaches are recommended.

1) For qualitative research, we suggest methods such as interviews and focus group discussions within a household as they could provide overall insight into the causal relationship between attitudes, the built environment, household allocation patterns, and activity-travel behavior especially if viewed through a gendered lens. This is also beneficial for proposing theoretical arguments in new research areas, such as the role of ICT and (shared) autonomous vehicles in intra-household travel.
2) For quantitative research, activity-travel surveys at the household level are highly recommended for data collection, where the information of each household member should be collected. We additionally suggest longitudinal data to clarify the causal relationships between attitudes, built environment, intra-household decisions, and activity-travel behavior. Such data collection is recommended within a residential relocation process, where changes in both travel attitudes and household allocation patterns tend to occur, in addition to changes in the built environment. In this situation, a multiple-wave household-level survey (i.e., before and after residential relocation) could be conducted to track the changes in life events at the household level, and in activity-travel patterns and travel-related attitudes at the individual level. It may be difficult to recruit people because researchers would have to identify and select people before they move. An alternative may be to add questions to existing panel studies; Table 2 suggests questions for such studies. Next, data need to be analyzed, often through modeling, with options being structural equation models, hybrid choice models, and latent class transition models. The preferred methodology depends on the specific research questions the researchers aim to answer.

CRediT authorship contribution statement

Yang Hu: Conceptualization, Funding acquisition, Investigation, Data curation, Methodology, Writing – original draft, Writing – review & editing. **Bert van Wee:** Conceptualization, Formal analysis, Writing – review & editing. **Dick Ettema:** Conceptualization, Formal analysis, Writing – review & editing.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

Data availability

Data will be made available on request.

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Appendix 1 Relevant papers in intra-household transport research

	Author (Year)	Region / city	Country	Intra-household decision focus	Built environment (Residence/ Workplace / Trip destination)	Arrows addressed in Fig. 2
1	Anggraini et al. (2008)	–	Netherlands	Car allocation	Residence	2a
2	Anggraini et al. (2012)	–	Netherlands	Car allocation	Residence	1b, 2a
3	Bernardo et al. (2015)	–	USA	Household task allocation Time use and activity generation	–	2a,2b
4	Borgers and Timmermans (1993)	–	Netherlands	Residential location choice	Residence	1a
5	Bradley and Vovsha (2005)	Atlanta	USA	Time use and activity generation	–	2a, 2b

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	Author (Year)	Region / city	Country	Intra-household decision focus	Built environment (Residence/ Workplace / Trip destination)	Arrows addressed in Fig. 2
6	Cao and Chai (2007)	Shenzhen	China	Household task allocation Time use and activity generation	–	2a,2b
7	Chakrabarti and Joh (2019)	California	USA	Car use/travel patterns	Residence	1b, 2a
8	Chidambaram and Scheiner (2020)	–	Germany	Commute distance	–	2a Implicit: 1a
9	Chu (2022)	New York	USA	Time use and activity generation	Residence, workplace, and commute route	1b, 2a
10	Clark et al. (2003)	Seattle	USA	Commute time/distance	–	Implicit: 1a
11	Deding et al. (2009)	–	Denmark	Commute distance	–	Implicit: 1a
12	Ettema and van der Lippe (2009)	–	Netherlands	Household task allocation Time use and activity generation	Residence	1b, 2a, 2b
13	Ettema et al. (2007)	Amsterdam and Utrecht	Netherlands	Household task allocation Time use and activity generation	Residence	1b, 2a, 2b
14	Feng et al. (2020)	Nanjing	China	Time use and activity generation	Residence	1b 2a 2b
15	Fujii et al. (1999)	Osaka-Kobe	Japan	Time use and activity generation	–	2a, 2b
16	Gao et al. (2022)*	–	Netherlands	Car use/travel patterns	Residence	4a, 1b, 2a, Implicit: 3c
17	Gliebe and Koppelman (2002)	Puget Sound	USA	Time use and activity generation	–	2a, 2b
18	Gliebe and Koppelman (2005)	Puget Sound	USA	Activity participation and travel patterns	–	2a,2b
19	Golob and McNally (1997)	Portland	USA	Time use and activity generation	–	2a 2b
20	Guan and Wang (2019a)*	Beijing	China	Car use/travel patterns	Residence and workplace	4a, 1b, 2a, Implicit: 3c
21	Guan and Wang (2019b)*	Beijing	China	Car use/travel patterns Residential location choice	Residence	4a, 1b, 2a, Implicit: 3c
22	Guo et al. (2020)	Shenyang	China	Commute time	–	Implicit:1a
23	Gupta and Vovsha (2013)	San Francisco	USA	Time use and activity generation	–	2a,2b
24	Habib (2014)	Toronto and Hamilton	Canada	Car allocation/mode choice	Residence and workplace	Implicit: 1b, 2a
25	Han et al. (2019)	–	Netherlands	Escorting children to school and activity generation	–	2a,2b
26	Hjorthol and Vågane (2014)	–	Norway	Household task allocation, Commute distance	Residence	2a, 2b Implicit: 1a, 1b
27	Ho and Mulley (2013a)	Sydney	Australia	Time use and activity generation	–	2a, 2b
28	Ho and Mulley (2013b)	Sydney	Australia	Car use/travel patterns Time use and activity generation	–	2a, 2b
29	Ho and Mulley (2015a)	Sydney	Australia	Car allocation/mode choice Time use and activity generation	Residence and trip destination	1b, 2a, 2b
30	Hsu and Saphores (2014)*	California	USA	Escorting children to school and activity generation	Residence	2a
31	Hu et al. (2022)*	Ganyu	China	Travel mode choice	Residence and workplace	1b, 2a
32	Janke (2021)*	Vienna	Austria	Travel mode choice	Residence	4a, 1b, 2a Implicit: 3c
33	Jun and Kwon (2015)	Seoul	Korea	Residential location choice Commute distance Time use and activity generation	Residence and workplace	1a, 2a, 2b
34	Kalter and Geurs (2016)*	–	Netherlands	Car use	–	2a
35	Kang and Scott (2011)	Toronto	Canada	Time use and activity generation	–	2a, 2b
36	Kato and Matsumoto (2009)	Tokyo and Toyama	Japan	Time use and activity generation	–	2a, 2b
37	Kim and Parent (2016)	Cincinnati	USA	Car use/travel patterns	Residence	2a, 2b
38	Kim et al. (2015)	Seoul	Korea	Travel patterns	Residence	2a, 2b
39	Korsu (2012)	Paris	France	Commute distance	–	Implicit: 1a
40	Kroesen (2015)	–	Germany	Car use/travel patterns	Residence	Implicit: 3a, 1b, 2a
41	Kwon and Akar (2021)	–	USA	Commute distance	Residence	Implicit: 1a
42	Lai et al. (2019)	Hong Kong	China	Time use and activity generation	Residence	2a,2b
43	Lee et al. (2022)	–	USA	Commute time	–	Implicit: 1a
44	Liu et al. (2018)	Bandung	Indonesia	Time use and activity generation	Residence	1b, 2a
45	Liu et al. (2022)	Beijing	China	Travel mode choice and travel distances	Residence and workplace	2a
46	Lu et al. (2022)	Brisbane	Australia	Travel mode choice	Residence	2a
47	Maat and Timmermans (2009)	Randstad region	Netherlands	Car allocation/mode choice	Residence and workplace	1b, 2a
48	Mok (2007)	Toronto	Canada	Commute distance	–	Implicit: 1a
49	Picard et al. (2013)	Paris	France	Commute time/distance Travel mode choice	–	2a Implicit: 1a
50	Plaut (2006)	–	USA	Commute time/distance	Residence	Implicit: 1a
51	Roorda et al. (2009)	Toronto	Canada	Car transaction and allocation	Residence	2a
52	Rouwendal and Rietveld (1994)	–	Netherlands	Commute distance	–	Implicit: 1a
53		Bhubaneswar	India	Time use and activity generation	–	2a 2b

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	Author (Year)	Region / city	Country	Intra-household decision focus	Built environment (Residence/ Workplace / Trip destination)	Arrows addressed in Fig. 2
	Sarangi and Manoj (2021)					
54	Scheiner (2020)	–	Germany	Car use Time use and activity generation	–	2a, 2b
55	Scheiner and Holz-Rau (2012a)	–	Germany	Car use	Residence	2a
56	Scheiner and Holz-Rau (2012b)	–	Germany	Car use	Residence	2a
57	Schwanen et al. (2007)	Amsterdam and Utrecht	Netherlands	Household task allocation Time use and activity generation	Residence	1b, 2a, 2b
58	Scott and Kanaroglou (2002)	Toronto	Canada	Time use ad activity generation	–	2a, 2b
59	Sermons and Koppelman (2001)	San Francisco	USA	Commute time	–	Implicit: 1a
60	Singell and Lillydahl (1986)	–	USA	Commute time	–	Implicit: 1a
61	Smart et al. (2017)	–	USA	Household task allocation Time use and activity generation	–	2a,2b
62	Solá (2016)	Gothenburg	Sweden	Car use/travel patterns Time use and activity generation	–	2a, 2b
63	Srinivasan and Athuru (2005)	San Francisco	USA	Household task allocation Time use and activity generation	–	2a
64	Srinivasan and Bhat (2005)	San Francisco	USA	Household task allocation Time use and activity generation	–	2a, 2b
65	Srinivasan and Bhat (2006)	San Francisco Bay Area	USA	Time use ad activity generation	Residence	1b, 2a,2b
66	Srinivasan and Bhat (2008)	–	USA	Time use ad activity generation	–	2a, 2b
67	Sultana (2005)	Atlanta	USA	Commute distance/time	Residence and workplace	Implicit: 1a
68	Surprenant-Legault et al. (2013)	Montreal	Canada	Commute distance	Residence and workplace	Implicit: 1a
69	Timmermans et al. (1992)	Tilburg	Netherlands	Residential location choice	Residence	1a
70	Vovsha and Petersen (2005)	Atlanta	USA	Escorting children to school and activity generation	Residence	2a,2b
71	Vovsha et al. (2003)	Mid-Ohio	USA	Activity participation and travel patterns	Residence	2a,2b,1b
72	Vovsha et al. (2004a)	Mid-Ohio	USA	Activity participation and travel patterns	Residence	2a,2b,1b
73	Vovsha et al. (2004b)	Mid-Ohio	USA	Time use ad activity generation	Residence	2a,2b,1b
74	Wang and Li (2009)	Hong Kong	China	Household task allocation Time use	–	2a,2b
75	Weiss and Habib (2020)	Toronto and Hamilton	Canada	Car use/travel patterns	–	2a
76	Wen and Koppelman (2000)	Portland	USA	Activity participation and travel patterns	–	2a, 2b
77	Wheatley (2014)	–	UK	Time use and activity generation Commute time	–	2a, 2b Implicit: 1a
78	Yang et al. (2019)*	Nanjing	China	Car use/travel patterns	Residence	1b, 2a
79	Yao et al. (2017)	Beijing	China	Time use and activity generation Car use/travel patterns	–	2a,2b
80	Yao et al. (2020)	Beijing	China	Time use and activity generation Travel distance	–	2a, 2b
81	Yarlagadda and Srinivasan (2008)	San Francisco Bay Area	USA	Time use ad activity generation	Residence	2a, 2b, 1b
82	Yoon and Goulias (2010)	California	USA	Time use ad activity generation	Residence	2a, 2b, 1b
83	Zhang and Fujiwara (2006)	Kakeya and Akayi	Japan	Time use ad activity generation	–	2a, 2b
84	Zhang and Fujiwara (2009)	Hiroshima	Japan	Residential location choice	Residence	1a
85	Zhang et al. (2002)	Rotterdam	Netherlands	Time use ad activity generation	–	2a, 2b
86	Zhang et al. (2005)	South Rotterdam Region	Netherlands	Household task allocation Time use and activity generation	–	2a, 2b
87	Zhang et al. (2009)	Hiroshima	Japan	Car use	–	2a

Built environment refers to the general built environment such as urban and suburban/rural areas, or city size, and specific built environment factors such as density, diversity, design, destination accessibility and distance to transit in terms of land use and road facilities.
"-" in the "Region / city" column refers to surveys that used national-level data or did not report the city/region for data collection.
* Refers to studies that explicitly included travel-related attitudes.

Empirical studies with both arrows "2a, 2b" addressed in the conceptual framework mainly explored the allocation of household tasks and activities; in these cases, the household allocation decision is implicitly influenced by the preferred activity-travel patterns of household members.

References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211.

Altintas, E., Sullivan, O., 2016. Fifty years of change updated: cross-national gender convergence in housework. Demogr. Res. 35, 455–470.

Anggraini, R., Arentze, T.A., Timmermans, H.J., 2008. Car allocation between household heads in car deficient households: a decision model. Eur. J. Transp. Infrastruct. Res. 8.

Anggraini, R., Arentze, T.A., Timmermans, H.J., 2012. Car allocation decisions in car-deficient households: the case of non-work tours. Transportmetrica A: Transp. Sci. 8, 209–224.

Auld, J., Zhang, L., 2013. Inter-personal interactions and constraints in travel behavior within households and social networks. Transportation 40, 751–754.

Barnett, I., Guell, C., Ogilvie, D., 2013. How do couples influence each other's physical activity behaviours in retirement? An exploratory qualitative study. BMC Public Health 13, 1197.

Beirão, G., Cabral, J.S., 2007. Understanding attitudes towards public transport and private car: a qualitative study. Transp. Policy 14, 478–489.

Bernardo, C., Paleti, R., Hoklas, M., Bhat, C., 2015. An empirical investigation into the time-use and activity patterns of dual-earner couples with and without young children. Transp. Res. A Policy Pract. 76, 71–91.

Bhat, C.R., Pendyala, R.M., 2005. Modeling intra-household interactions and group decision-making. Transportation 32, 443.

Borgers, A., Timmermans, H., 1993. Transport facilities and residential choice behavior: a model of multi-person choice processes. Pap. Reg. Sci. 72, 45–61.

Bradley, M., Vovsha, P., 2005. A model for joint choice of daily activity pattern types of household members. Transportation 32, 545–571.

Buehler, R., 2011. Determinants of transport mode choice: a comparison of Germany and the USA. J. Transp. Geogr. 19, 644–657.

Cao, X., Chai, Y., 2007. Gender role–based differences in time allocation: case study of Shenzhen, China. Transp. Res. Rec. 2014, 58–66.

Cassel, S.H., Macuchova, Z., Rudholm, N., Rydell, A., 2013. Willingness to commute long distance among job seekers in Dalarna, Sweden. J. Transp. Geogr. 28, 49–55.

Cervero, R., Kockelman, K., 1997. Travel demand and the 3Ds: density, diversity, and design. Transp. Res. Part D: Transp. Environ. 2, 199–219.

Chakrabarti, S., Joh, K., 2019. The effect of parenthood on travel behavior: evidence from the California household travel survey. Transp. Res. A Policy Pract. 120, 101–115.

Chidambaram, B., Scheiner, J., 2020. Understanding relative commuting within dual-earner couples in Germany. Transp. Res. A Policy Pract. 134, 113–129.

Chu, Y.-L., 2022. A copula-based approach to accommodate intra-household interaction in workers' daily maintenance activity stop generation modeling. J. Traffic Transp. Eng. (English edition) 9, 59–68.

Clark, W.A., Huang, Y., 2003. The life course and residential mobility in British housing markets. Environ. Plan. A 35, 323–339.

Clark, W.A., Huang, Y., Withers, S., 2003. Does commuting distance matter?: commuting tolerance and residential change. Reg. Sci. Urban Econ. 33, 199–221.

Crane, R., Takahashi, L., 2009. Sex changes everything: the recent narrowing and widening of travel differences by gender. Public Works Manag. Policy 13, 328–337.

De Vos, J., Derudder, B., Van Acker, V., Witlox, F., 2012. Reducing car use: changing attitudes or relocating? The influence of residential dissonance on travel behavior. J. Transp. Geogr. 22, 1–9.

De Vos, J., Ettema, D., Witlox, F., 2018. Changing travel behaviour and attitudes following a residential relocation. J. Transp. Geogr. 73, 131–147.

Deding, M., Filges, T., Van Ommeren, J., 2009. Spatial mobility and commuting: the case of two-earner households. J. Reg. Sci. 49, 113–147.

Ettema, D., Nieuwenhuis, R., 2017. Residential self-selection and travel behaviour: what are the effects of attitudes, reasons for location choice and the built environment? J. Transp. Geogr. 59, 146–155.

Ettema, D., van der Lippe, T., 2009. Weekly rhythms in task and time allocation of households. Transportation 36, 113–129.

Ettema, D., Schwanen, T., Timmermans, H., 2007. The effect of location, mobility and socio-demographic factors on task and time allocation of households. Transportation 34, 89–105.

Ewing, R., Cervero, R., 2001. Travel and the built environment: a synthesis. Transp. Res. Rec. 1780, 87–114.

Ewing, R., Cervero, R., 2010. Travel and the built environment: a meta-analysis. J. Am. Plan. Assoc. 76, 265–294.

Feng, J., Chuai, X., Lu, Y., Guo, X., Yuan, Y., 2020. Who will do more? The pattern of daily out-of-home activity participation in elderly co-residence households in urban China. Cities 98, 102586.

Festinger, L., 1957. A Theory of Cognitive Dissonance. Stanford University Press.

Fotheringham, A.S., Wong, D.W., 1991. The modifiable areal unit problem in multivariate statistical analysis. Environ. Plan. A 23, 1025–1044.

Frändberg, L., Vilhelmson, B., 2014. Spatial, generational and gendered trends and trend-breaks in mobility. In: Gärling, T., Ettema, D., Friman, M. (Eds.), Handbook of Sustainable Travel. Springer, pp. 15–32.

Frank, L., Engelke, P., Schmid, T., 2003. Health and Community Design: The Impact of the Built Environment on Physical Activity. Island Press.

Fujii, S., Kitamura, R., Kishizawa, K., 1999. Analysis of individuals' joint-activity engagement using a model system of activity-travel behavior and time use. Transp. Res. Rec. 1676, 11–19.

Gao, J., Yamamoto, T., Helbich, M., 2022. The role of residential consonance and dissonance between couples in travel behavior. Transp. Res. Part D: Transp. Environ. 104, 103196.

Geurs, K.T., Van Wee, B., 2004. Accessibility evaluation of land-use and transport strategies: review and research directions. J. Transp. Geogr. 12, 127–140.

Gliebe, J.P., Koppelman, F.S., 2002. A model of joint activity participation between household members. Transportation 29, 49–72.

Gliebe, J.P., Koppelman, F.S., 2005. Modeling household activity–travel interactions as parallel constrained choices. Transportation 32, 449–471.

Golob, T.F., McNally, M.G., 1997. A model of activity participation and travel interactions between household heads. Transp. Res. B Methodol. 31, 177–194.

Guan, X., Wang, D., 2019a. Influences of the built environment on travel: a household-based perspective. Transp. Res. A Policy Pract. 130, 710–724.

Guan, X., Wang, D., 2019b. Residential self-selection in the built environment-travel behavior connection: whose self-selection? Transp. Res. Part D: Transp. Environ. 67, 16–32.

Guan, X., Wang, D., Jason Cao, X., 2020. The role of residential self-selection in land use-travel research: a review of recent findings. Transp. Rev. 40, 267–287.

Guo, J., Feng, T., Zhang, J., Timmermans, H.J., 2020. Temporal interdependencies in mobility decisions over the life course: a household-level analysis using dynamic Bayesian networks. J. Transp. Geogr. 82, 102589.

Gupta, S., Vovsha, P., 2013. A model for work activity schedules with synchronization for multiple-worker households. Transportation 40, 827–845.

Habib, K.N., 2014. Household-level commuting mode choices, car allocation and car ownership level choices of two-worker households: the case of the city of Toronto. Transportation 41, 651–672.

Han, B., Kim, J., Timmermans, H., 2019. Task allocation and gender roles in dual earner households: the issue of escorting children. Travel Behav. Soc. 14, 11–20.

Handy, S.L., Boarnet, M.G., Ewing, R., Killingsworth, R.E., 2002. How the built environment affects physical activity: views from urban planning. Am. J. Prev. Med. 23, 64–73.

Haustein, S., Nielsen, T.A.S., 2016. European mobility cultures: a survey-based cluster analysis across 28 European countries. J. Transp. Geogr. 54, 173–180.

Heider, F., 1982. The Psychology of Interpersonal Relations. Psychology Press.

Heinen, E., Maat, K., Van Wee, B., 2011. The role of attitudes toward characteristics of bicycle commuting on the choice to cycle to work over various distances. Transp. Res. Part D: Transp. Environ. 16, 102–109.

Hjorthol, R., 2008. Daily mobility of men and women—a barometer of gender equality. In: Uteng, T.P., Cresswell, T. (Eds.), Gendered Mobilities, pp. 193–210.

Hjorthol, R., Vågane, L., 2014. Allocation of tasks, arrangement of working hours and commuting in different Norwegian households. J. Transp. Geogr. 35, 75–83.

Ho, C., Mulley, C., 2013a. Incorporating Intrahousehold interactions into a tour-based model of public transport use in car-negotiating households. Transp. Res. Rec. 2343, 1–9.

Ho, C., Mulley, C., 2013b. Tour-based mode choice of joint household travel patterns on weekend and weekday. Transportation 40, 789–811.

Ho, C., Mulley, C., 2015a. Intra-household interactions in tour-based mode choice: the role of social, temporal, spatial and resource constraints. Transp. Policy 38, 52–63.

Ho, C., Mulley, C., 2015b. Intra-household interactions in transport research: a review. Transp. Rev. 35, 33–55.

Hong, J., Shen, Q., Zhang, L., 2014. How do built-environment factors affect travel behavior? A spatial analysis at different geographic scales. Transportation 41, 419–440.

Horner, M.W., Murray, A.T., 2002. Excess commuting and the modifiable areal unit problem. Urban Stud. 39, 131–139.

Hsu, H.-P., Saphores, J.-D., 2014. Impacts of parental gender and attitudes on children's school travel mode and parental chauffeuring behavior: results for California based on the 2009 National Household Travel Survey. Transportation 41, 543–565.

Hu, L., Sun, T., Wang, L., 2018. Evolving urban spatial structure and commuting patterns: a case study of Beijing, China. Transp. Res. Part D: Transp. Environ. 59, 11–22.

Hu, Y., Sobhani, A., Ettema, D., 2022. Exploring commute mode choice in dual-earner households in a small Chinese city. Transp. Res. Part D: Transp. Environ. 102, 103148.

Janke, J., 2021. Re-visiting residential self-selection and dissonance: does intra-household decision-making change the results? Transp. Res. A Policy Pract. 148, 379–401.

Jun, M.-J., Kwon, K.-H., 2015. Why dual-earner households in Seoul live closer to the Wife's workplace than the Husband's? Urban Policy Res. 33, 217–232.

Kalter, M.-J.O., Geurs, K.T., 2016. Exploring the impact of household interactions on car use for home-based tours: a multilevel analysis of mode choice using data from the first two waves of the Netherlands mobility panel. Eur. J. Transp. Infrastruct. Res. 16.

Kamruzzaman, M., Baker, D., Washington, S., Turrell, G., 2016. Determinants of residential dissonance: implications for transit-oriented development in Brisbane. Int. J. Sustain. Transp. 10, 960–974.

Kang, H., Scott, D.M., 2011. Impact of different criteria for identifying intra-household interactions: a case study of household time allocation. Transportation 38, 81–99.

Kato, H., Matsumoto, M., 2009. Intra-household interaction in a nuclear family: a utility-maximizing approach. Transp. Res. B Methodol. 43, 191–203.

Kim, C., Parent, O., 2016. Modeling individual travel behaviors based on intra-household interactions. Reg. Sci. Urban Econ. 57, 1–11.

Kim, S.-N., Mokhtarian, P.L., Ahn, K.-H., 2012. The Seoul of Alonso: new perspectives on telecommuting and residential location from South Korea. Urban Geogr. 33, 1163–1191.

Kim, S.-N., Choo, S., Mokhtarian, P.L., 2015. Home-based telecommuting and intra-household interactions in work and non-work travel: a seemingly unrelated censored regression approach. Transp. Res. A Policy Pract. 80, 197–214.

Kitamura, R., Mokhtarian, P.L., Laidet, L., 1997. A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area. Transportation 24, 125–158.
Korsu, E., 2012. Tolerance to commuting in urban household location choice: evidence from the Paris metropolitan area. Environ. Plan. A 44, 1951–1968.
Kroesen, M., 2014. Modeling the behavioral determinants of travel behavior: an application of latent transition analysis. Transp. Res. A Policy Pract. 65, 56–67.
Kroesen, M., 2015. Do partners influence each other's travel patterns? A new approach to study the role of social norms. Transp. Res. A Policy Pract. 78, 489–505.
Kroesen, M., Handy, S., Chorus, C., 2017. Do attitudes cause behavior or vice versa? An alternative conceptualization of the attitude-behavior relationship in travel behavior modeling. Transp. Res. A Policy Pract. 101, 190–202.
Kuhnimhof, T., Armoogum, J., Buehler, R., Dargay, J., Denstadli, J.M., Yamamoto, T., 2012a. Men shape a downward trend in car use among young adults—evidence from six industrialized countries. Transp. Rev. 32, 761–779.
Kuhnimhof, T., Buehler, R., Wirtz, M., Kalinowska, D., 2012b. Travel trends among young adults in Germany: increasing multimodality and declining car use for men. J. Transp. Geogr. 24, 443–450.
Kwon, K., Akar, G., 2021. Have the gender differences in commuting been shrinking or persistent? Evidence from two-earner households in the US. Int. J. Sustain. Transp. 1–10.
Lai, X., Lam, W.H., Su, J., Fu, H., 2019. Modelling intra-household interactions in time-use and activity patterns of retired and dual-earner couples. Transp. Res. A Policy Pract. 126, 172–194.
Lee, A.S., Lahr, M.L., Wang, S., 2022. Couple households and the commuting time–gender gap. Prof. Geogr. 1–16.
Litman, T., 2005. Land Use Impacts on Transport: How Land Use Factors Affect Travel Behavior, p. http://www.vtpi.orglandtravel.pdf.
Liu, C., Susilo, Y.O., Dharmowijoyo, D.B., 2018. Investigating intra-household interactions between individuals' time and space constraints. J. Transp. Geogr. 73, 108–119.
Liu, S., Yamamoto, T., Yao, E., 2022. Joint modeling of mode choice and travel distance with intra-household interactions. Transportation 1–26.
Lu, Y., Prato, C.G., Sipe, N., Kimpton, A., Corcoran, J., 2022. The role of household modality style in first and last mile travel mode choice. Transp. Res. A Policy Pract. 158, 95–109.
Maat, K., Timmermans, H., 2009. Influence of the residential and work environment on car use in dual-earner households. Transp. Res. A Policy Pract. 43, 654–664.
Mao, Z., Wang, D., 2020. Residential relocation and life satisfaction change: is there a difference between household couples? Cities 97, 102565.
McDonald, N.C., 2015. Are millennials really the "go-nowhere" generation? J. Am. Plan. Assoc. 81, 90–103.
Milakis, D., Van Arem, B., Van Wee, B., 2017. Policy and society related implications of automated driving: a review of literature and directions for future research. J. Intell. Transp. Syst. 21, 324–348.
Mok, D., 2007. Do two-earner households base their choice of residential location on both incomes? Urban Stud. 44, 723–750.
Mokhtarian, P.L., Cao, X., 2008. Examining the impacts of residential self-selection on travel behavior: a focus on methodologies. Transp. Res. B Methodol. 42, 204–228.
Mokhtarian, P.L., Collantes, G.O., Gertz, C., 2004. Telecommuting, residential location, and commute-distance traveled: evidence from state of California employees. Environ. Plan. A 36, 1877–1897.
Mosa, A.I., Esawey, M.E., 2013. An investigation of household interactions in daily in-home and out-of-home maintenance activity participation and social behavior in Cairo, Egypt. Transp. Lett. 5, 201–212.
Mouratidis, K., Peters, S., van Wee, B., 2021. Transportation technologies, sharing economy, and teleactivities: implications for built environment and travel. Transp. Res. Part D: Transp. Environ. 92, 102716.
Næss, P., 2009. Residential self-selection and appropriate control variables in land use: travel studies. Transp. Rev. 29, 293–324.
Picard, N., De Palma, A., Dantan, S., 2013. Intra-household discrete choice models of mode choice and residential location. Intra-household discrete choice models of mode choice and residential location, pp. 419–446.
Plaut, P.O., 2006. The intra-household choices regarding commuting and housing. Transp. Res. A Policy Pract. 40, 561–571.
Reid, L., Sutton, P., Hunter, C., 2010. Theorizing the meso level: the household as a crucible of pro-environmental behaviour. Prog. Hum. Geogr. 34, 309–327.
Roorda, M.J., Carrasco, J.A., Miller, E.J., 2009. An integrated model of vehicle transactions, activity scheduling and mode choice. Transp. Res. B Methodol. 43, 217–229.
Rouwendal, J., Rietveld, P., 1994. Changes in commuting distances of Dutch households. Urban Stud. 31, 1545–1557.
Sarangi, P., Manoj, M., 2021. Analysis of activity participation and time use decisions of partners: the context of low-and high-income households. Transportation 1–42.
Scheiner, J., 2020. Changes in travel mode use over the life course with partner interactions in couple households. Transp. Res. A Policy Pract. 132, 791–807.
Scheiner, J., Holz-Rau, C., 2012a. Gender structures in car availability in car deficient households. Res. Transp. Econ. 34, 16–26.
Scheiner, J., Holz-Rau, C., 2012b. Gendered travel mode choice: a focus on car deficient households. J. Transp. Geogr. 24, 250–261.
Schwanen, T., Mokhtarian, P.L., 2004. The extent and determinants of dissonance between actual and preferred residential neighborhood type. Environ. Planning B: Planning Des. 31, 759–784.
Schwanen, T., Ettema, D., Timmermans, H., 2007. If you pick up the children, I'll do the groceries: spatial differences in between-partner interactions in out-of-home household activities. Environ. Plan. A 39, 2754–2773.
Scott, D.M., Kanaroglou, P.S., 2002. An activity-episode generation model that captures interactions between household heads: development and empirical analysis. Transp. Res. B Methodol. 36, 875–896.
Sermons, M.W., Koppelman, F.S., 2001. Representing the differences between female and male commute behavior in residential location choice models. J. Transp. Geogr. 9, 101–110.
Singell, L.D., Lillydahl, J.H., 1986. An empirical analysis of the commute to work patterns of males and females in two-earner households. Urban Stud. 23, 119–129.
Smart, M.J., Brown, A., Taylor, B.D., 2017. Sex or sexuality? Analyzing the division of labor and travel in gay, lesbian, and straight households. Travel Behav. Soc. 6, 75–82.
Solá, A.G., 2016. Constructing work travel inequalities: the role of household gender contracts. J. Transp. Geogr. 53, 32–40.
Srinivasan, K.K., Athuru, S.R., 2005. Analysis of within-household effects and between-household differences in maintenance activity allocation. Transportation 32, 495–521.
Srinivasan, S., Bhat, C.R., 2005. Modeling household interactions in daily in-home and out-of-home maintenance activity participation. Transportation 32, 523–544.
Srinivasan, S., Bhat, C.R., 2006. A multiple discrete-continuous model for independent- and joint-discretionary-activity participation decisions. Transportation 33, 497–515.
Srinivasan, S., Bhat, C.R., 2008. An exploratory analysis of joint-activity participation characteristics using the American time use survey. Transportation 35, 301–327.
Sultana, S., 2005. Effects of married-couple dual-earner households on metropolitan commuting: evidence from the Atlanta metropolitan area. Urban Geogr. 26, 328–352.
Surprenant-Legault, J., Patterson, Z., El-Geneidy, A.M., 2013. Commuting trade-offs and distance reduction in two-worker households. Transp. Res. A Policy Pract. 51, 12–28.
Susilo, Y.O., Liu, C., Börjesson, M., 2019. The changes of activity-travel participation across gender, life-cycle, and generations in Sweden over 30 years. Transportation 46, 793–818.
Timmermans, H., Borgers, A., van Dijk, J., Oppewal, H., 1992. Residential choice behaviour of dual earner households: a decompositional joint choice model. Environ. Plan. A 24, 517–533.
Timmermans, H., van der Waerden, P., Alves, M., Polak, J., Ellis, S., Harvey, A.S., Kurose, S., Zandee, R., 2003. Spatial context and the complexity of daily travel patterns: an international comparison. J. Transp. Geogr. 11, 37–46.
Timmermans, H.J., Zhang, J., 2009. Modeling household activity travel behavior: examples of state of the art modeling approaches and research agenda. Transp. Res. B Methodol. 43, 187–190.
Van Ham, M., Clark, W.A., 2009. Neighbourhood mobility in context: household moves and changing neighbourhoods in the Netherlands. Environ. Plan. A 41, 1442–1459.
Van Wee, B., 2009. Self-selection: a key to a better understanding of location choices, travel behaviour and transport externalities? Transp. Rev. 29, 279–292.
Van Wee, B., Cao, J., 2020. Residential self-selection in the relationship between the built environment and travel behavior: a literature review and research agenda. Adv. Transp. Pol. Plan. 9, 75–94.
Van Wee, B., De Vos, J., Maat, K., 2019. Impacts of the built environment and travel behaviour on attitudes: theories underpinning the reverse causality hypothesis. J. Transp. Geogr. 80, 102540.
Vovsha, P., Petersen, E., 2005. Escorting children to school: statistical analysis and applied modeling approach. Transp. Res. Rec. 1921, 131–140.
Vovsha, P., Petersen, E., Donnelly, R., 2003. Explicit modeling of joint travel by household members: statistical evidence and applied approach. Transp. Res. Rec. 1831, 1–10.
Vovsha, P., Petersen, E., Donnelly, R., 2004a. Impact of intrahousehold interactions on individual daily activity-travel patterns. Transp. Res. Rec. 1898, 87–97.
Vovsha, P., Petersen, E., Donnelly, R., 2004b. Model for allocation of maintenance activities to household members. Transp. Res. Rec. 1894, 170–179.
Wang, D., Li, J., 2009. A model of household time allocation taking into consideration of hiring domestic helpers. Transp. Res. B Methodol. 43, 204–216.
Wang, D., Lin, T., 2019. Built environment, travel behavior, and residential self-selection: a study based on panel data from Beijing, China. Transportation 46, 51–74.
Wang, D., Zhou, M., 2017. The built environment and travel behavior in urban China: a literature review. Transp. Res. Part D: Transp. Environ. 52, 574–585.
Weiss, A., Habib, K.N., 2020. Understanding joint travel and vehicle allocation at the household level through inference of revealed preference data. Travel Behav. Soc. 19, 207–218.
Wen, C.-H., Koppelman, F.S., 2000. A conceptual and methdological framework for the generation of activity-travel patterns. Transportation 27, 5–23.
Wheatley, D., 2014. Travel-to-work and subjective well-being: a study of UK dual career households. J. Transp. Geogr. 39, 187–196.
Yang, S., Fan, Y., Deng, W., Cheng, L., 2019. Do built environment effects on travel behavior differ between household members? A case study of Nanjing, China. Transp. Policy 81, 360–370.
Yao, M., Wang, D., Yang, H., 2017. A game-theoretic model of car ownership and household time allocation. Transp. Res. B Methodol. 104, 667–685.
Yao, M., Wang, D., Yang, H., 2020. Modeling household housing and car ownership decisions: a group decision-based time allocation approach. Transportmetrica A: Transp. Sci. 16, 409–438.
Yarlagadda, A.K., Srinivasan, S., 2008. Modeling children's school travel mode and parental escort decisions. Transportation 35, 201–218.
Yoon, S., Goulias, K., 2010. Impact of time-space prism accessibility on time use behavior and its propagation through intra-household interaction. Transp. Lett. 2, 245–260.
Zhang, J., Fujiwara, A., 2006. Representing household time allocation behavior by endogenously incorporating diverse intra-household interactions: a case study in the context of elderly couples. Transp. Res. B Methodol. 40, 54–74.

Zhang, J., Fujiwara, A., 2009. Intrahousehold interaction in transit-oriented residential choice behavior represented in stated preference approach. Transp. Res. Rec. 2134, 73–81.
Zhang, J., Timmermans, H., Borgers, A., 2002. Utility-maximizing model of household time use for independent, shared, and allocated activities incorporating group decision mechanisms. Transp. Res. Rec. 1807, 1–8.
Zhang, J., Timmermans, H.J., Borgers, A., 2005. A model of household task allocation and time use. Transp. Res. B Methodol. 39, 81–95.
Zhang, J., Kuwano, M., Lee, B., Fujiwara, A., 2009. Modeling household discrete choice behavior incorporating heterogeneous group decision-making mechanisms. Transp. Res. B Methodol. 43, 230–250.
Zhao, P., Liu, D., Yu, Z., Hu, H., 2020. Long commutes and transport inequity in China's growing megacity: new evidence from Beijing using mobile phone data. Travel Behav. Soc. 20, 248–263.