Impact of the Transformation of Built Environment on Personal Travel Behavior in Historic Urban District

Dissertation Abstract

Impact of the Transformation of Built Environment on Personal Travel Behavior in Historic Urban District

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Abstract

This PhD research aims to evaluate the impact of historic district built environment (HDBE) on personal experience and travel behavior based on the framework of HDBE indicators and personal travel indicators under the intervention of regeneration project (RP). There is a lack of researches on the impact of the built environment (BE) on personal travel behavior under the intervention of neighborhood-scale improvement measures. The empirical study on the comprehensive assessment of BE impact on various transport modes in china's context also needs to be supplemented. Based on this, we select the case of Zhangzhou historic district in Fujian Province, China, which has been affected by the implementation of RP, focus on end-users travel behavior in the historic district and their experience feedback on HDBE. Based on department report data, measurement data, and social survey data, we establish before-after walkability indexes and traffic system indicators to identify the impact of HDBE change on private active travel and motorized travel combined with the survey of residents' walking behavior, visitors' parking behavior and activity behavior. Finally, we evaluate the social, economic, and environmental intervention content of RP through physical and community-based HDBE indicators, and identify the sustainable contents of regenerated HDBE recognized by end-users' feedback. The PhD research can provides targeted improvement strategies and environment supporting suggestions for the next phase of HDRP implementation.

Chapter 1.   Introduction

The urban regeneration language in the 21st century has changed. Sustainability is continuously explored in urban regeneration practice with increasing attention to the environment and social impact. In many countries, the practice for promoting declining historic areas through urban regeneration is increasing rapidly. As an initiatory spatial scale in most development projects, the transformation of urban regeneration on neighborhood's BE has been widely discussed. Especially in historic areas, urban regeneration is more complex and uncertain than general urban regeneration, always needs to consider and try to concurrently balance several potentially contradictory goals: historical resources' protection and modernizing development, social network preserving, and improving the structure of industrial structure and economical. Therefore, the impacts of urban regeneration in the historic district need to be paid more attention.

Researches on active travel (mainly walking) occupy the majority of existing research on the topic of persons' active travel and motorized travel. Many scholars measure different areas' walkability from a cross-sectional perspective and investigate the relationship between walking and health, BE and walking. However, a cross-sectional study is easily raised causal attribution (Ewing and Cervero, 2010). Furthermore, most current longitudinal studies focus on life events' impact, such as residential location or family status changes. Longitudinal studies' quantity on the correlation between BE and walking based under the intervention of regeneration measures or environment improvement measures in the same site is insufficient. These studies are also lack of consideration on walking perception and experience. Besides, a large number of walking studies are carried out in the context of western countries' cases (Bauman and Bull, 2007). China's high-density neighborhood environmental context is different from the sprawling western context, which brings great significance in longitudinal studies on the correlation between neighborhood's BE and walking behavior.

The research takes the ancient city historic district of Zhangzhou City, Fujian Province, China as the research object, to evaluate the change of BE under regeneration project (RP) intervention and its impact on persons' active travel (walking) and motorized travel (automobile) behavior and their feedback on the transformation of the historic district built environment (HDBE).

This dissertation is divided into six chapters. In the second chapter, we introduce the selection reason for the research area and the basic situation of the RP implementation. In the third chapter, we analyze the impact of the HDBE change on

residents' walking behavior and the specific affected walking travel content. In the fourth chapter, we discuss the impact of the physical change of HDBE traffic system on visitors' automobile travel. In the fifth chapter, through the establishment of HDBE hard (physical) and soft (community-based) indicators framework under RP intervention, and cross-sectional and longitudinal ex-post evaluation (EPE) system, we identify the contents of regenerated built environment recognized by end-users. In the final chapter, we summarized the research conclusions of the doctoral dissertation and put forward the future works that need to be further supplemented.

Chapter 2. Study area and regeneration practice

The research area is the Zhangzhou ancient city historic district. Zhangzhou is a mid-sized coastal city of Fujian Province in Southeast China. Its particular state of preservation was added to the list of National historical and cultural city in 1986. The historic district is located in a core part of Zhangzhou ancient city, which morphology is basically a structured grid square, and its scale is suitable for research.

The ancient city historic district has implemented several local renovations since 1988. Unlike the past, the first phase of RP started in 2015 is a comprehensive integration vision and action for the entire historic district. After the primary completion of phase I, more than 10,000 residents have been retained. The historic district is reopened to the public after the implementation of RP is a tourism destination with a comprehensive community for life, culture, and tourism and reopened to the public. The first phase of RP retains the original form of streets and alleys, mainly implements environmental design, traffic system optimization, commercial planning, and architectural renovation.

Chapter 3. Impact of the HDBE's transformation on residents' walking travel behavior

3.1 Introduction

A certain number of studies support the hypothesis that some improvement measures can positively affect pedestrians (Sun, 2014; Ewing et al., 2015). However, most quantitative researches on the topic related to BE and walking are cross-sectional and are easily raised causal attribution (Ewing, 2010). The majority of current researches are based on the case backgrounds of the United States, Europe, or Australia. In urban neighborhood BE scale, Asian cities, including China, with a high density and compact context, which are different from sprawling western context, and urgently need to supplement Asian cases. For the research on the correlation between

BE and walking, previous researches experience and shortcomings are summarized and absorbed; we put forward a more comprehensive measurement index and longitudinal framework.

3.2 Framework and method

In the first step, we summarized the developed walkability index and set up 23 HDBE walkability indicators of three groups, including street connectivity, destination accessibility, and perceived walkability. The final comprehensive walkability score is calculated by weight function. Then, we interpret the baseline of HDBE walkability and run paired sample t-test to examine the significant difference between before-after groups of walkability indexes. Analysis of covariance was run to identify the degree of difference between three groups of walkability index impact on the HDBE's transformation.
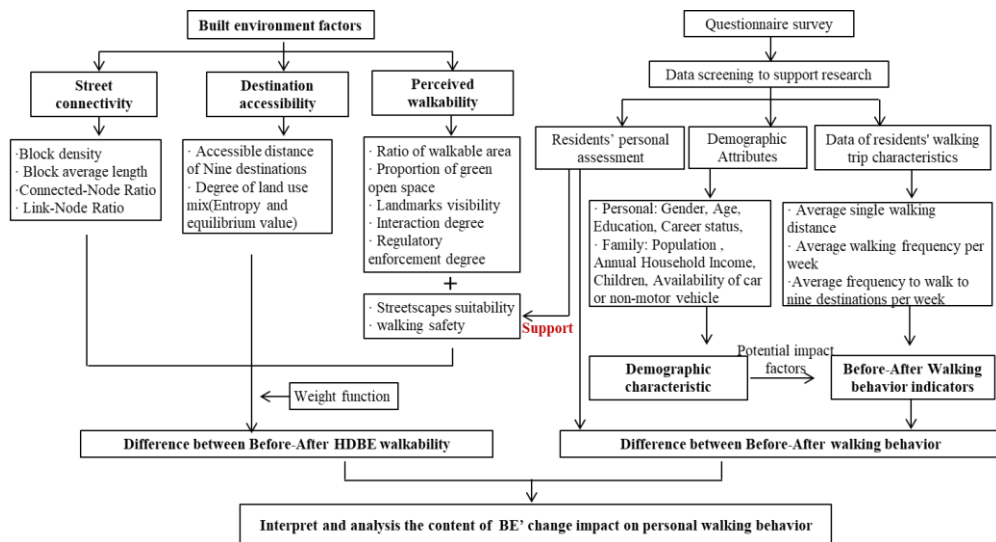

Figure 1Research framework

In the second step, we followed the quasi-longitudinal design and conducted a random family interview survey on community residents' walking travel experience. The survey also collected demographic information as covariates and divided into individual attribute and household attribute. Residents were requested to report a self-assessment of project implementation influence degree on the change of personal walking behavior, personal assessment of destinations with improved or reduced accessibility, and walking behavior measurement data. We performed a paired sample t-test to examine the measurement data of all samples' reports of before-after walking behaviors, confirm the significance of change, and perform Spearman correlation analysis to examine the statistical correlation between self-assessment results and demographic characteristics. A chi-square test was run to determine the subgroups

with significant differences in demographic variables.

Finally, sub-groups that changed significantly were separately run by paired sample t-test and Mann-Whitney-Wilcoxon test to explain the active intervention of BE's transformation on residents' walking travel.

3.3 Analysis result

The walkability score is improved significantly after the HDRP implementation. The result of the t-test indicates that there is a significant difference between before and after walkability. From ANCOVA analysis, we can identify that the perceived walking group's index has a greater contribution to the BE's transformation than the other two groups. It can be concluded that the significant improvement of BE walkability is mainly due to the improvement of walking perception in the district.

The results of the paired-sample t-test on all samples show significant differences in walking frequency and walking distance. Among them, the walking frequency has increased significantly. Results of the correlation test preliminarily confirm that there are differences in self-assessment results of four categories of demographic attribute variables (age group, education group, career group, and car group). Further chi-square test reveals that walking behavior of middle-aged and elderly classes, under high school class of education group and none-car class of automobiles group change significantly. Results of three subgroups further walking behavior tests show that HDBE change significantly promoted recreational walking behavior of middle-aged and elderly residents, and also promoted utilitarian walking of non-car residents and low educated residents to retail stores and restaurant destinations.

3.4 Conclusion of this Chapter

The HDRP has significantly improved perceived walkability, and residents have also reported a desirable walking safety and streetscape experience index. The walking perception change of BE can effectively promote recreational walking behavior, especially for the middle-aged and elderly. Besides, we need to consider other transport modes like driving to contribute a comprehensive strategy of BE impact on travel.

Chapter 4.   Impact of the HDBE's transformation on visitors' automobile travel behavior

4.1 Introduction

Although much evidence show that automobile ownership makes car dependence and affects travelers' attitudes and choices to public transportation or walking, the choice of personal travel mode still depends on the influence of personal specific circumstances (He and Thøgersen, 2017). The convenience advantages of an automobile in short distance travel, such as carrying goods, giving a lift, saving time or reducing the impact of adverse weather were studied and reported by many scholars (Forward, 1999; Cullinane and Cullinane, 2003; Mackett, 2003; Walton and Sunseri, 2010). Especially when destinations involve shopping trips or connecting two or more destinations, travelers are more likely to drive (Lee et al., 2017). Besides, when destination's BE with condition of optimized transportation system, diversified commercial types and walking friendly, it will improve visitors' number and satisfaction degree, increase commercial activities, and may indirectly attract private visitors to choose automobile travel to handle a possible long time recreation situation. Therefore, to confirm the impact of HDBE change on private automobile travel under RP intervention, we conducted quantitative analysis on the transportation system part of BE and assessed the driving environment and parking environment of the historic district after RP implementation. Combined with characteristics of visitor's activity behavior, we established the correlation between BE and private automobile travel, to further identify the positive factors that attract private automobile access.

4.2 Framework and method

The evaluation framework of impact is discussed base on three steps.

Firstly, we establish a before-after indicator system of the motorized traffic system, including longitudinal related urban road loading capability and longitudinal bus accessibility indicators. Road loading capability indicator is composed of traffic volume, traffic saturation, and road service level indicators of four related road sections in two directions. The bus accessibility indicator is composed of bus stop, bus line, and accessibility score in the calculation area. We assess the change of driving environment and parking environment through the before-after calculation results.

In the second step, we establish a static traffic indicator system, namely, parking lot usage indicator in the historic district. The physical construction of the district's traffic system under the intervention of HDRP is mainly reflected in parking lot configuration. Through continuous measurement method and discontinuous observation method to investigate two entrance underground parking lots. The data comes from the collection of real-time monitoring data in smart parking APP and

field surveys. The survey lasted for three consecutive days in January 2018, including a weekday and weekends.

In the third step, we set up a social survey on visitors. The survey sites are two underground parking lots in the historic district. Parking users who have just finished their visit activity and were ready to drive away were eligible for the investigation. Based on a quasi-longitudinal method, respondents are requested to report their previous parking status. Then, we collect activity behavior of parking users in the historic district, including consumption, activity area and activity duration.To establish the correlation of parking configuration and visitors, parking users also requested to report their estimates of parking configuration in historic district, self-assessment of influence of parking convenience on personal visit, and their attitudes towards automobile travel. The demographic attributes were collected as the covariate, including age, gender, number of passengers, annual personal income, visit identity, and visit frequency.
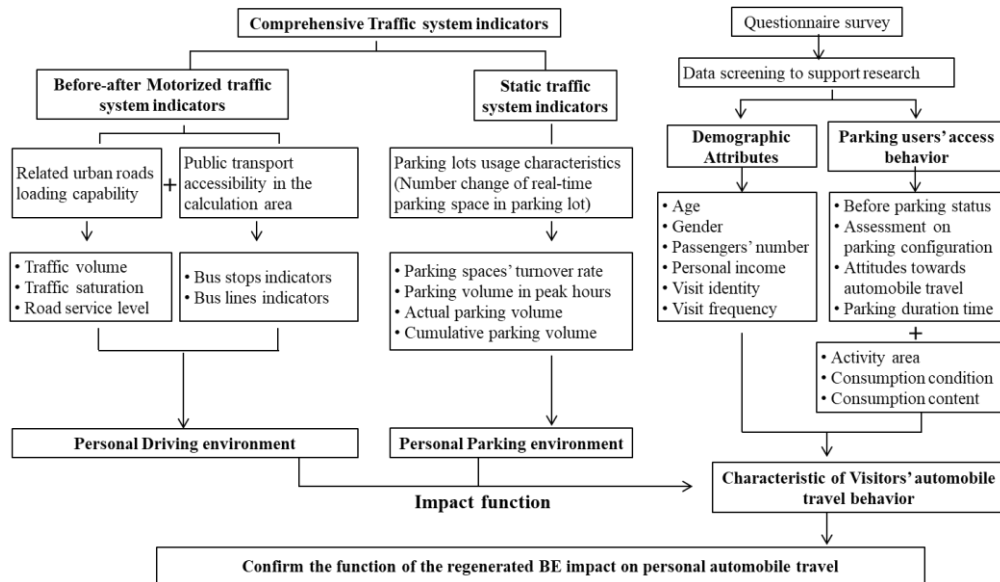

Figure 2 Research framework

4.3 Analysis result

The analysis results of before-after related roads' service level indicate that the construction of parking lots and traffic control do not aggravate surrounding traffic, and do not have a significant negative impact on personal driving experience. Therefore, we can exclude the negative effects and further analyze potential positive effects.

Although four bus stops and two ancient city special lines added after HDRP implementation improve the density and coverage of stops, there is no impact on the total bus accessibility score. However, the extremely low value of optimal coefficients

of public transit network and extremely high value of optimal coefficients of route distance reveal bus lines repetition rate is very low, and passengers have to endure very long waiting times. The convenience of bus access has not been substantially improved with the implementation of HDRP. The terrible experience caused by intolerable waiting time will reduce satisfaction of passengers' satisfaction and stimulate them to give up public transport. It is necessary to supplement the respondent's attitude of travel mode choice under an assumptive condition of ideal bus supply and convenience degree in subsequent analysis.

Analysis of use change of parking lots indicates that the traffic volume of private automobile visits at the weekends is higher than that on the weekday. The peak use period of parking on weekday is the night rest period after statistical peak hour, while the peak use period of north parking lot lasts from 10:00 to 21:00 on Saturday, and 15:00 to 21:00 on Sunday. Automobiles' parking duration time in parking lots at weekends is more extended than the weekday. We can make a preliminary hypothesis that parking configuration may promote recreational visits by private who travel using automobiles.

The information reported by respondent drivers indicates that most drivers have consumed, have multiple consumption content, and with a long sojourn time in historic district. Their consumption areas are concentrated in the street section around the pedestrian entrance of parking lots. A considerable part of these respondent drivers are high-income groups in Zhangzhou and carry more than one companions. For the impact of parking configuration, most respondent drivers have reported a positive impact. For their travel mode, even the bus supporting system in the area is convenient and impeccable, majority drivers still prefer to drive or need determine according to specific situation, only 20% of them are willing to switch.

4.4 Conclusion of this Chapter

The results support the hypothesis that parking configuration in the historic district improves parking convenience and access attitude of visitors, has a positive attraction on a recreational visit of private who travel using automobile and promote their consumption activities. For mid-sized cities which still in the stage of urban construction and motor vehicle flourishing development, appropriate parking events play a positive role in promoting private automobile visits and driving them to produce long-time recreation and consumption behavior.

Chapter 5. Ex-post impact evaluation of regenerated HDBE from personal perspective

5.1 Introduction

HDRP is more complicated than that of ordinary RP, and the conflict of stakeholders is also the critical factor that leads to failure (Yu and Kwon, 2011). As important participants that can affect the implementation result of regeneration strategy, end-users' view plays a crucial role in determining how to implement the plan. The existing assessment based on whole project lifecycle is broad and untargeted and does not well address local preferences and location-specific responses.

The circular feedback and promotion of continuous improvement of ex-post evaluation have been widely recognized (Hadjri and Crozier, 2009). In the field of urban planning, the experience and evaluation of actual users after implementation of regeneration is of great significance for feedback and promotion of programme. After a phase completion of RP, through appropriate EPE of end-users, effective content of the regeneration plan can be given effective feedback to a certain extent for decision-makers to improve the strategy and application environment further.

5.2 Framework and method

Quantitative and qualitative research strategies are adopted in the research. The evaluation system is carried out in three phases.

The first phase form HDBE indicators system based on the summarization of existing literature combines with tripartite stakeholders' interviews. Tripartite stakeholders include two staffs of government's subdistrict agency, three representatives of residents, and two urbanists involved in the conservation and regeneration project. Based on residents' and visitors' different experiences, 19 HDBE indicators of two groups in both hard (physical) and soft (community-based) aspects were summarized. 11 of the 19 indicators are common indicators.

In the second phase, a structured questionnaire was developed, and a survey was conducted based on HDBE indicators. The investigation is conducted by a field survey (resident group) and on-line (visitor group). Visitors have visited previously, and residents who have experienced HDRP implementation were eligible to participate. Respondents were requested to use a 5-point Likert scale to evaluate indicators from 1 point (very disagree / dissatisfied) to 5 points (very agree / satisfied) scale, of which 3 points were neutral attitude.

In the third phase, we ran the reliability analysis of the questionnaire, KMO and

Bartlett's test of sphericity. Then factor analysis is run to extract main factor groups. Through the mean value of each factor group, we interpret the result of users' satisfaction preferences. Besides, eleven common HDBE indicators are tested by independent sample t-test between resident and visitor, and eleven before-after HDBE indicators are tested by paired sample t-test to identify cross-sectional and longitudinal differences.
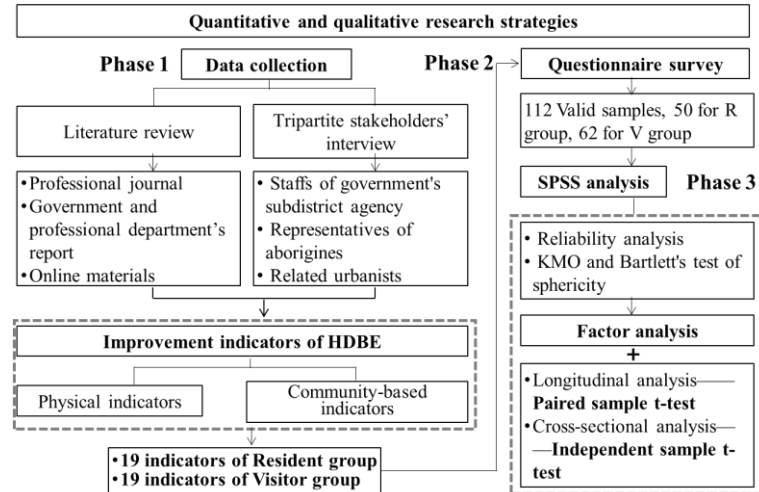

Figure 5 Research framework

5.3 Analysis result

Five main factors were extracted in the resident group, and the cumulative interpretative variance ratio was 70.14%. Four main factors were extracted from the visitor group, and the cumulative interpretative variance ratio was 67.12%. Combined with the mean value of each factor group, the resident group has the highest satisfaction with intervention outcome of HDBE space supporting, followed by historical environment protection, which has prominent local characteristics; the visitor group has the highest satisfaction with intervention outcomes of HDBE historical feature protection and environmental improvement. The two groups' common recognition contents are reflected in the effectiveness of HDRP in the conservation of historical features and environment support. However, daily facilities that serve residents and strategies of industrial and commercial economy need to be further improved in the next phase of HDRP.

5.4 Conclusion of this Chapter

Through bottom-up feedback of end-users on HDRP implementation, we identify the contents of the regenerated BE approved by end-users. HDRP promotes the construction of a pedestrian-friendly environment by improving the pedestrian environment and open space and is also recognized in the protection of historical features. As for the configuration and improvement of street furniture and parking

facilities, there is a particular gap between two groups of users due to a higher relationship with the tourism facilities. Besides, the content of the industrial economy and commodity economy strategy has not been significantly recognized. At present, HDRP implementation has only completed the first phase. In the next phase, it is necessary to further targeted support on facility configuration according to the service object, and further, optimize the industrial economy and commodity economy strategy. There is still a need for continuous assessment, not only for users but also for all other stakeholders.

Chapter 6.   Conclusions

In this PhD research we pay attention to the transformation of BE under RP intervention, and evaluate the impact of regenerated HDBE on travel behavior of residents and visitors, and their feedback on the transformation of HDBE.

The HDRP intervention has brought about a significant difference of before-after BE walkability, and the most significant transformation content is reflected in perceived walkability. The regenerated BE has a positive impact on recreational walking activities, especially for the middle-aged and elderlies. The conclusion that the transformation of BE affects recreational walking behavior is contrary to the conclusion in the sprawling context of western countries, including the US. The research provides a supplementary sample for walking study in high-density and compact traditional community environment in China. For the Zhangzhou city, which still in the stage of automobile's prosperous development, the HDRP implementation event plays a positive impact on private's automobile travel attitudes and promotes visitors who travel using automobiles to carry more companions to consumption and sustained recreation. Urban regeneration in the historic district is more complex and uncertain than general urban regeneration. The evaluation of residents and visitors reports a positive effect of RP in promoting a walking-friendly environment and protecting historical features, which provide a positive role for sustainable urban development. The evaluation results lay a foundation for the research of BE promote residents' walking travel and visitors' automobile travel.

Whether active travel or motorized travel, personal travel behavior is complex and uncertain, which is easily affected by various factors, and the BE is only one part of them. There are still deficiencies in this research. In future research, we will expand the present longitudinal research and assemble a catalog by combining more cross-sectional city cases.

学位論文審査報告書（甲）

1．学位論文題目（外国語の場合は和訳を付けること。）

Impact of the Transformation of Built Environment on Personal Travel Behavior in Historic Urban District

（和訳：）歴史的市街地における都市環境の変化が個人の交通行動に及ぼす影響

2．論文提出者　（1）所　　属　　環境デザイン学　専攻

　　　　　　　　（2）氏　　名　　ZENG　Fen

3．審査結果の要旨（600～650字）

　　　ZENG氏の学位請求論文は「歴史的市街地における都市環境の変化が個人の交通行動に及ぼす影響」である。持続可能な開発という新しい視点から、中国漳州市において伝統的な商店街の都市環境整備が行われた後に個人の交通行動調査を行い、地域の整備事業が個人の交通手段の選択や歩行行動のパターンへ与えた影響に着目して、中心市街地の活性化へもたらす影響や効果を評価した事例研究として位置づけられる。

　　都市整備事業の事後評価に着目した既存研究では、事業の採算性の視点から評価を行うものが多く、特に事業や事業がもたらした地域の環境変化に着目して、住民の視点から持続可能な開発としての都市整備の事後評価を行った例は少ない。ZENG氏の研究では、歴史的中心市街地における商店街の環境整備に伴う交通量の増加に注目し、自家用車の利用増加と駐車場整備、歩行による買い物行動への影響を実証的に分析した。具体的には、商店街の都市環境整備により、居住者、来訪者と商店主からみて歴史的要素の継承という社会的環境整備の効果や、歩行者のウォーカビリティの向上等による環境的効果が確認され、さらに駐車場整備・道路環境の改善により商店街の活性化という経済的な整備効果があることも認められた。

　　ZENG氏は、本学在学中に、学位論文の参考論文として、査読論文2編（うち1篇はSCIE）、国際会議1編を公表した。本審査委員会は、ZENG氏が優れた研究成果を挙げており、博士（工学）に値すると判定した。

4．審査結果　　（1）判　　定（いずれかに〇印）　（合　格）　不合格

　　　　　　　　（2）授与学位　　博　士（工学）