

A SYSTEMATIC REVIEW ON PSYCHOLOGICAL FACTORS ENCOURAGING CARPOOLING

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Introduction

Since 1970s, studying on carpool has begun (Ferguson, 1997). It has an aim to encourage individuals to carpool in order to fulfil many purposes such as reducing resources consumption, mitigating traffic congestion, and reducing car usage, and improving environmental situation (Chan and Shaheen, 2012).

Carpool can be defined in various meanings depended on different views such as the role of participants (drivers or riders), relationships of carpoolers, profit generation, the length of detouring, and trip purposes (see, e.g., Dickinson *et al.* 2015; Shaheen and Cohen, 2018). In this manuscript, carpool components are follows: 1) carpoolers are one driver sharing the use of her/his privately owned car and one or more riders; 2) both have the same origin and destination sharing a common route; 3) carpoolers must not live in the same household (this allows for friends/friend-of-friends, neighbours, co-workers, and strangers); 4) riders may or may not share some expense with the driver; and 5) the driver does not aim at profit making (i.e., received cash just to cover costs or purely donation).

Through times, carpooling has not been popular among travellers but researchers are always called for effective carpool intervention programs (e.g., Koppelman *et al.*, 1993; Chan and Shaheen, 2012; Gheorghiu and Delhomme, 2018). The more understanding of barriers and benefits of carpooling the more the success of intervention programs (Margolin *et al.*, 1978; Tischer and Dobson, 1979; Wang *et al.*, 2018). Regarding factors encouraging carpooling, researchers found that early and most of research on these factors focused less on psychological aspect (De Almeida Correia *et al.*, 2013; Neoh *et al.*, 2017).

This manuscript conducts a systematic review on psychological factors encouraging carpool behaviour (hereafter psychological factors). A concept of consumer buying behaviour borrowed from marketing is applied to capture psychological factors investigated in literature. The manuscript starts with literature review and follows by the methodology. Next, reports of the search and psychological factors appeared in the literature are illustrated. Finally, discussions and conclusion are presented.

Literature review

Internet-based technology has improved the capacity of ride-matching services which is expected to help increase more sustainable mobility (Chan and Shaheen, 2012; Shaheen and Cohen, 2018). Still, researchers and matching agencies are struggling to find market mechanisms that help attract participants (Furuhata *et al.*, 2013; Stiglic *et al.*, 2015). This two-sided matching is based on “how efficiently and effectively suitable matches can be found” and this creates of the chicken-and-egg problem to matching agencies (Stiglic *et al.*, 2015, p.30). In the perspective of economics, in order to “attract buyers [riders], an intermediary [matching agency] should base of registered sellers [drivers], but these will be willing to register only if they expect many show up” (Caillaud and Jullien, 2003, p.310). To increase the availability of matches is to build critical mass by motivating both drivers and riders and changing their behaviours (Nielsen *et al.*, 2015). As the influences of factors on carpoolers depend on whether they are drivers or riders (Neoh *et al.*, 2017; Park *et al.*, 2018), this shows that different roles have different needs, wants, and motivations (Nielsen *et al.*, 2015).

Many transportation researchers see traveller’ behaviour as consumer behaviour (e.g., Margolin *et al.*, 1978; De Almeida Correia *et al.*, 2013; Standing *et al.* 2018). This is because “transportation is affected by human behaviour through its consumers (drivers, riders, vehicle buyers, and shippers)” (McFadden, 2007, p.269). Consumers may select a transport mode choice depended on discouraging and encouraging factors (Stern, 1999). Among three levels of analyses, other than physical analogies and economic optimisation, transport researchers may understand traveller’s behaviour from insights

provided by psychological concepts (McFadden, 2007). Previous studies on carpool encouraging factors focused on instrumental factors and demand modeling; there is lack of research on psychological factors (De Almeida Correia *et al.*, 2013; Nielsen *et al.*, 2015; Neoh *et al.* 2017).

Based on the fact that economics and psychology are the foundation of marketing (Hunt, 2010), understanding psychological factors of carpoolers from the perspective of marketing should be advantageous. Kotler and Armstrong (2010) proposed a set of characteristics affecting consumer behaviour (i.e., cultural, social, personal, and psychological) and provided definitions of psychological aspect as follows. Motivation refers to an individual's needs that drive one to behave and seek satisfaction. Perception refers an individual's meaningful of the world derived from the process of select, organise, and interpret information one perceived. Learning refers to an individual's behaviour changes that influenced by experience. Beliefs refer to an individual's descriptive thoughts. Finally, attitudes refer to an individual's relatively consistent evaluations, feelings, and tendencies toward an object or ideas. Transportation researchers also suggest definitions of psychological factors in various meanings (see, e.g., De Almeida Correia *et al.*, 2013; Devarasetty *et al.*, 2014; Neoh *et al.*, 2017). Comparing these definitions should be studied in future research. The other characteristics in the set suggested by Kotler and Armstrong (2010) should be explored further.

Systematic review

To understand what those psychological factors are, this study conducts the systematic review due to three reasons. First, the method is a fundamental scientific activity that helps identify key scientific contributions to the field (Tranfield *et al.*, 2003; Booth *et al.*, 2012). Second, it helps researchers conduct an exhaustive and comprehensive searching with a protocol entailing a series of standard techniques minimising bias and error (Tranfield *et al.*, 2003; Grant and Booth, 2009). Last, it shows us what is known, remains unknown and, guides us future research questions (Grant and Booth, 2009).

The review method followed the guideline provided in Booth *et al.* (2012). Due to one limitation of accessing to offline journals, this manuscript aims only for electronic databases. Three databases and one database host were chosen. ISI Web of Science (ISI) and Transport Research Information Services (TRIS) were selected as similar to the previous study adopting systematic search method (Neoh *et al.*, 2017). Scopus and ProQuest were further chosen as the former is comprehensive and multidisciplinary in nature than ISI (Meho and Yang, 2007), and the latter serves as a database host. Keywords were "carpool" and other equivalent words (i.e., rideshare, liftshare, and carshare) as the literate suggested that these words are used interchangeably (Neoh *et al.*, 2017; Gheorghiu and Delhomme, 2018). Regarding timespan, articles in three databases were searched spanning from 1970 to 2018 (early August), except for ISI which allowed us to search the oldest one appeared since 2001. Aiming to know the key scientific contributions on psychological factors, only the articles written in English and published through peer-reviews journals were selected. Duplicated articles were screened out. An article's title, abstract, and keywords were explored based on this manuscript's definition of carpool and Kotler and Armstrong (2010)'s definitions of psychological factors. Only articles explicitly showing that they studies on the topic of carpool behaviour and psychological factors were chosen. It should be noted that the systematic review method is not free from limitations as it is oriented with a qualitative appraisal (Grant and Booth, 2009). Determining inclusion or exclusion of an article is subject to biases such as the authors' determinations in selections of databases and papers. Future research should explore this research question with other review methodologies. It should further expand a search to other databases and consider published-offline and conference papers as well as white papers. In total, there are thirty-four articles that met the criteria (see Table 1).

Database	ISI	TRIS	Scopus	ProQuest
Initial results	813	734	1087	249
Carpool-related articles	214	152	254	39
Carpool-related psychological factors	21	24	26	3
Total articles excluding duplications			34	

Table 1: The search results of four databases

Search results

The first article studied on psychological factors was written by Horowitz and Sheth in 1977. There are only ten articles for almost three decades before the year 2004, the year of technology-enabled ride-matching (Chan and Shaheen, 2012). Figure 1 suggests that since 2004, articles have been published increasingly. Interestingly, there are five articles published since January of 2018. This suggests that researchers are increasingly interested in this topic. This may be because of the awareness of sustainable mobility as well as the advances in ride-sharing technology (Shaheen and Cohen, 2018). Twenty-eight articles are published in transportation-related journals (see Table 2).

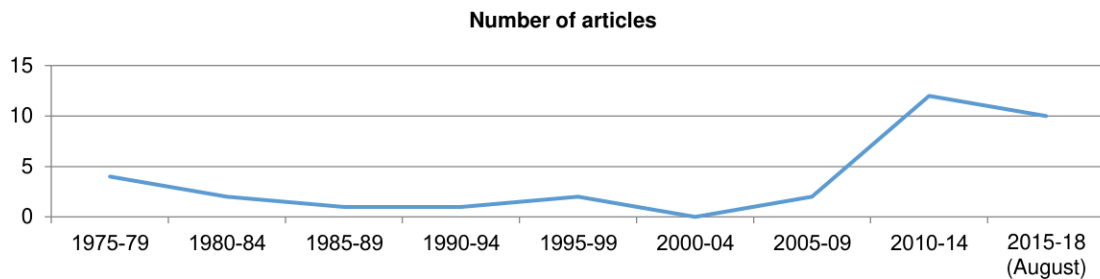


Figure 1: Numbers of articles published in a period of five years

Journal	Num	Journal	Num
Journal of the Transportation Research Board	8	Journal of the Eastern Asia Society for Transportation Studies	1
Transportation Research Part A	7	Journal of Advanced Transportation Environment and Behavior	1
Transportation Research Part D	2	Journal of Services Marketing	1
Transportation Research Part F	1	Bulletin of the Psychonomic Society	1
Transportation	4	Journal of Applied Social Psychology	1
Transportation Planning and Technology	3		
Transport Policy	3		

Table 2: Numbers of articles published in each journal

Regarding to methodology, consistent with Neoh *et al.* (2017), most articles are empirically driven. Survey data drawing from various sources such as highways, high-occupancy vehicle (HOV) lanes, and government survey was mostly used. Few articles conducted research in theoretically driven manner (e.g., Dickinson *et al.*, 2018; Neoh *et al.*, 2018) and adopted alternative methods such as in-depth interview (Owens, 1981), focus group (Malodia and Singla, 2016), and ethnographic interview (Gergen, 1973). Data in most articles were collected in Western countries (i.e., US, Canada, UK, French, Portugal, Netherlands, Denmark, and New Zealand). Only two are non-Western countries which are India (Malodia and Singla, 2016) and Japan (Yotsutsuji *et al.* 2013).

Borrowing models and theories from other related-disciplines could be useful for future research (Neoh *et al.*, 2017). In-depth interview, focus group, and experimental design should be used more in future studies. Understanding carpooler behaviour is an understanding of changes in people which is not easy (Nielsen *et al.*, 2015). Future research should adopt various methodologies and explore more in non-Western countries, especially, a country that does not have a HOV lane. This lane is an intervention method that offers rewards (i.e., travel time savings) to carpoolers. Reward is offered in order to increase the frequency of responding of people (Gergen, 1973). Without such reward, carpooler's motivations might be different. Intention-behavioural gap is another serious issue. Owen (1981) found that attitudes toward carpooling did not affect behaviour. Nielsen *et al.* (2015) also suggested that individuals hardly shift transportation mode. Stated preference is subject to limitation. It is also sensitive to socially desirable bias when researchers asked respondents about environmental-related questions (Malodia and Singla, 2016). Longitudinal study might mitigate this limitation. A good example of such study is the study by Wang and Chen (2012); however, the authors studied on household carpooling. Longitudinal study comparing stated and revealed preferences on psychological

factors for non-household carpooling should be used in future research.

Psychological factors

Twenty-five articles do not specify the role of carpoolers (see Table 3). This is consistent with Neoh *et al.* (2017). The set of none-specified factors should be further considered in future research by testing the factors regarding the role of carpoolers. In this set, there are four factors (altruistic, perceived peer pressure, positive attitude towards group members, and a sense of belonging to the community) that have not been tested regarding on the role of participants. Among all of thirty-four articles, nine articles studied the factors separately on either drivers or riders (see Table 4). Three factors in the set of factors for drivers (economic advantages, pro-environmental, responsibilities to one's family) and one factor in the set of factors for riders (socialisation) show conflict results. Future research should continue to test these factors. Furthermore, five factors from the set of factors for drivers (i.e., prosocial, empathy, shared experience, companionship, positive attitude towards carpooling) should be tested on the role of riders. Furthermore, emotional-related factors (e.g., empathy, frightening, anxiety, enjoyment, trust) have been rarely tested in the literature. It should be noted that, in Neoh *et al.* (2018), one possible reason explaining why the latent named "responsibilities to one's family" was not significant is that the latent might not be purely emotional-related factors (i.e., "caring"). As emotion is a part of psychological factors (Kotler and Armstrong, 2010), future research should study more on these factors as well as other types of emotions.

Factors that do not clarify the role of participants		Authors
Significant/found	Non-significant/not found	
Convenience, Pleasant, Comfort, Economic advantages	n/a	Horowitz and Sheth (1977)
Convenience, Schedule flexibility, Cost-saving, Safety	Comfort	Margolin <i>et al.</i> (1978)
Cost-saving, Socialisation	n/a	Tischer and Dobson (1979)
Convenience, Comfortable	n/a	Dumas and Dobson (1979)
Friendship, Convenience, Enjoyment, Positive attitude towards the group	n/a	Owens (1981)
Pro-environmental	n/a	Flannelly and McLeod (1989)
Commute cost	n/a	Young (1995)
Prosocial, Trust	Pro-environmental	Van Lange <i>et al.</i> (1998)
Save time, Enjoyment, Pro- environmental, Socialisation Cost- saving	n/a	Li <i>et al.</i> (1998)
n/a	Pro-environmental, Cost-saving	Buliung <i>et al.</i> (2009)
Cost-saving, Pro-environmental, Socialisation	n/a	Canning <i>et al.</i> (2010)
Unspecified motivations	Cost-saving, Altruistic	Buliung <i>et al.</i> (2010)
Cost-saving	n/a	Correia and Viegas (2011)
Cost-saving	n/a	Akar <i>et al.</i> (2012)
n/a	Pro-environmental, Cost-saving	Buliung <i>et al.</i> (2012)
Saving money, Reliability of carpooling, Socialisation, Saving time	n/a	Abrahamse and Keall (2012)
Socialisation	n/a	DeLoach and Tiemann (2012)
Positive attitude towards group	n/a	De Almeida Correia <i>et</i>

Factors that do not clarify the role of participants		Authors
Significant/found	Non-significant/not found	
members		<i>al</i> (2013)
Cost-saving, Flexibility, Comfortable, Socialisation	n/a	Nielsen <i>et al</i> (2015)
Economical advantages, Pro-environmental, Positive feelings towards carpooling	n/a	Malodia and Singla (2016)
Pro-environmental, Comfortable	n/a	Delhomme and Gheorghiu (2016)
Prosocial, A sense of belonging to the community, Convenience, Monetary gains, Personal benefits	n/a	Guyader (2018)
Pro-environmental, Financial incentives, Schedule reliability, Perceived peer pressure, Positive attitude towards carpooling	n/a	Gheorghiu and Delhomme (2018)
n/a	Trust, A sense of community	Dickinson <i>et al.</i> (2018)

Table 3: Psychological factors which the articles do not specify the role of carpoolers

Despite the fact that technologies facilitating ride-sharing have shaped traveller' behaviour (Dickinson *et al.*, 2015), only seven articles conducted research under the context of ride-matching technologies. Five articles studied in the context of web-based ride-matching technologies: Carpool Zone (Buliung *et al.*, 2009, 2010, 2012); Let's Carpool (Abrahamse and Keall, 2012). Three articles used ride-matching apps: Notteko! (Yotsutsuji *et al.*, 2013); FacePorter (Tahmasseby *et al.*, 2016); BlaBlaCar (Guyader, 2018). Future research should study psychological factors under the context of ride-matching technology.

Factors for drivers		Authors
Significant/found	Non-significant/not found	
Economic advantages	n/a	Levin (1982)
Convenience	Cost-saving, Pro-environmental	Arbour-Nicitopoulos <i>et al.</i> (2012)
Prosocial	n/a	Yotsutsuji <i>et al.</i> (2013)
Prosocial, Empathy, Shared experience, Socialisation, Enjoyment, Trust, Safety	Monetary incentives, Frightening, Uncomfortable	O'Brien and Dunning (2014)
Companionship, Convenience, Positive attitude towards carpooling	n/a	Devarasetty <i>et al.</i> (2014)
Pro-environmental, Convenience	Monetary incentives	Tahmasseby <i>et al.</i> (2016)
Convenience, Socialisation, Flexibility, Cost-saving	n/a	Park <i>et al.</i> (2018)
n/a	Responsibilities to one's family	Neoh <i>et al.</i> (2018)

Factors for riders		Authors
Significant/found	Non-significant/not found	
Comfort, Convenience	n/a	Levin (1982)
Socialisation, Enjoyment	Anxiety	O'Brien and Dunning (2014)
Convenience, Time savings, Monetary savings	Pro-environmental, Socialisation	Shaheen <i>et al.</i> (2016)
Pro-environmental, Monetary savings, Convenience	n/a	Tahmasseby <i>et al.</i> (2016)

Factors for drivers		Authors
Significant/found	Non-significant/not found	
Safety, Flexibility, Cost-savings	n/a	Park <i>et al.</i> (2018)

Table 4: Psychological factors regarding the role of carpoolers

Discussion and conclusion

De Almeida Correia *et al.* (2013) stated that attracting individuals to carpool could be done through psychological interventions. There are eight common factors for both drivers and riders (i.e., Cost-saving, Convenience, Flexibility, Safety, Trust, Socialisation, Enjoyment, Pro-environmental). These should be useful for practitioners who seek to create an intervention program. For any intervention program, the benefits proposed and messages communicated to individuals should be at least consisted of these encouraging factors. Since governments and public agencies (e.g., environmental agencies, and traffic management agencies) are interested in reducing urban problems by means to promote efficient car use, the factors found in this manuscript might increase the effectiveness of intervention campaigns. Regarding business implication, companies desire to increase their users and aim at addressing the problem of chicken-and-eggs (Furuhata *et al.*, 2013). Psychological factors might be helpful for their carpool programs and schemes to build the critical mass.

Important evidence found in the results is that there are articles found significances and non-significances of the same psychological factor. For example, perceived environmental concerns were significant in some studies but not in the others. Shaheen *et al.* (2016) found that environmental and socialization motivations were not major factors for riders of casual carpool. However, in the latter study, Gheorghiu and Delhomme (2018) found that these motivations emerged in the later trips of carpooling. This is also the same to other encouraging factors such as socioeconomics (see, e.g., DeLoach and Tiemann, 2012). This evidence gives us some senses that carpool behaviour might be better understood through different stages. As individuals' motivations change due to experiences they receive (Kotler and Armstrong (2010), psychological factors that make individuals start, maintain, and stop carpooling might be different. One can see in the case of casual carpool in the study by O'Brien and Dunning (2014). Carpoolers reported that they did not know each other but later on they quickly became mutual friends. This also supports findings of Gheorghiu and Delhomme (2018) by suggesting that the relationship between drivers and riders were changing dynamically through time that they participated in carpooling. We expect that the results from previous studies both significant and non-significant might be all indeed significant if researchers test them according to a particular stage of carpool cycle. Developing the carpool cycle might be an urgent need (Neoh *et al.* 2017).

Some studies explored the formation of carpool (Abrahamse and Keall, 2012), experiences of carpoolers (O'Brien and Dunning, 2014; Guyader, 2018), and the reasons explaining why carpoolers had stopped carpooling (Akar *et al.*, 2012; Nielsen *et al.*, 2015). These articles could serve as a guideline for developing the carpool cycle. Factors discouraging carpooling could also be illustrated in the perspective of the factors encouraging car use (Abrahamse and Keall, 2012). For example, individuals disliked carpooling because they felt lack of flexibility and carpooling made them depending on others while solo driving was in the opposite. This is not surprise and consistent with Neoh *et al.* (2018) who conducted a study examining on car-use motivations and concluded a set of carpool motivations. Knowing the carpool cycle may allow researchers to understand more of carpool behaviour and know more how to encourage them to carpool via carpool programs and schemes (Neoh *et al.*, 2017). Transportation researchers might need theories from other related domains to develop the carpool cycle. Theory in marketing is not new for transportation researchers. For example, market segmentation is the approach frequently used in marketing filed to understand consumer behaviour (Smith, 1956) and have been used in three articles found in the search results (Margolin *et al.*, 1978; Koppelman *et al.*, 1993; Nielsen *et al.* 2015). As mentioned at the beginning, researchers have requested for an effective marketing campaigns and interventions in order to promote sustainable mobility. Market segmentation theory alone applied in research on carpool might sufficiently to help understand complexities of carpoolers. Transportation researchers may now need to borrow other theories from marketing (e.g., consumer behaviour, consumer buying decision making, and social marketing), conceptualise them in

the context of carpool, and develop a framework that helps understand a holistic view of carpool behaviour.

This systematic review contributes to three folds. First, it used the theory from marketing as the basis understanding of psychological factors of carpooling. Second, based on the systematic review of this manuscript, this is the first systematic review on psychological factors of carpooling. Finally, based on the results from the search, this study illustrated the trend of research on carpool-related psychological factors, summarised factors used in the articles, and suggested several future research on this topic.

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