

Factors that influence women's participation in public bicycle-sharing programs: A critical review

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Abstract: Public bicycle-sharing programs has received increasing attention as a sustainable transport alternative to address the challenges of global motorization and climate change. Bikesharing, a shared use of a bicycle fleet, is presumed to contribute towards healthy lifestyle, energy savings and efficiency. However, the way bikesharing is planned and operated presents major challenges to its users, yet limited scholarly work addresses its social dimension, particularly the extent to which specific subgroups are transport-disadvantaged. Through a systematic literature review, and by using the socio-ecological model as its analytical framework, this paper aims to address: *the mobility/accessibility challenges, barriers/facilitators, and factors affecting the decisionmaking process of women bikesharer/cyclist*. By generating a better understanding of how transport affects the travel behaviour of women and how women are likely to experience transport disadvantage in the use and uptake of bikesharing calls for increased women's involvement in transportation policy-making and leadership.

Keywords: active transport, non-motorised transport, sharing economy, transport disadvantage, women, gender issues in transport

1. INTRODUCTION

Traveling is derived from an individual's desire to participate in one or several opportunities in our urban areas. Whether we would like to go to work, go to school, socialise with friends, go shopping, or visit a health facility, our transportation decision is influenced by the level of mobility and accessibility a particular transport mode affords. Yet the way our transportation is presently planned, implemented and operated have continuously presented major challenges, particularly in not being able to adequately respond to the different travel requirements of individuals and groups in our society, leaving children, the elderly and women the most affected and disadvantaged.

Gender is a significant factor that influences our daily travel behavior and decisionmaking. Several studies have shown that gendered differences in transport were demonstrated in travel patterns of individuals in terms of distance travelled, mode of travel, and trips purpose, frequency and complexity (Dowling, Gollner and O'Dwyer 1999; Hamilton and Jenkins 2000; Law 1999; Rosenbloom 1989; 1996). This calls for greater understanding and sensitivity to the needs of these different demographic subgroups, particularly women, who comprise more than half of the global population, so as to achieve a more sustainable and inclusive society.

Bicycle sharing is one transport strategy that contributes towards achieving the sustainable and inclusive agenda in cities. Public bicycle-sharing programs (PBSP), a shared use of a bicycle fleet, have received increasing attention not only as a sustainable transport alternative but also as an inclusive transport mode to address socio-spatial disadvantage (DeMaio, 2009, Shaheen et al., 2010, Zhao et al., 2015). Similar to other non-motorised means of transport, it has always been associated with healthy lifestyle, energy savings and efficiency (Shaheen et al., 2010, Castillo-Manzano et al., 2015). However, to date, limited scholarly studies have addressed its social dimension, particularly its impact on specific subgroups (e.g. female participation).

This paper seeks to explore the potential factors that may contribute to the bikeshare participation of women in order to shed light on developing not only a sustainable but also a more equitable and inclusive transportation system, by answering the following three questions:

1. What mobility and accessibility challenges do women experience in relation to bikeshare/cycling use?
2. What are the barriers and facilitators to their use of bikeshare and/or cycling?
3. What are the different factors considered in the decisionmaking process of women bikeshare/cycling users?

As an initial step, this paper aims to critically review secondary scholarly work in the area of gender and bicycle sharing. It will initially seek to gain a better understanding of the difference in male to female travel behaviour, then go through the selection process to identify relevant literatures.

This section is followed by a critical review on gender and transport with the aim of establishing the gendered difference in transport behaviors. Subsequently, the systematic literature review (SLR) which is the methodological design employed by this paper is described. This is then followed by the Results and Findings to the three research questions. It utilizes the socio-ecological model framework to systematically aggregate results.

2. CRITICAL LITERATURE REVIEW

The cities of the developing, transitional economies differ greatly in economic, political and demographic characteristics (Gwilliam, 2003). As such, different modes of transport and transport systems are employed to cater to the needs of society, in relation to the travel characteristics of its community.

2.1. Gender and transport

Travel behaviour of women is dependent on the roles and responsibilities associated with the different stages of their life cycle (Turner and Fouracre, 1995). Jones et.al. (1983) defined the life cycle groups in relation to family structure and age, and explained how travel characteristics of individual and household differed over the life cycle groups. Significant differences were exhibited in the travel pattern of women as they shift from younger, married females without children to mothers of schooling children. Men's travel pattern on the other hand, did not significantly change throughout the family life-cycle.

2.2. Trip-chaining and care-giving

Care-giving responsibilities and gendered social roles further complicate the travel pattern of women. By the time women conceive and have children, their travel behavior is largely dependent on their parental as well as their household responsibilities. Rosenbloom (1996) described women's travel as consisting of trip chaining (particularly those with children), doing home-related errands, shopping and addressing concerns related to safety concerns, as well as prioritising their activities according to the limitations imposed by time and space in their daily schedule. Typical travel patterns of Australia women consist of undertaking linked trips, and is highly associated with women's social role as the family taxi driver (Lang 1992). Rosenbloom also noted women's lack of lifestyle options and choice of transport mode due to constraints imposed by financial difficulties, single-parent status, or distance and location of residential home, which has not been extensively examined.

The gendered social role of women is further supported by the findings of the survey conducted by Dowling and Lyth (2003) and Flood and Barbato (2003). The study shows that more trips are made by females compared to males in order to "serve" their households or children. Women also travel twice as much as men to do shopping and are more likely to conduct chauffeuring of household members. The drop-off and pick-up activities of men with children is about one tenth of men's trips, which is considerably lower as compared to those of women with children, which is one fifth of the total trips they make.

2.3. Bicycle sharing, evolving generations

Since 28 July 1965 the first bikeshare programs – White Bikes – launched in Amsterdam, bikeshare has undergone three generations: free bike systems, coin-deposit systems and IT-based systems (DeMaio, 2009, Shaheen et al., 2010). The current generation includes a series of improvements on technologies, such as auto-locking bicycle racks at docking stations, personal check-in/check-out smartcards, wireless communication technology such as global positioning system (GPS), mobile phone access, etc. (DeMaio, 2009, Ricci, 2015). The first two generations mostly happened in European countries and North America, while Asia and South America did not have bikeshare until the third generation (Shaheen et al., 2010). DeMaio (2009) and Shaheen et al. (2010) also predicted that the future bikeshare systems will tend to have flexible and improved distribution of docking stations, electric (pedal assistance) bikes, integration with other transport modes, etc.

During 50 years since bikesharing programs have been implemented, some common challenges are addressed in association with bikeshare planning, implementation and operations, including bicycle theft and vandalism, bicycle redistribution, information systems, insurance and liability considerations, and prelaunch considerations (Shaheen et al., 2010).

Since bikeshare is a relatively new topic, only a limited number of studies addressed the challenges faced by some underrepresented groups. For example, little cycling and PBSP research has focused on the older adults who are a rapidly growing population (Winters et al., 2015). In addition, women and residents of deprived areas were also underrepresented in some cities such as London (Goodman and Cheshire, 2014).

In recent years, a large number of studies focused on cyclist behaviours when using PBSP and users' rationale to use bikeshare, such as the user destination choice preference (Faghih-Imani and Eluru, 2015), users' preference change from bikeshare to bicycle ownership (Castillo-Manzano et al., 2015), bikeshare for holiday cycling (Kaplan et al., 2015), to name a few. Gender, as a key demographic component, has been mentioned in many scholarly articles. However, no article has mainly focused on gender issues, some of the scholarly articles that did made only a very brief discussion of gender-based differences. In general, the majority of PBSP users tend to be younger, affluent and well-educated male who are more likely to be engaged in cycling (Bernatchez et al., 2015, Ricci, 2015).

3. METHODOLOGY

Two electronic databases (Web of Science and Scopus) and Google Scholar were searched for published articles investigating the female behaviour on bikeshare. Google Scholar was only used as an alternative search tool and most articles from Google Scholar can be also found in Web of Science and/or Scopus. The combination of "bike/bicycle" and "share/sharing" were used in the initial search. Since PBSP is a relatively new research topic, it was found that most bikeshare articles were published after 2012. There were 851 articles in Web of Science and 569 articles on Scopus mentioned bikeshare. The timeframe in this review was set for after 2013, which included 370 articles on Web of Science and 280 articles on Scopus. Then the research focusing areas were narrowed into categories of "transport", "social science", "women's study", "urban studies" or "demography", and "gender", "female" or "women" were used as key words. 44 articles were left and their titles and abstracts were reviewed. At last, a total of 13 articles met the criteria and were included in this review. To group and structure the findings from these 13 articles, a social ecological model based on McLeroy et al., (1988) was used and all the findings were then categorised into five levels: individual, interpersonal, institutional, community and public policy. The summary of articles is depicted in Table 1.

Table 1 Summary of Articles

Study	Location	Methodology	Social ecological model				
			Individual	Interpersonal	Organisational	Community	Public policy
Beecham and Wood, 2014a	London, UK	Data analysis	✓	✓			
Beecham and Wood, 2014b	London, UK	Data analysis	✓		✓		
Bernatchez et al., 2015	Montreal, Canada	Telephone survey and multivariable logistic regression analyses	✓		✓		
Buck et al., 2013	Washington, D.C., USA	Data analysis and surveys	✓				
Castillo-Manzano et al., 2015	Seville, Spain	Fieldwork based survey and discrete choice model	✓				
Faghih-Imani and Eluru, 2015	Chicago, USA	Data analysis and random utility maximisation approach in the form of a multinomial logit model			✓		✓
Goodman and Cheshire, 2014	London, UK	Data analysis, survey and geographic and comparative analyses			✓		✓
Goodman et al., 2014	London, UK	Observation, data analysis and raw percentages and multivariable logistic regression analyses.	✓				✓
Murphy and Usher, 2015	Dublin, Ireland	Questionnaires	✓	✓	✓		
Ricci, 2015		Literature review	✓				
Vogel et al., 2014	Lyon, France	Data analysis and cluster analysis	✓				
Wood et al., 2014	London, UK	Data analysis	✓		✓		
Zhao et al., 2015	Nanjing, China	Data analysis, z-score analysis, visual analytic techniques and chi-statistic	✓	✓			

The 13 articles selected are mostly studies from European countries and North America. Only one article was the study of a Chinese city. In addition, 12 articles selected focused on a single city. Particularly, London was the most ‘popular’ city since 5 articles included were based on the analysis of London.

Analysing the datasets from cities’ bikeshare usage and users’ demographic information and survey were the most common methods used in the 13 articles. Other methods used also included literature review and observation. Different models were adopted to analyse the collected information.

Based on the review, the factors which were identified were categorised into a 5-level social ecological model of health behaviour (McLeroy et al., 1988). Table 2 summarises these identified factors based on the model.

Table 2 Identified factors based on social ecological model of health behaviour

Social ecological model				
Individual	Interpersonal	Organisational	Community	Public policy
Awareness of PBSP Concerns of safety risks Educational attainments Personal purpose Age Income level	Family members Friends Colleagues	Traffic condition Availability of infrastructure Land uses		Access to casual use

The summarized results from Table 1 indicate that most of the articles addressed the factors in individual level and that many articles also identified some factors from organizational level. No article can be found which addressed any factors from community level, however, Beecham and Wood (2014a) identified that women tend to do group-cycling journeys which indicates some facilitator such as the establishment of group-cycling associations can be considered locating in community level. Only one factor was found in public policy level but was addressed in three articles.

4. DISCUSSION

Overall, males still play a dominant role in cycling, as well as in bikesharing (Ricci, 2015). In this part, this paper seeks to explore the factors resulted in the low participation of women in cycling and PBSP by concluding the findings from literature review structured around three research questions which are illustrated below.

Research Question 1. What mobility and accessibility challenges do women experience in relation to bikeshare use or cycling use?

Based on the review, most of the mobility and accessibility challenges are all from individual level, for example, this review identified that these challenges are from women’s awareness of PBSP and their concerns of safety risks.

Survey-based evidence in Montreal, Canada showed that females are more likely to be ‘PBSP-unaware’ compared to male groups (Bernatchez et al., 2015). The possible reasons for the lack of awareness of PBSP to a large extent are related to people’s lower educational attainments and absence of public bicycle docking stations within walking distance, however, no evidence showed that there are different results between males and females (Bernatchez et al., 2015).

Several reviewed articles addressed that women are more concerned about their safety risks when cycling than men (Beecham and Wood, 2014a, Beecham and Wood, 2014b, Murphy and Usher, 2015). Murphy and Usher (2015) concluded from other studies that females tend to be more reluctant to cycle because of the associated safety risks, this is a causal reason for the imbalance of male and female participation in PBSP. In addition, Beecham and Wood (2014a) concluded from analysing data from London Cycle Hire Scheme (LCHS) that women feel safer when cycling in groups and the authors also argued that women tend to choose comparatively slow and low-traffic routes in comparison with another study (Beecham and Wood, 2014b). This safety risk is also associated with the factor of traffic condition, which is identified as a barrier to the use of bikeshare for women and will be discussed later. Lastly, Garrard et al. (2008) also observed from a survey in Australia that some aggressive vehicle drivers may affect the women to cycle.

Some mobility and accessibility challenges such as the availability of infrastructure and traffic condition, which are also identified as barriers or facilitators to women in the use of PBSP or cycling, will be discussed in the next research question.

RQ2. What are the barriers and facilitators to the use of bikeshare and/or cycling to women?

Based on the review, most articles seek to find some specific barriers and facilitators to the use of bikeshare to women. These barriers and facilitators are located in different levels, from individual to organisational. They may also exist in community level.

4.1. Individual level

In individual level, some demographic factors such as age and income level were identified as possible barriers. However, these factors vary from different cities.

Some cities reflected that aging issue is a barrier. Based on the results from surveys and dataset analyses in the reviewed articles, the overall situation in most cities is that PBSP users tend to be younger (Buck et al., 2013, Bernatchez et al., 2015, Ricci, 2015). Winters et al. (2015) addressed that cycling rates among older adults (over 60 years old) are extremely low throughout North America. It is possible that female PBSP users are younger but it needs further studies in order to clarify. However, there are also some exceptions. In some cities, the gender and age profiles did not display strong differences, for example, Vogel et al. (2014) found that there is no distinct contrast between men and women in Lyon, France and Castillo-Manzano et al. (2015) found that age and gender do not appear to be factors that affect the use of PBSP in Seville, Spain.

Different income levels among females result in different levels of participation in bikeshare. Ricci (2015) concluded from reviewing literatures that the PBSP users are more likely to be affluent. The result is consistent with London where studies showed that female users were generally from affluent inner city areas (Beecham and Wood, 2014a, Beecham and Wood, 2014b, Ricci, 2015). However, based on the data analysis from the bikeshare system in Washington, D.C., users are more likely to have lower household incomes among women (Buck et al., 2013).

4.2. Interpersonal level

All the elements from interpersonal level identified are seen as facilitators or barriers to the use of bikeshare to women. These factors include family members, friends and colleagues.

Family members can be either a barrier or a facilitator for women to use bikeshare. On the one hand, Rodríguez and Joo (2004) argued that evidence has shown women use non-motorised transport to undertake household responsibilities. In addition, Bopp et al. (2014) identified in women who have children that their participation in physical activity is affected. Zhao et al. (2015) provided evidence which showed that women tended to use PBSP to finish more complex trips on household and childcare related tasks. On the other hand, Murphy and Usher (2015) argued family members, particularly children, are also a barrier in the use of bikeshare to women since activities such as shopping and transporting children to school are more likely to be adopted by the private cars instead of by public transport or cycling.

The influence from friends facilitates women in using bikeshare or cycling. Bonham and Wilson (2012) found that social or group cycling can increase the participation of female in cycling and Beecham and Wood (2014a) identified that this result is consistent with the use of PBSP in London. Compared with the male users, female PBSP users preferred to cycle in groups, notably the “first time group cyclists” – cyclists who attend the group cycling for the first time – are overrepresented by female users (Beecham and Wood, 2014a). In addition, the analysis also showed that 92% of female users who were “first time group cyclists” were with their best friends who are mostly male (Beecham and Wood, 2014a).

The last factor from interpersonal level is colleagues which is identified as a facilitator by Bopp et al. (2014) but it can be a barrier identified by Murphy and Usher (2015). Bopp et al. (2014) addressed that co-worker normative beliefs can influence women’s participation in cycling to and from work. However, Murphy and Usher (2015) identified a barrier associated with colleagues in that women are less likely to use PBSP since they care more about their appearance at work than men and do not want to arrive at work in a dishevelled manner. This barrier is also associated with the factor of availability of some end-of-trip facilities at workplaces, which is addressed in the organisational level.

4.3. Organisational level

Most of the factors from organisational level are identified as barriers and/or facilitators. As mentioned in the mobility challenge, heavy traffic conditions are associated with the women’s concerns of the safety risks and it is an obvious barrier to the use of PBSP to women. The concerns result in women tending to use slow and low-traffic routes when using PBSP and eventually decrease their participation into cycling (Beecham and Wood, 2014b).

Based on the issues addressed in some reviewed articles, the availability of cycling or bikeshare infrastructure, including cycle path and cycle facilities, are a barrier or facilitator to the use of bikeshare to women (Faghih-Imani and Eluru, 2015, Beecham and Wood, 2014b, Murphy and Usher, 2015). Only one article was found which observed that people tend to use PBSP where with access to longer bicycle paths nearby, but no discussion about the differences between genders (Faghih-Imani and Eluru, 2015). Furthermore, no articles were found but it is a possible facilitator that the segregated cycle paths have a positive influence on women in the use of PBSP since their concerns of safety risks which discussed in the first research question. In relation to cycle facilities, the factor of availability of facilities can be only found in association with women commuters (Murphy and Usher, 2015). As mentioned in the interpersonal level, the impression of work colleagues negatively affected women in using PBSP to and from their workplaces. The authors also found that the participation to women will be lower if there is no access to shower and dress changing facilities at workplaces (Murphy and Usher, 2015). Further evidences are also provided in the article proved that the provision of such facilities will increase the participation of cycling to women (Murphy and Usher, 2015).

Faghih-Imani and Eluru (2015) argued that some land uses can increase the use of PBSP. There are some studies in London showing that women are more likely to use PBSP in some big parks (Goodman and Cheshire, 2014, Beecham and Wood, 2014b, Wood et al., 2014). This can be explained by the purpose of the women using PBSP: women tend to use PBSP in a leisure and recreational function, comparing to men who use PBSP as a commuting and transport function (Goodman and Cheshire, 2014, Beecham and Wood, 2014b, Wood et al., 2014). The leisure and recreational function results in women using bikeshare more in weekends than weekdays, while men who use bikeshare mainly for commuting and transport function and it can be seen that male usage is more on weekdays than weekends (Goodman and Cheshire, 2014, Beecham and Wood, 2014b, Wood et al., 2014).

4.4. Community level

No reviewed articles addressed any factors in community level. Nevertheless, the most important component of community level – community norms – can be a facilitator or a barrier to the use of bikeshare to women. Further research can explore the influence on the use of PBSP to women by community norms. Specifically, studies are recommended to seek the evidence that addresses whether greater proportion of women who use PBSP will have a positive influence on more women in using PBSP.

RQ3. What are the different factors considered in the decisionmaking process of women? What are the different factors in transport decision making of women bikeshare/cycling users?

Although most of articles explored the facilitators and barriers to the use of bikeshare, fewer factors can be found which were considered in the decisionmaking process. To the author's knowledge, only LCHS adopted a short-term scheme use which addressed both bikeshare and female into decision making process.

From the review, extending PBSP access to ‘casual’ use will increase its use by females (Goodman and Cheshire, 2014). Since the factors which addressed as barriers and facilitators that women tend to use PBSP on weekends and to use it for recreational function, the observations based on Goodman et al. (2014) supported the evidence that the introduction of ‘casual’ use memberships has increased the use of PBSP by females in London. This result is also consistent with the PBSP in Washington, D.C., where it has been observed that women who are members make no or fewer trips than men per month (Buck et al., 2013), hence the casual use memberships may possibly increase the bikeshare use by women in Washington, D.C.

Faghih-Imani and Eluru (2015) addressed that examining the impact of travel distance, land use, built environment and access to public transport infrastructure on users’ destination preferences allow bikeshare system to operate more effectively. In addition, clear policy, public support and positive cycling culture are also essential elements needed to be considered in decision making process (Ricci, 2015). These factors are recommended for further research in the decisionmaking process of women bikeshare users.

5. DISCUSSION, SUMMARY AND CONCLUSION

When access to transport is accompanied by difficulties, this is known to be “transport disadvantage.” From this paper, we generated a better understanding of why women are one of those groups within the community likely to experience transport disadvantage more than others. By understanding how the transport system affected the travel behaviours of women and how it created transport disadvantage to this group, calls for increased women’s involvement in transportation policy-making and leadership. In addition, this paper also explored the different factors that have potential to influence women’s participation in public bicycle sharing programs. To systematically review the articles, it utilized a social and ecological model to better structure all identified factors.

Some recommendations can be drawn based on the discussion of challenges, facilitators and barriers, and they are recommended to be used in the future decision making process of bikesharing programs to women. Firstly, some necessary education or publicity may increase women’s awareness of bicycle sharing; secondly, providing the necessary and adequate infrastructure to support bicycle sharing and cycling, including relatively safe cycling environment and bicycle amenities such as end-of-trip facilities are key to women’s participation in cycling; thirdly, providing access to adequate bicycle sharing bikes near parks; and lastly, since women tend to cycle in pairs or groups, establishing some cycling or bicycle sharing groups or associations may appeal more to women to use bicycle sharing.

However, this review was limited to female behaviours in their use of public bicycle sharing programs. In addition, this review may not be exhaustive due to the short research time, only articles after 2013 were reviewed and only limited databases were searched. More important factors may not be addressed in this review but still have a significant influence on women to use bicycle sharing. Since bicycle sharing is a relatively new topic in study, particularly in other geographical settings such as ASEAN countries, further research is still required to gain a better and more comprehensive understanding in the use and patronage of public bicycle sharing programs of women and other underrepresented groups may need to be further explored.

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