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Is sustainability being a driver of service innovation in the public transport sector?

A case study of BRT in Changzhou, China

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Abstract

Purpose - The aim of the thesis is to examine whether the sustainability ideology in public transport service development can act as a driving force for the service oriented innovations.

Design/methodology/approach – The study adopts a qualitative research approach, by using a case study to undertake the analysis of sustainability and service innovation in Changzhou (China) public transportation system.

Findings – The study reveals and proposes a viable model of how sustainability could drive service innovation in the terms of public transport sector, from social, environmental and economic perspectives.

Research limitations/implications - The single case-study design of present study does not able to make generalizations. Future research in this area should focus on the generalizing the present finds based on a comparative-case study to clarify the links between sustainability and service innovation.

Practical implications – The study provides useful insight into the adoption of BRT system as an active method to achieve sustainability and innovative in public transport development.

Originality/value – The thesis makes an original contribution to the study of exploring the relationship between sustainability and service innovation of BRT system based on S-D logic thinking.

Key words Sustainability, Sustainable public transport, Service innovation, Value creation, value network, BRT system, Changzhou
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<tr>
<td>BRT</td>
<td>Bus Rapid Transit</td>
</tr>
<tr>
<td>CBD</td>
<td>Central Business District</td>
</tr>
<tr>
<td>CO²</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CNY</td>
<td>Chinese Yuan</td>
</tr>
<tr>
<td>CZTB</td>
<td>Chang Zhou Transportation Bureau</td>
</tr>
<tr>
<td>CZTCC</td>
<td>Chang Zhou Command Center</td>
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<tr>
<td>CZTG</td>
<td>Changzhou Transit Group</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Position System</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>IRTU</td>
<td>International Road Transport Union</td>
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<tr>
<td>ITDP</td>
<td>Institute for Transportation and Development Policy</td>
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<td>ITS</td>
<td>Intelligent Transportation Systems</td>
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<td>PTA</td>
<td>Public Transportation Authorities</td>
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<td>SPT</td>
<td>Sustainable Public Transport</td>
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<td>WCED</td>
<td>World Commission on Environment and Development</td>
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Lu Chaoren
1. Introduction

This chapter demonstrates the background of the research, the practical and theoretical research gap within the public transport service content. Then it describes the main purpose of the study, research objectives and research questions of the thesis.

1.1. Background

Road based transportation system is important for social and economic development for both developed and new developed countries (Häll 2006). Throughout the years, most attention goes to increase private cars volume to improve the transportation situation as the convenient door-to-door service (ibid). However, the increasing usage of auto mobile consequences the problems, such as traffic congestion, inconvenience of travel and environmental pollution, has become increasingly prominent for the social and economic development (Jianchen 2008). The paradox creates growing pressures to evaluate transport system into a sustainable development way nowadays (Kennedy et al. 2005).

Facing these challenges, there is an increasing voice supports to use high capacity transport forms to improve the efficiency of transits with limited road space in the city (Downs 2004; Junyi 2011). Designing transport corridors and structures to provide safety transport services, increase accessibility, with cost-effective concerns, needs innovative ways of management, communication and technology application, to resolve the political, social and economic forces (Kennedy et al. 2005). More than that, the environmental issues (e.g. global climate change, land ecosystems) have also been involved in the consideration for developing of such transport system, which pose a challenge that extends “human ingenuity”, “organizational capability” (Homer Dixon 2001, cited Kennedy et al., 2005 p.393).

Rather than a definition, sustainability is a simple concept with complex implications (Litman and Burwell 2006), which could be view as a guide in the decision-making process (Carey 2004). In the public transport context, how to evaluate public transit system into a sustainable development way is complex, especially given the many interest groups involved, which with different concentrations. Kennedy et al. (2005)
argued four dimensions to the process to achieve more sustainable transportation system – effective governance of land use and transportation, stable funding, strategic infrastructure investments, and attention to neighborhood, which extend the SPT thinking into some part of economy and social aspects. While, those sustainable public transport decision thinking had followed a traditional “goods-dominant logic” (G-D logic), thus transportation service is seen as a “public goods” and customer only play a passive role (Gebauer et al. 2010). In the public transport content, the service is customer-oriented and relational, and the value is created by (and co-created with) the customer (Sebhatu et al., 2011a), who perceives “value” in terms of “value-in-use” based on the service-dominant (S-D) logic (Vargo and Lusch 2004; 2008). During the value creation (or co-creation) process, both parties (service provider and customers) are value integrators and benefiters (Sebhatu et al. 2011a). Thus, to implement sustainable public transport service, it is important to stand from customer point of view to identify whether and how customer could receive the values (e.g. accessibility, mobility, reliability), rather than calculating the numbers (e.g. number of stations, volume of fleets).

The goal of developing sustainable public transport is to create long term value, which ensures the economic, social and environmental aspects are factored into decisions affecting transportation activity (Loo and Chow 2006). The sustainability thinking has changed the way of “problem identification” and “solution implementation” (Litman 2008, p.2). A growing amount of companies and organizations are willing to developing or using sustainable sources or clean energy sources (e.g. wind and solar power), applying techniques and developing new delivery technologies to reduce the impact to the environment thus achieve a sustainable developing way. As Nidumolu et al. (2009) stated, sustainability concerning drives innovations in a dynamic context. Turning to the public transport content, innovations are not relying on upgrading the physical resources or improving the “efficiency and punctuality of traffic service” (Gebauer et al. 2010). To reach the goals for sustainable public transit, innovations needs to innovate the way value is created by customers and providers (Sebhatu et al. 2011a). Rather than creating new and better resources or resource configurations, the target of service innovations should facilitate the resources for customers to co-create value with service providers in a specific ways (Edvardsson and Enquist 2011). Within the transport service process, value is created by multi-actors including
providers, customers and other interest groups. The value network is helpful to be adapted to understand how to apply the service innovation tactics to enhance the integration between multi actors within the network thus increase the potential for “synergistic value co-creation” (Vargo and Lusch 2008).

The implication of S-D logic is to let the transport authors to focus on the quality of interaction with customers (Gebauer et al. 2010). Although the S-D logic emphasizes the active role of operant resources, it still claims that the service providers or other operators should provide fundamental resources for customers to co-create values. Although earlier studies of value co-creation in public services have different focuses and different emphasis (e.g. achieving competitive advantages, creating new business opportunities, and helping organization to manage value creation process) (Prahalad and Ramaswamy 2004; Gebauer et al. 2010), those cases are mainly referenced in the industrialized countries. However, in many new industrial countries, such as China, there are many medium and small size cities do not have sufficient resources (e.g. infrastructure, technology) to provide the quality value proposition for value co-creation in the public transport sector. So how it adopts sustainability strategy thus use innovative tactics to provide value co-creation opportunities or activities with customers, guided by the sustainability concept, is very important.

The present thesis choses Changzhou BRT system as a case study, and tries to explore whether sustainability concept can drive service innovation in the public transport sector. Changzhou is the first prefecture-level city that launched BRT system, and overall the third one in China. Before launching the BRT system, the public transport service is rarely used by residents. It is also unclear whether the improved transportation situation could only exist a short period, as Downs (2004)’s claims that the better road condition will attract more traffic demand then results worse transportation situation again. Moreover, how to attract more residents to engage into the public transport services, co-create value the customers and provide the “value-in-use” to the customers through the bus services are important for Changzhou to develop sustainable public transport services. Moreover, to meet the sustainability target, the way how the Changzhou PTA could re-invent the value is needed to analyze from multi-dimensions.
In particular, the thesis adopted the SPT principles, defined by CST (2005), to analysis the sustainability performance in Changzhou BRT system; and adopted DTI’s (2007) four dimensions of service innovation (products/services, process, position, paradigm/mental) to analysis the transport services in Changzhou BRT system based on a S-D logic. The present study of sustainable public transport would use the case study approach to assess the influence of sustainability thinking to the service innovation in the public service operation, and assess the applicability of the S-D logic to the service innovation in the public service.

1.2. Problem statement and purpose of the study

Along with the rapid economic development and the improvement of living condition, the number of automobiles has increased rapidly. To resolve the traffic increasing related problems and create a sustainable public transport system, it is essential to invest the resources based on the social, economic and environmental perspectives. Then it is important to understand how the sustainability concept influences the transport-related decision making, which results in an innovative way to optimize the service operation process, especially in a newly industrial city. Rather than goods-dominant logic, the present thesis would adopt the service-dominant logic as the key construct to assess the service innovation in the public transit service to understand whether or how the customer could identify the value within the service process.

1.3. Research Objectives

The objectives of this thesis are:

a. To understand and analyze the role of sustainability based on economic, social and environmental perspectives as driver of service innovation;
b. To understand and analyze the service innovation means to sustainability from the public transit perspective based on the BRT system;
c. To understand and analyze the role of sustainability and service innovation, and how value is co-created in the case of Changzhou BRT system.

Based on the above discussions, this thesis focused on the relationship between sustainability and service innovation, with a case study of Changzhou BRT system by raising the following research questions:
a. How does sustainability being a driver of service innovation in the public transport sector?
b. How does the service innovation driven by sustainability can be understood in the case of Changzhou BRT system?

1.4. Structure of the thesis

The outline of this thesis is created as the follow steps:

Chapter 1 – Introduction: It introduced the background of research, the main purpose, the research objectives and research questions.

Chapter 2 – Methodology: It demonstrated the research approach, data collection and analysis method, and the credibility of the research.

Chapter 3 – Theoretical framework: It described the fundamental theoretical framework, which involved sustainability and sustainable public transport (SPT), service innovation, value creation and value network.

Chapter 4 – Empirical studies of BRT in Changzhou: It illustrated the results that got from the research. The case study started with the background information of Changzhou city and its public transportation. The empirical data showed the implementation and operation of BRT system in Changzhou city, as well as its contribution and future development target.

Chapter 5 – Analysis and discussion: It used sustainability and service innovation principals as the theory model to access the research gap on the linkage between them. Then it analyzed and interpreted the empirical data to answer research questions.

Chapter 6 – Conclusion: It drew the conclusion, and revealed the managerial implications as well as the recommendation for future study.
2. Methodology

This chapter presents the research methodology applied to investigate the research questions, describe procedures and assess the case study.

2.1. Research approach

This section gives an overview of the research methodology, which is based on qualitative case study approach.

2.1.1. Qualitative approach

Research methods could be separated with various ways, while one common distinction is between qualitative and quantitative research approach (Myers 1997), with the main difference of usage of analytical method (Berg and Lune 2004).

Rather than quantification in the analysis of number and data, qualitative research approach is emphasis on words information (Bryman and Bell 2007). As Myers (1997) mentioned, to understand a phenomenon in a particular social and culture context, certain information would be lost when textual data quantified. Then, based on the objective and research questions of the thesis, I chose the qualitative method as the main research approach, due to the strength of the method could contain many details relate to the problem and provide opportunities to understanding the context in a certain social phenomena (Myers 1997). The qualitative method is developed in the social sciences to enable researcher to understand certain social and cultural phenomena with a holistic view, which emphasis the researcher’s opinions and explanations (Berg and Lune 2004).

To use qualitative research method, interviews and observations are the most common ways to access information. In order to collect accurate data, I performed interviews with officers in Changzhou Transit Group (CZTG), officers in Nanjing Zhongbei Group Co. Ltd, as well as Changzhou local residents.

The interview process includes three stages. In the first stage, I had interviewed a fleet leader – Sun Wei, in Nanjing ZhongBei Group Co. Ltd (one of the four main bus
transport operators in Nanjing) for two times. Those interviews results brought me the general situation about public transport development in Jiangsu Province. In the second stage, I have interviewed some local customers, which include the students, office workers, taxi drivers and so on. In the third stage, I went to Changzhou Transit Group (CZTG) and had a focus group interviews with the duty general manager - Sun Luming, vice mayor of Changshu – Rui, and a metro designer – Li. The interview was formed as an urban investigation. It lasted more than two hours and partially recorded. The duty general manager introduced the developing process and general situation of Changzhou BRT system at the beginning, and followed an intensive discussion within the transport service even in some detail parts. The qualitative research approach enhances my reflection on the officer documents and current research articles related to Changzhou BRT services.

2.2. Research method

2.2.1. Case study approach
The case study is a research strategy that focuses on understanding the dynamics present within the context (Eisenhardt 1989). The case study is particularly suited to the research questions which require detailed understanding of social or organizational process because of the rich data collected in context (Cassell and Symon 2004). The advantage of case study is it could deal with a full range of evidence (Yin, 1994), and focus on different levels of analysis, from public policy to individual psychodynamics (Cassell and Symon 2004).

Within the research strategy, multiple qualitative methods can be combined, thereby avoiding too great a reliance on one single approach (Myers 1997). Participant observation, direct observation, ethnography, interviews (semi-structured to relatively unstructured), focus groups, documentary analysis, and even questionnaires may be used.

A case study, therefore, cannot be defined through its research methods. Rather, it should be theoretical oriented. Although the case study may start from a rudimentary theory foundation, it should continue create new theoretical framework to make sense of the data, and could be examined within the case for reliability (Myers 1997).
Furthermore, the theoretical framework developed from the case should be considered whether it could make sense to general relevant or interesting cases (ibid).

There are two major approaches for theory development in the case study approach, deductive theory testing and inductive theory building (Perry 1998). Whether a case study is inductive or deductive tends to be affected by whether a quantitative or qualitative research strategy has been applied (Bryman and Bell 2007). As the present thesis is adopted qualitative research strategy, this case study tends to use an inductive approach to build the relationship between theory and empirical data (ibid). More specifically, the inductive representing phenomenological paradigm, which can divided into three: “constructivism”, “critical theory”, and “realism” (Guba and Lincoln 1994). The “realism” is considered as the preferable approach for case study, because it is often characterized by researcher objective that an external world can be researched. However, deductive approach would adopt in somehow, as pure induction or pure deduction is “untenable and unnecessary” and that the process of ongoing theory advancement requires “continuous interplay” between the two (Parkhe 1993, p.252, 256).

This present case study tends to combine the inductive and deductive approaches, as the case study area is contemporary and pre-paradigmatic, even the case study tends more as inductive theory building it still needs deduction from existing principles (Perry 1998). Then this case study is designed as an “exploratory case study”, which attempts to understand what had happened within the case by looking through the features surrounding the context (CAPAM 2010). To proceed the case study, from specifying the research question to reaching closure, the case study structure design following Eisenhardt (1989)’s roadmap: 1) Getting started: building theory based on initial definition of research question; 2) Selecting case: selecting specified population, neither theory nor hypotheses; 3) Crafting instruments and protocols: using multiple data collection methods; 4) Entering the field: based on flexible and opportunistic data collection; 5) Analyzing data: applying within-case and cross-case pattern analysis; 6) Shaping hypotheses: iterating tabulation of evidence for each construct and searching evidence for the replication; 7) Enfolding literature: comparing with conflicting and similar literature; 8) Reaching closure: ending the revision of a manuscript when the incremental improvement in its quality is minimal.
To start with, this thesis initiative focused on the relationship between sustainability and service innovation, and well defined the research question as “how does” sustainability being a driver for service innovation in public transport sector. Because “how do” emphasis the capture of positive rather than normative dichotomy, and describing of the real world phenomena not developing normative decision models is what this case study concentrate on (Perry 1998).

To make the selected case study more meaningful, I reviewed the Flyvbjerg (2006)’s analysis about the conventional misunderstandings about case-study research. According to Flyvbjerg (2006)’s analysis about case-study research, both the theoretical knowledge and practical knowledge are valuable and the single-case study can contribute to scientific development even it cannot generalize. Based on the research question, Changzhou BRT system has been chosen as the target case for the present study after a certain extent comparison. Changzhou is a newly developed industry city, and is the first prefecture-level city that launched BRT system in China. Before launching the BRT system, the public transport service is rarely used by local residents in Changzhou. Since Changzhou adopted BRT system, the mobility and accessibility of public transport service had increased obviously. In this regard, Changzhou even got national award for huge improvement of public transport service. How to understand the evaluation of public transport service in Changzhou from a sustainable consideration is interesting. Also, whether the Changzhou’s “experience” could be generalized to apply into other middle or small size cities in newly industrial countries is also attract my attention.

To find the answer to the research question, I combined multiple data collection methods within the case study approach. Face-to-face interview, online interview, observation, and media document review were the main data collection methods in the present research. Quantitative and qualitative evidence were combined within the thesis. Quantitative evidence, such as boarding time, passenger volume, ticket price and bus line length, could indicate the relationships which may not be salient to the research. On the other hand, the qualitative data, such as the public transport development history and designing plan of CZ, customer experiences, were useful for understanding the rationale or theory underlying relationships revealed in the quantitative data.
To understand the case study, building a rudimentary theoretical framework is helpful for the following data analysis (Eisenhardt 1989). Thus, I went through the theories within value co-creation, service innovation, and value networks in public transport, and overlapped data analysis with data collection.

The heart of the process is the data analyzing. One key step is that the within-case analysis has been employed. It involves detailed case study write-ups for each site, which comes from CZTG official documents, previous research, and experts’ interviews. The simply descriptions are central to the generation of insight.

The next step of highly iterative process is to compare systematically the emergent frame with the evidence from the case study to access how well it fits with case data. During this process, the hypotheses of the thesis has been shaped, which involving refining the construct for the thesis and building evidence which measures the construct of the case of Changzhou BRT.

Following, I compared the emergent concepts, or hypotheses with the extant literature. Examining the emergent theory with literature is helpful to access and minimize the conflict finds, therefore reshaped the construct to be more generalize.

Lastly, the thesis reached closure of the case study, when the incremental improvement in its quality is minimal.

2.3. Data collection

The data collection method is the technical that used to collect the empirical data, which could separate into six categories: questionnaires, interviews, focus groups, tests, observation, and secondary data (e.g. official documents, physical data) (Johnson and Turner 2003). In order to capture the research question about the linkage between sustainability and service innovation within the public transport service in Changzhou, different sources of primary data and secondary data had been gathered and combined. The primary data were mainly collected from interviews and observations; and the secondary data were mainly gathered from literature review, official documents, case studies, video and photo news.
2.3.1. **Primary Data**

Qualitative data are gathered primarily in the form of spoken or written language, and the sources are from interviews with participants, observations, documents, and artifacts (Link and Donald 2005). In the present case study, I gathered the primary data from multi sources, such as interviews with customers and officers in CZTG, observation, official documents, and related news and video records.

**a. Interviews**

Interview is a major data collection method, which has been commonly used into business and organizations’ research (Hirschman et al. 1993). The main advantage of interview is the interviewers could probe with the interviewees for some specific questions if it is needed (Johnson and Turner 2003). On the other hand, interviews are usually more expansive than questionnaires and observations. Besides that, for this research, the distance was another problem. So I started this method from on-line interviews, and chose the interviewees based on personal relationships at the beginning. One key principle of doing interviews is the interviewers should always remain nonjudgmental to the responses (ibid), so do the interviewees to the questions. So I had always described my nature of the study is an academic research that wanted the respondents to provide unbiased judgment. Then I also wrote the transcript quickly without any personal point of view that revert the original narratives.

As mentioned above, the interview process includes three parts, authority officers, local residents and manager in PTA. Total amount of seventeen people have been interviewed, which include five officers, eleven local residents and one manager. Based on private relationship, I successful contacted with one vehicle team leader – Sun Wei. We had two times face-to-face communication in his office, with total amount of four hours. Rather than the general information about the public transport operation in the city, Sun Wei mainly introduced his initiative developed management philosophy - “Square & Round Map”, within the daily operation management. He emphasized the “*nothing can be accomplished without rules*”. The “Square” and “Round” representatives different working departments (operation, maintenance, logistic and regulation) and different parties (Government, Group Company, leadership and employees) within the public transport operation. Then in the second
stage, I tried to assess some local residents in Changzhou to understand how they viewed the value of public transport service to them. To make the beginning easily, I began the customer interviews from contacting several college friends who came from Changzhou or lived in Changzhou for several years. I described my purpose of the research is a part of my master thesis, which is an academic research not related to any business usage. Therefore, I wanted them to describe their personal fairly reflection of the BRT system rather than repeating the official words. More than that, I also went to Changzhou, and had some short communications with local taxi drivers. The customer interview results shown, contract with the official news, mostly local residents still had veiled criticism to the BRT system in Changzhou. The main complaints were focused on the accessibility and the land usage of BRT system. In the third stage, I companied with Vice Mayor of Changshu and interviewed the manager in Changzhou Transit Group. As the general manager is on another meeting, the duty general manager organized the interview, which settled in the conference room in Changzhou Transit Group. That interview lasted two hours, and had partially recorded. We started from the general questions relate to Changzhou BRT system, such as the construction process, extended services. Then Sun Luming described some deeper questions that CZTG was working on, such as the fare design strategy, future cooperation with the Metro system. The face-to-face discussion with the PTA in Changzhou enhanced my understanding about BRT service operation in Changzhou. All in all, total seventeen people had been interviewed, including six officers in the PTA and eleven Changzhou residents. The total interview time is around twenty hours, with the shortest time of 10-min (with a taxi driver) and longest time of 140-min (with duty general manager of CZTG). During the interviews, most of the them were accepted to record thus increased the data validity.

b. Observation

As Potter (1996) described,

Observation is the technique of gathering data through direct contact with an object – usually another human being. The researcher watches the behavior and documents the properties of the object (p. 98).

The observations could be used to supplement and clarify data derived from
participant interviews (Link and Donald 2005). To get visual reflection of BRT operation in Changzhou, the author went to Changzhou city and experienced the BRT service there. The author reached to several BRT stations and observed surrounding service environment and traffic situation during daytime. This source brought the author the real experience about the selected case study.

2.3.2. Secondary Data

The main advantages of using secondary data are: firstly economic, for both time and cost, secondly the inclusion of more variables, more diverse sample thus help researchers to rethink data and use more advanced techniques to analysis data (Dass and Arends 2009). To broaden the view on the Changzhou BRT system, I started my research journey from gathering secondary data resource. In general, there are three secondary research strategies, which named content analysis, secondary analysis and systematic review (ibid). The content analysis is based on various forms of human communication; secondary analysis is using previous quantitative research results; and the systematic review is combining and investigating other output with same or similar phenomenon (ibid). In this thesis, I chose “systematic reviewing” as my main secondary data research strategy, with some combination of content analysis.

a. Library source

The main secondary data sources were gathered from library and on-line library, including newspapers, books, theses, and articles. To be specific relate to the theory, I used Google Scholar, EBSCO, IEEE as the search engines searched the key theory words of the thesis. When I used “sustainability” and “service innovation” as two key words searched in EBSCO and IEEE, I got 569 and 71 results. While, when I added “BRT” as the third key word, the search engines showed zero result. Then I got 41 results from Google Scholar for searching “sustainability” and “Changzhou BRT”, while no result if it added “service innovation”. There have several official reports explored thoroughly about the Changzhou BRT system (ITDP 2007) and even other Chinese cities’ BRT system (Darido 2006). To enrich my data scope, I also searched the key words in CNKI (National Knowledge Infrastructure) and got around 20 Chinese articles related to Changzhou BRT system. Besides that, I also got much official information from Changzhou Transit Group (CZTG)’s homepage, which
include the principles and future target of BRT system in Changzhou. These secondary data are important for me to understand the social context in Changzhou, which developed the solid foundation for my further research.

b. Documentary and Visual data

Documentary evidence can consist of written, oral, visual, or cultural artifacts (Dass and Arends 2009). Documents are underused source of data for counseling psychology (ibid). The transcripts and videotapes of these sessions contain a reservoir of data that can serve counseling researchers (ibid). To complement the interview results limitation, I gathered some internal documents from one of the officer in CZTG, which includes the official data about the operation rules in Changzhou public bus service. Also I found some interview records and videos from internet, which partially matched the author’s research area. In some videos, the interviewees were the experts within the area that I could not access personally. Then I translated some selected information, which enriched the research results in some specific area.

2.4. Data analysis

Qualitative research method would generate large amount of textual data, which could be described as an “attractive nuisance” (Miles 1979). The systematic preparation and analysis the data is time consuming, that even a transcription of a single-interview would takes several hours (Pope et al. 2000). However, the rudimentary description gathered from the interviews made no sense to the researcher, until the categorized data has been inductively or deductively approached either at the beginning or part way through the analysis (ibid). Miles and Huberman (1984) described the data analysis process could be considered as three components: data reduction, data display and conclusion drawing/verification. Based on that, Spiggle (1994) categorized the data analysis procedure into seven activities: coding, categorization, abstraction, comparison, dimensionalisation, integration, and interpretation. Rather than describing these analyzed data, the data analysis should emphasis the explanation or interpretation in the end (Spiggle 1994). The researcher’s reflection or interpretation, in somehow, let the organized research data makes more sense.

Inspired from Spiggle (1994), the data analysis method of the present study is
generally separated into three main streams:

Firstly, as we can see it, data reduction occurs continuously throughout the life of this research. Even before the data are actually collected, anticipatory data reduction is occurring after the author chose the case in a specific city - Changzhou, and defined the research questions – relate to sustainability and service innovation. The author narrowed the literature review into those two main theories, and focused the research area mainly in Changzhou BRT system. As data collection proceeds, further data reduction occurs by writing summary of the interview results, making clusters of different prospects based on the previous case study of Changzhou BRT, and also writing memos for each document that inspired the author.

The second major flow of analysis activity is data display. Looking at displays helps the author to understand the present situation and future directions based on the understanding of the case. Some quantitative based data display, such as price strategy, traffic usage rate, boarding time and bus emission comparison, that all are designed to assemble organized information into an immediately accessible or compact form. And the author displayed the data through variety of charts and graphs, by which to simplify the information that the author can hold.

The third stream of analysis activity is conclusion drawing and verification. From the start of data collection, the author is beginning to decide what things means. The author compares and overlaps the selected theory indicators with the case study results in a possible configuration to reveal the overall conclusion. According to Miles and Huberman (1994), the three types of analysis activity and the activity of data collection itself from an interactive cyclical process, that the researcher need to steadily moves among the four “notes” for the remainder of the study. Thus the author holds the conclusion lightly, maintaining openness and skepticism, and continually modified the conclusions and minimize the conflicts for future studies.

2.5. Trustworthiness

The validity and reliability are two important factors that should be concerned when designing a study, analyzing results and judging the quality of the study (Patton 2001).
Although “reliability” is the concept that evaluates the quantitative research, it also used for all kinds of research (Golafshani 2003). However, qualitative research emphasizes seeking instead illumination and extrapolation to similar situations, rather than seeking causal determination and generalization of findings as quantitative research (ibid). So the quality of the research should be judged by its own paradigm (Healy and Perry 2000). For example, the reliability and validity are two important criterions for quantitative paradigm, in qualitative paradigm the terms credibility, dependability and applicability are several essential criteria for quality (Golafshani 2003). To be specific of the reliability in qualitative research, Golafshani (2003) claim “dependability” is closely corresponds to the notion of “reliability” in quantitative research. More than that, the researcher’s ability and skills would also influence the reliability of the research. In the present research, the key data information I got were mainly gathered from the official documents from local public transport authority and public official information posted on their homepage. Those data set the basis of the research and further interviews. During the interviews, I as far as possible to introduce the purpose of the research is an academic research and let respondents to describe their options fairly without bias or affecting by my attitude. However, Patton (2001) with the regards of the skills and ability of researcher in any researches claims that the reliability is the consequence of validity. In other words, the demonstration of validity is sufficient to establish the reliability (Golafshani 2003, p.603).

The concept of validity is not a single or universal concept; many qualitative researchers developed their concept of validity and also generated or adopt some suitable terms, such as quality, rigor and trustworthiness (Golafshani 2003). If the validity or trustworthiness can be maximized then the more credible result may lead to generalizability, which is a criterion for the quality of qualitative research (ibid). Although the ability to generalize finds has been commonly concerned as the test of validity of quantitative and qualitative research, but Patton (2001) claims the quality of case study is also depending on the case selected and studied. So, before I select the case, I concerned the common mistake of the case-study research, and compared several cities in China. The selection principle for me is the case should be typical but not specific, and this case should be meaningful for building both theoretical and practical knowledge. Changzhou is a common medium size city in China, and also the “pioneer” that launched BRT system in China. Its experience would bring the
reference for following large amount of similar size city’s “public transport revolution”. On the other hand, triangulation is a useful strategy for improving the validity and reliability of the research. As Mathison (1988) claims, triangulation strengthen the qualitative approach from controlling bias and establishing valid propositions. In this case study, even the main stream is the qualitative research, while some quantitative method had been combined, such as the data relate to the BRT operation in Changzhou. In the interview procedures, all the six officers were used to working in the public transport area for many years with valuable practice experience. Their despondences mostly came from real working experience or events. For the customer respondents, all were randomly selected thus they did not prepare any report or manuscript. Most of the residents I interviewed were well educated and had their own judgment on common sense of the BRT system in Changzhou. Besides that, during all the interviews, I tried to control the focus of the interview mainly focus on the BRT system, while did not direct the communication with any bias. All the effort I did is to evaluate this research into a high validity and reliability research.

2.6. Limitations

The present research has certain limitations. First is the distance limitation. This research was mainly performed when I was in Sweden. I had only been back in China for two times during the research, thus could have limited chance for observing the commutes’ behavior, facial expression and surroundings. Second is the time limitation. For a longitudinal study, more interview results from customers and public transport service operators are required. The third is single-case limitation. The empirical results gathered from single-case could hardly generalized to wider groups and circumstances. Further cross-case studies are necessary to improve the validity of the research.
3. Theoretical framework

This chapter assesses the theoretical background of the study, which includes: sustainability, service innovation, value co-creation, value network, and sustainable public transport concept.

3.1. Sustainability and Sustainable development

Sustainable development (SD) concept is widely adapted in many areas. The common ground definition of SD comes from the Brundtland Commission’s report that “such development can be defined simply as an approach to progress which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WECD 1987, p.1). This definition has led many to see the focus of intergenerational equity (Kates et al. 2005). More explicitly, that report states the human needs are basic and essential; economic growth should in a quality way; and the equity is encouraged by effective citizen participation and global cooperation to share resource with poor (WCED 1987).

Following the creative ambiguity definition from the Brundtland Commission’s report, a range of groups assemble under the sustainable development trend, and create veritable industry to deciphering what sustainable development really mean (Kates et al. 2005). One important study made by US National Academy of Sciences, described the SD concept from two separate parts: ‘what to be sustained’ and ‘what to be developed’, with the time horizon of the future. Rather than the early literature focused on the economic development, which providing employment and wealth, the recent literature more focused on the human development, such as enhancing people expectancy, education and equal opportunities. Additionally, society development had also been concerned, which emphasized the values of social well-being and security (ibid).

A further expansion of the standard definition was formulated with three pillars – economic, social and environmental. The Johannesburg Declaration emphasized the collective responsibility to reinforce and strengthen the pillars of sustainable development (economic development, social development, and environmental
protection) from local, national and international levels (ibid). In general, the environmental sustainability concerned the human activities impact on living and non-living system, including ecosystems, land, air and water; the economic sustainability concerned the unbiased and accurate depiction of financial and economic performance based on the institution’s selection and communication (Callens and Tyteca 1999); and the social sustainability concerned the noneconomic social designation, human development and issues of justice and equity (Kates et al. 2005). Even these three pillars were widely adopted; there was no universal definition to their details. In addition, the relationship between the three elements are strong, numerous and complex.

Although SD definition was creative ambiguity, many serious efforts tried to define it in the terms of indictors. According to Kates et al. (2005), these indicators emerged two observations: firstly, because the SD concept was malleability, there were large amount of items to be sustained and to be developed; secondly, few of the indicators provided the target time period.

To draw a clear picture about what SD seeking to achieve, three sets of goals had been created based on different time-horizons: the one-generation goals (2015) of the UN Millennium Declaration; the two-generation goals (2050) of the Sustainability Transition of the Board on Sustainable Development; and the long-term goals (beyond 2050) of the Great Transition of the Global Scenario Group. While these goals all could be viewed as the values that represent sustainable development (Leiserowitz et al. 2006).

Defining the values of SD is another mode of defining the sustainable development. The values, in the sustainable development, have many meanings. The values are expressed as the belief that guides selection of evaluation of behavior that transcends specific situations. Then, the three elements of sustainable development, the three stages of goals, and the many other indicators all could be viewed as values. The fundamental values set in the UN Millennium Declaration included: freedom, equality, solidarity, tolerance, respect for nature, shared responsibility (UNMD 2000). Then, derived from the many declarations and reports, international laws, global ethics movement and contemporary science, the Earth Charter set the fundamental principles
for building a sustainable global society, which set the values like the “the community of life”, “ecological integrity”, “social and economic justice”, and “democracy, non-violence, and peace” (Kates et al. 2005).

More importantly, defining SD through practices is essential. The practice includes the “many efforts at defining the concept, establishing goals, creating indicators, and asserting values” (Kates et al. 2005, p.17). In general, the practices include four aspects. First is the social movement, which contains the sustainable livelihoods movement – seeking to create opportunities to offer sustainable alternatives, the global solidarity movement – seeking to support poor people, and the corporate responsibility movement – seeking to harness the knowledge, energies and activities of corporation to better serve nature and society (ibid). Second is organizing institutions. Many national governments have been established to create and monitor SD strategy (ibid). Third is developing sustainable science and technology, which seeking to enhance the knowledge that contributes environmental sustainability and human development in the society (ibid). Lastly, practicing SD is a compromise between the stakeholders, which include those who are principally underline to protect the nature and environment, those who are emphasis the economic development and those who are dedicated to improving the human conditions (WECD 1987).

In summary, sustainable development was a creative ambiguity concept. On one hand, it has been viewed as an “oxymoron” that the pillars within the concept is fundamentally irreconcilable. On the other hand, this ambiguity concept mainly draws on the resonance and creativity within the key elements, which gives opportunities to variety areas to adapt this concept into their values. All in all, based on the standard definition of SD (WECD 1987), it evolved the fundamental values and guide principles for the SD should meet people’s needs from now till future, for economy, social, environment.

3.2. Service innovation, value co-creation and value network

The service innovation is multifaceted, which not only involves new services, but also requires new technology, new business model, new organization structure, and new governance approach (Edvardsson and Enquist 2011). Previous literature defined
service innovation as “encompassing ideas, practices or objects which are new to the organization and to the relevant environment, that is to say to the reference groups of that innovator” (Van der Aa and Elfring 2002, p. 157). However, innovation theories mainly based on manufacture industry (Sundbo 1997), that most researches had focused on product innovation rather than service innovation. Moreover, the service innovation has been identified from G-D logic, that the service innovation process is a special case within the product innovation.

Then understanding the unique service features is important for distinguishing the service innovation out of manufacture innovation. Comparing with tangible goods, services have four main unique features: intangibility, inseparability, heterogeneity and perishability (Zeithaml et al. 1985). More detail, services are performance rather than objects, which goods cannot be sensed; the services production and consumption process cannot be separated; services has high potential variability in the performance; and services cannot be saved (ibid). Understanding the unique service features is not only to distinguish the goods and services, more importantly, it helps to identify the marketing problems within the services sector and find appropriate solutions (ibid), which guide the directions for the service innovation. For instance, the services are produced and consumed simultaneously, which customer must be present during many services (e.g. train trips, massage). Then companies could strengthen the consumers’ management approach to motivate customer rolling within the value co-creation process (ibid).

In contract with product innovation, which emphasis the new technology, new production – whereby value is created by the company, service innovation emphasis the interaction with customers, whereby the value is co-created by both companies and customers (Edvardsson and Enquist 2011). While countless research emphasis the nature of interaction and coupling process of services, much thinking in the policy making default the linear view of the process and the knowledge push model (DTI 2007). In the context of service innovation, the use of demand side knowledge is critical. The appropriate usage of demand side knowledge in the production and consumption process may contribute the success of the service innovation (ibid). Thus, service innovation should not only be created by the providers, but sometime balance the involving of demand side (customer) knowledge is important. As Edvardsson and
Enquist (2011) argued the service innovation “is thus not only about developing new and ‘better’ resource configurations, but also about how such resource configurations can be made available for customers to utilize in specific ways to co-create value with the provider”.

The services innovation could take several forms: “Products/Services innovation” – changes in the things (products/services) which an organization offers; (2) “Process innovation” – changes in the ways in which they are created and delivered; (3) “Position innovation” – changes in the context in which the products/services are introduced; (4) “Paradigm/mental model innovation” – changes in the underlying mental models which frame what organization does (DTI 2007). For example, a new insurance and a new home entertainment system could be viewed as the products/services innovation. The on-line shopping approach could be viewed as a process innovation. Examples of position innovation include the creation of new market, such as low-cost flying, which shift the customer target from businessman to students or other cost consciousness travelers. Sometimes service innovation opportunities from the shift of mental model, such as the provision of online insurance, reposition the drinks like coffee as “premium designer products” (ibid).

Moreover, such service innovations could be radical or incremental (Edvardsson and Enquist 2011). The incremental innovation refers to the day-to-day implementation of certain services performance, which is different with the occasionally radical changes (DTI 2007).

Creating more and better values is one important target of service innovation. According to S-D logic, the values of innovation was defined as “how firms can better serve, rather than what firms produce as output” (Vargo and Lusch 2005, p.5). Relate to Michel et al. (2008), the service innovation activities should embed in S-D logic that changing the concept from “product” innovation to value propositions. In line with the S-D logic, the service innovation is realized in use, which emphasizes using the knowledge and skills, or the operant resources, with the innovation activities. Moreover, there are many potential sources for service innovation to co-create values, which involve the users, employees, technological trajectories, management trajectories, and new value and priorities in society (Edvardsson and Enquist 2011).
Thus to understand the service innovation, it is essential to clarify the nature and role of value co-creation and value network.

**Value co-creation**

Companies are pressured to create better services to meet customer dynamic needs and keep competitive advantages (Edvardsson et al. 2011). During this process, organizations learned to collaborate with customers to create value for them (Sebhatu et al. 2011). While encouraging customer participation creates another competition, which needs the shift concept from G-D logic to S-D logic for marketing (ibid).

G-D logic emphasizes the using of operand resources (physical products) and describes the value as created and added in units of output (Edvardsson and Enquist, 2011). In contrast, S-D logic emphasizes the using of operant resources (knowledge and skills) and concerns the value is co-created between customers and suppliers (ibid). According to S-D logic, value is always defined and co-created by customers as “value-in-use”, rather than embed in the notion of output created by suppliers (Vargo and Lusch 2008). The S-D logic concerns the value is created through using the operant resources to operate operand resources, and the value is co-created by both parties.

However, Grönroos (2008) argues the percent concerning about “value-is-use” has mainly stand from customers’ perspective, actually, it is as important for suppliers as for customers – because the “value-in-use” can lead customer satisfaction, customer loyalty and resulting the profitability for the service suppliers (Gebauer et al. 2010). As the value-in-exchange is more dependent on the “value-in-use”, so it is important to understand the service supplier’ role is the value facilitator, which provides sufficient resources for customers to create value and builds the foundation for the value co-creation (ibid).

Although S-D logic emphasizes the role of customer is the value co-creator in the value creation process, Grönroos (2008) argued the supplier remain the ultimate value creator (Gebauer et al. 2010). In contrast, Grönroos (2008) claims the customer is always the value creator, while the supplier can be value co-creator (in the value fulfillment model) and/or value facilitator (in value facilitation model).
In summary, it is apparent that from whether S-D logic (Vargo and Lusch, 2008) or service logic (Grönroos 2008) points of view, value is co-created by both suppliers and customers. In other words, according to Normann and Ramirez (1998, p.69), “the key to creating value is to co-produce offerings that mobilize customers”. During the value co-creation process, according to S-D logic, operant resource is the key to value co-creation, which is the ‘skills and knowledge’ that is employed to act on operand resources (or other operant resources) (Vargo and Lusch 2004). The skills and knowledge within the organizations (e.g. organization capability and employee skills) and the environment (e.g. customer knowledge and culture) drive creation of value. Thus the value is seen from co-produced operant resources acting on operand resource or through operant resources collaboration, and the value co-creation is realized in value-in-use (Echeverri and Skålén 2011).

Value network

Successful services innovation results from collaboration between service providers and customers within a value network whereby they co-create innovation by combing their capability and other resources to create new and useful capability in value co-creation (Ramaswamy and Gouillart 2010). From the S-D logic perspective, the co-creation of value is facilitated by the value network (Lusch et al. 2010). The distinctive contribution of S-D logic for the theory of value network is it declared that no individual network could have adequate resources to create value by them own (Mele et al. 2010).

In line with this view, a multi-process oriented network is required for the resource integration, whereby all parties integrate their resources for their own benefits and others benefits (Lusch et al. 2010). One important thing is to understand the creation of service is not only limited within the seller-buyer relationship, but multi stakeholders have involved within the value creation activities (Mele et al. 2010). Then, the concern of stakeholder value has been developed further into the notion of “network value”, which refers to all the benefits the network partners create through the value creation activities (ibid).

Lusch et al. (2010, p.20) taken those views and continue developed the notion of “value network”, which they formally defined as,
a spontaneously sensing and responding spatial and temporal structure of largely loosely coupled value proposing social and economic actors interacting through institutions and technology to: 1) co-produce service offerings; 2) exchange service offerings; and 3) co-create value.

By elaborating on value configurations according to different value creation logic, Lusch et al. (2010) argue the value network creates value by facilitating a network relationship between the organizations and their customer, using a mediating technology. As Mele et al. (2010) argued, the competitive advantage of such value network is dependent on the learning capability of stakeholders within the network. Furthermore, the network interactions are designed with the object to foster learning and transfer knowledge (ibid).

3.3. Sustainable Public Transport

The definition of sustainable public transport has been discussed in length in the literature. Although the SPT does not have a universal definition, it strives to optimize the balance within the social, environmental and economic objectives (Litman and Burwell 2006). In general, according to the Centre for Sustainable Transportation (2005), the sustainable transportation could be identified in three kinds of definitions.

The first is the literal economist’s definition, which emphasis the full social cost should be paid by the transportation beneficiaries (Litman and Burwell 2006). However, this definition did not explicitly explore what services were required nowadays and in future. The transport system might still unsustainable even reached that requirement

The second kind of definition could be seen as an environmental focused sustainable transportation. It emphasizes the reasonable usage of renewable and non-renewable resources (ibid), as well as the environment quality, ecosystem integrity, and not worsens the global phenomena. While this kind of definition might mainly focused on defining what sustainable transportation should not do rather than what should do.

The third type of definition could be called as the comprehensive type of definition, which has been widely adopted. The definition is illustrated as following:

A sustainable transport system is defined as one that:
• Allows the basic access and development needs of individuals, companies and societies to be met sagely and in a manner consistent with human and ecosystem health, and promotes equity with and between successive generations;
• Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development;
• Limits emissions and waste within the planet’s ability to absorb them, uses renewable resources at or below their rates of generation, and, uses, non-renewable resources at or below the rates of development of reviewable substitutes while minimizing the impact on the use of land the generations of noise (CST 2005, p.5).

This comprehensive definition reflects the sustainability plan should find strategies that achieve all the economic, social and environmental objectives synchronous over the long run by increasing the transportation system efficiency (Litman and Burwell 2006). The conventional planning assumes the transport progress as linear, that newer and faster transport methods replace the older and slower ones. In contrast, the sustainable planning assumes each mode can be useful, that people use the each mode as it is the best (ibid). It reflects not the faster transport mode (e.g. Metro) must better than slower transport mode (e.g. bus or bicycle). Whether this mode is suitable for the city or region is depends on the certain social context. It assumes the improvement of transport system is not necessarily to increase the speed, improvements may come from more safety and comfortable, cost saving transport services.

The sustainability of the transport system is often measured by some indicators to catch the development trend, compare activities between areas, evaluate transport policies and set targets (Litman and Burwell 2006; CST 2005). When selecting the indicators, it is important to understand the distinction between goals and objectives. The goals are the society ultimately want, while the objectives are the things that supporting the goals achievement. For policy makers, it is helpful to focus on the easy-to-measured objectives or impacts, and overlook the hard-to-measured goals in the long run (ibid). Turning to the transport system indicators, there basically exist three sets of methods.

The first was the conventional transport indicators, which consider more upon the traffic conditions (Litman 2006). However, these indicators mainly favor on the motorized travel, ignored other travel modes (e.g. bicycling or walking), which tends contradict to the sustainable transport objectives. Another set of indicators could be
viewed as the simple sustainable indicators, which using relative simple set of indicators and easily available data. However, these overly simple indicators may only identified one or two objectives, while overlook the solutions that “provide modest but multiple benefits” (ibid, p. 337). The third is the comprehensive sustainable transportation indicators, which take into account about the wide range of impact and reflect the sustainable transport system goals and objectives (Table 1).

Table 1. Comprehensive sustainable transportation indicators (Litman and Burwell 2006, p.337).

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
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<tbody>
<tr>
<td>Economic sustainability</td>
<td>Accessibility – commuting</td>
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<td></td>
<td>Accessibility – land use mix</td>
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<tr>
<td></td>
<td>Accessibility – smart growth</td>
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<tr>
<td></td>
<td>Transport diversity</td>
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<td></td>
<td>Affordability</td>
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<td></td>
<td>Facility costs</td>
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<td></td>
<td>Freight efficiency</td>
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<td></td>
<td>Planning</td>
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<tr>
<td>Social sustainability</td>
<td>Safety</td>
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<tr>
<td></td>
<td>Health and fitness</td>
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<tr>
<td></td>
<td>Community livability</td>
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<tr>
<td></td>
<td>Equity – fairness</td>
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<tr>
<td></td>
<td>Equity – non-drivers</td>
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<td></td>
<td>Equity – disabilities</td>
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<tr>
<td></td>
<td>Non-motorized transport planning</td>
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<tr>
<td></td>
<td>Citizen involvement</td>
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<tr>
<td>Environment sustainability</td>
<td>Climate change emissions</td>
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<td></td>
<td>Other air pollution</td>
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<td>Noise pollution</td>
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<td>Water pollution</td>
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<td>Land use impacts</td>
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<td>Habitat protection</td>
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<td>Resource efficiency</td>
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</tbody>
</table>

The ultimate goals for sustainable transport system are to increase the accessibility of the transport activities, while it usually measures the traffic (traffic movement) and mobility (the ability to move people and goods) as it is normally easy to access (Litman and Burwell 2006). The comprehensive sustainable transport indicator links the indicators with the objectives and goals of the sustainable transport system, and gives the directions of each indicator. Rather than a stationary indicator, this set of indicators is quite flexible. Because some of the indicators still can be reflected by the social context, or in other words, disaggregated by demographic (e.g. gender, age, income, physical ability, etc.), geographic factors (e.g. urban, suburban), time (e.g. peak time, off-peak time), and trip (e.g. commercial, entertainment, tourism). The fundamental consideration of the indicators is to provide basic access to the transport
system, with high values (e.g. safety, comfortable, education), and higher quality of service to equality everyone (e.g. different income, different age, disable people, socially disadvantaged groups, etc.) (ibid). Some of the indicators may overlap each other, such as the emission indicators in the environment consideration also influence the health consideration within the social categories. So it is essential to give them similar weight to judge them. Also, some of the indicators may difficult to get the data. Because some data is not efficient to use numbers gathered from quantitative research method to describe certain questions, thus the subjective answers gathered from the qualitative research method is needed. Actually, this indicator not covers every detail of the system. Some impact may not show in the list, but should not ignore. Such as some transport modes use electronic power are considered more sustainability, while how the electronic developed is important to see whether it is sustainability. The nuclear generated power may have less environment impact, while it may generate other risks (e.g. thermal pollution, terrorist threats) that could not be considered as sustainability.

**Value co-creation in SPT**

As mentioned above, the interaction between customers and service providers is essential in the value co-creation process. Both of the parties (customers and service providers) are the resource integrators and beneficial receivers (Gebauer et al. 2010; Sebhatue et al. 2011a). There are many strategic options for companies to provide value co-creation opportunities. Gebauer et al. (2010) categorized the strategies into five dimensions within the transportation system, based on Prahalad (2004)’s value co-creation activities: 1) customer engagement; 2) self-service; 3) customer experience; 4) problem-solving; and 5) co-designing (Figure 1). The term “customer engagement” refers to service providers seeks opportunities to co-create value with customers, such as persuade customers through promotions and advertisements approaches (Gebauer et al. 2010). “Self-service” means empower the customers to order, buy, and exchange resources through certain technical media (e.g. internet, mobile phones, and personal computer terminals) without any direct interaction with the employees of service providers (ibid). “Customer experience” refers the services can create memorable experiences and event to customers (ibid). “Problem-solving” means service providers provide opportunities for customers to solve problems by themselves through certain
platforms (e.g. web site, internet-based communities, and answers to frequently asked questions) (ibid). “Co-designing” refers to the customers work collaboratively with providers to create new services or products which meet customers’ individual needs and wishes (ibid).

Figure 1. Value co-creation model (Gebauer et al. 2010, p.518).

Value network in SPT

Inspired from Enquist (2005; 2011)’s discussion and argument, the public transport system could be viewed as a “value-creating stakeholder network” (Enquist et al. 2011, p.224). Based on the studies in Swedish public transport system, Enquist et al. (2011) defined there are four main actors/stakeholders operating in a public-private partnership (Figure 2).

As shown above, Figure 3 illustrates the four main actors: the “Principal” (the owner of the PTA and made up of the county’s units), the “PTA” (which responsible for managing the service system), the “Source operators” (the private operators who are contracted to delivery transport services), the “Citizens” (the public transport commutes) (Enquist et al. 2011). The relationships between the four main stakeholders represent several dialogues: the governance dialogue between principals and PTAs; the contractual dialogue between PTA and source operators; the customer dialogue between source operators with customers; the citizen dialogue between politicians and citizens (ibid). This model clarifies the relationship within the transport system, and illustrates the PTAs should give consideration about social, commutes and corporate performance. In other words, the key performance indicators
should take reference about what create value for customer, as well as the sustainable
criteria: financial, social and environmental aspects. Moreover, with the dialogues
between the relationships, it enhances the service performance within the public
transport systems.

Figure 2. Public Transport as a value-creating network (Enquist et al. 2011, p.224).

3.3.1. Bus Rapid Transit system

Bus Rapid Transit, characteristics of dedicated running way, application of intelligent
transportation systems technologies, is considered as a cost-effective travel mode that
providing high quality transport services to meet resident’s travel needs (Deng and
Nelson 2011). A BRT system is an integrated package of rapid transit elements,
which generally includes seven main components (Table 2).

<table>
<thead>
<tr>
<th>Running ways</th>
<th>BRT vehicles operate primarily in exclusive transit-ways or dedicated bus lanes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations</td>
<td>Sufficient shelter from inclement weather, seating, customer information, appropriate lighting and ample platform space for boarding, alighting and waiting are the minimum requirements.</td>
</tr>
<tr>
<td>Vehicles</td>
<td>Quiet, comfort, visually attractive, high-capacity vehicles use clean fuels to protect the environment.</td>
</tr>
<tr>
<td>Service</td>
<td>High-frequency service. A variety of service alternatives, including all stops routes, limited stop service, feeder services.</td>
</tr>
<tr>
<td>Route structure</td>
<td>BRT uses simple, often color-coded routes</td>
</tr>
<tr>
<td>Fare collection</td>
<td>Pre-boarding fare collection. They allow multiple door boarding, reducing time in stations.</td>
</tr>
<tr>
<td>ITS</td>
<td>Applications of ITS technologies include automatic vehicle location (AVL) systems, passenger information systems, communication technologies and traffic signal preference at intersections.</td>
</tr>
</tbody>
</table>
These components reflect the efforts of BRT system are willing to implement the bus services (e.g. high-frequency service, high-capacity vehicles, multi-doors boarding, shorter boarding time, etc.). One critical condition is the segregated right-of-way, which closely links with the BRT service performances (e.g. puncture, reliable, fast operation, etc.) (Deng and Nelson 2011). In order to guarantee the dedicated road way, many methods have been used, such as operating BRT system alone railroad alignments, on median bus way, on bridge or even in tunnels (ibid).

To determine and evaluate the values of BRT system, ITDP develops a BRT service standard, with five categories (service, infrastructure, station design and station-bus interface, quality of service and passenger information systems, integration and access) (ITDP, 2012). This scorecard shows the criteria and point values of the standard BRT system, and states the best BRT system should combine the efficiency and sustainability to provide high service quality and better customer experiences (ibid). It emphasizes the sufficient resources and appropriate designing, provided by the suppliers, is important foundation of further customer-supplier’s value co-creation process and the success of the service operation.

3.4. Summary

In summary, this thesis reviewed the literature concepts of sustainable development, service innovation, as well as value co-creation and value network, which formed the foundation of theoretical framework for further analyzing and assessing the sustainable public transport development.

The SD concept focuses on intergenerational equity (Kates et al. 2005). More explicitly, it states the economic growth should in a quality way that without sacrifice of ecologic system, with human needs is basic and essential (WCED 1987). Thus the sustainability concept could be viewed as a guide for decision making, that all the activities should ensure the overall consideration of social, economic and environmental impacts. As the sustainability definition is creative ambiguity, to make it clear, many previous researches defined it in terms of indictors (Kates et al. 2005), time-horizons (Leiserowitz et al. 2004), values (UNMD 2000), and through practices (Kates et al. 2005). A good way to combine these considerations together is to, firstly understand the values of sustainability initially (e.g. “ecological integrity”, “social and
economic justice” and “community of life”), then view the sustainability goals as long-time target, and set objectives following the relative easy-to-measured indicators to support the SD target. Turing to the transportation context, it should continually make transportation objectives based on the sustainability objectives and try to find solutions to achieve them (Litmen and Burwell 2006).

Innovation is essential for sustainable achievement (Nidumolu et al. 2009). Making solution for SPT with the balance consideration of sustainability pillars, more or less, needs to use an innovative to design the service and value creation approach. The service innovation generally could be separated into four dimensions (Products/services, process, position and paradigm), which can be incremental or radical. Such service innovation is not about developing new better resource configuration, but more importantly to make the resource configuration facilitate customers to utilize and realized the value by co-creation with service suppliers (Edvardsson and Enquist 2011). The service innovation concept is based on the S-D logic, that value is co-created by customers and suppliers. PTA should view the customers as the proactive role rather than passive service receiver. Motivating the customer into the service process is the key for the success of the service innovation. Rather than customers and suppliers, according to S-D logic, no individual network could have adequate resources to create value by them own (Mele et al. 2010). Thus the service innovation needs to consider and combine the multi stakeholders’ resources and capabilities to create new and useful solutions for value co-creation (Ramaswamy and Gouillart 2010). In the public transport context, there are four main actors (principal, PTA, source-operators and citizens) operating in a public-private partnership (Enquist et al. 2011). The indicators set down within the contracts helps the transport authorities to monitor the service performance. Meanwhile, the dialogues (governance dialogue, contractual dialogue, customer dialogue and citizen dialogue) between the relationships enhance the service performance within the public transport system (ibid).
4. Empirical studies of BRT in Changzhou

This chapter illustrates the empirical findings, which include: general information of public transport in Changzhou, challenges of the development of public transport, implementation of BRT systems in Changzhou, and future development of public transport systems in Changzhou.

4.1. City Background

Changzhou City is a newly developed industrial city. According to Changzhou Statistical Bureau (2008, cited in Jianchen 2009), the city and urban area are 4375 km² and 1864 km² respectively, with the urban household population and floating population of 2.25 million and 1.3 million respectively (Jianchen 2009).

With the rapid economic development and urbanization expansion, the traffic related problems such as traffic gridlock, inconvenience of travel and environmental pollution had become increasingly prominent in Changzhou city.

4.2. The challenges for urban traffic development in Changzhou

Changzhou public transport service is operated by Changzhou Transit Group (CZTG). Founded in 1960s, until 2008, CZTG owned 2249 vehicles, operated 125 bus-lines with total length of 2343km.

The high demand of urban traffic

From 1998 to 2007, the annually road length growing rate (13%) in Changzhou is far below the urban traffic volume growing rate (35%) (Xinchun 2009). Meanwhile, Changzhou urban public bus system did not have backbone network, the high density of urban population gathered in the central area led to the increasing traffic pressure in the center of the city. In addition, the distribution of different traveling modes in Changzhou was imbalanced. According to a traffic survey report of Changzhou, until 2006, the walking and cycling were still the main transport for residents to travel (accounted for approximately 60%). However, only 9% of passengers used public bus as the travel mode.
Low public transport operation capability

The main problems related to the public transport development in Changzhou could be generalized into six categories (Jianxin 2008). Firstly, the transportation structure and network had not clearly drawn. Many bus lines overlapped each other, especially in the high demand areas, while only some lines extended into some residential quarter. Secondly, the transit parking hub and maintenance field was not efficient. The single function bus terminal limited the optimization of bus service operation, as well as the insufficient transit parking hub limited the service delivering scope. Thirdly, the bus service and management was in a low level. Low puncture rate and long waiting time was the main unsatisfied comments from Changzhou residents. A dynamic management to meet passenger need was lacking. Lastly, Changzhou lacked of wide range of bus priority development policy and measures to support public transport development.

4.3. The implementation of public transportation in Changzhou

Following the national political motivation, Changzhou Municipal Government launched several political measures for priority development of urban transport, with the purpose to improve accessibility of urban bus travel and alleviate urban transportation related problems.

4.3.1. The priority development of sustainable public transport in Changzhou

Priority develops transport policy: In 2007, Changzhou Municipal Government opened the 56th Mayor Executive Conference, and adopted “2007 Changzhou priority develop public transport implementation plan” (Zhang et al. 2012). Such conference convinced a “six measures” (decrease ticket; upgrade the bus level; optimize the network; increase speed; unify public transport with countryside; upgrade service and management) for priority develop of public transport and proposed to develop BRT system as a solution.

Regional integration: In 2002, Changzhou municipal government integrated Wujin County as a region into Changzho urban administration area. The regional integration created a favorable condition for further regional traffic integration. Next,
Changzhou municipal government unified the public bus operators into CZTG, recycled the vehicles from private bus companies, and thus terminated the vicious bus service competition within Changzhou city.

**Government’s funding supports:** According to Changzhou government report, the government public transport subsidies and input had increased from original 100 million CNY (≈ 100 million SEK) to 750 million CNY (≈ 750 million SEK) in 2008.

**Interaction with communities:** To increase communication with customers and continue implement the public transport service, CZTG used to hold serious theme activities, such as “Making Quality Public Bus” theme activity. Rather than questionnaires survey, CZTG opened a “Join Communities” activity to listen to public voice and complaints and discuss with the citizens about how to increase the bus service quality.

4.3.2. **Development goal and plan for Sustainable Public transport**

Based on the “people-oriented, sustainability and modern metropolis” development principal, CZTG set the public transport development objective as: to build a sustainable urban transportation system with characteristics of fast transport speed, frequent logistic, low consumption and emission, high efficiency and human equity (CZTG, 2011d). Against this objective, it set down a sustainable public transport development indicators:

**Environmental:**
- Traffic noise and air pollution on both sides of the primary and secondary roads should meet China National IV (emission) standard;

**Economic:**
- The travel cost should be affordable, that it should under a certain level relate to resident’s income;
- Residents’ average bus waiting time should be less than 5 minutes, average bus transfer times should be less than 1.4 times;
- Motor vehicle average travel speed should be no less than 20km/h;
- Multi transit model should facilitate residents travel need;
Social:
- 30-minutes traffic time to Centrum (Cultural Palace Square) in the main city;
- More than 95% City residents’ one-way travel time should be no more than 40 minutes;
- 95% City residents to reach public transportation (subway) station should be less than 500 meters;
- 80% City residents to reach public transportation (subway) station should be less than 300 meters;
- Traffic fatality rate should less than 10 person/ 10,000 cars.

CZTG used the number based simple indicators clearly described the future development target of public transport system.

4.3.3. Value network in Changzhou public transport

Inspired from Enquist et al. (2011), the stakeholders within Changzhou public transport system could be categorized into four main actors:

**Ministry of Construction of P.R. China (Politicians):** It takes responsibility concentrate on the fundamental principles governance public transport service provision. In addition, it contributes the funding support and enforced land-use policy for priority develops public transport.

**Changzhou Transit Group (PTA):** CZTG is an integrated public transport service operator, that responsible for the management of strategic marketing, transport planning, transport dispatch and financing.

**Sub companies belong to CZTG (operator):** There are 10 sub organizations under the governance of CZTG (See Appendix 10), the responsibilities include public transport service operation, property management, trading business, and vehicle maintenance and repairing.

**Customer (Citizens):** The customer scope involves the permanent and transient residents, which include the business workers, tourists, and other groups. With the expansion of the urbanization of Changzhou, the customer scope of Changzhou public transport service also covers the surrounding regions or villages.
4.4. The BRT services in Changzhou

Since 2008, Changzhou launched the BRT corridor-1 with total length of 24.5km, following the corridor-2 with total length of 22.9km in next year. According to the practical situation and resident’s travel demand, each corridor operated 3 sub-lines, which formed a ‘two-main lanes and six-branch lanes’ BRT structure. The average operation speed reached to 18 km/h, and the transmit volume passed over 200,000/day (Junyi 2011).

4.4.1. Infrastructure design

Segregated Right-of-way: A segregated right-of-way is one main characteristic of BRT system, which ensures the fast service speed and avoids congestion. Changzhou BRT used marking line and reflection spike to segregate the BRT running way with cameras to strengthen the traffic management. Comparing with usage of barriers, this method contributed better landscape and more conductive to play an emergency channel function, also needed less cost. More importantly, it increased the BRT running speed. According to Miss Wang’s, a journalist, description, the BRT running speed was as fast as the taxi in Changzhou. She did a simple experiment and found the B1 used 45 minutes from starting station till ending station (around 24 km), which cost quite similar time by taking a taxi. While at the beginning of the BRT operation, it suffered many complaints from the private car owners and taxi drivers. They complained the segregated BRT lane “fast a line, slow a city”. Relate to this comment, Jiang, an operation officer, replied,

The BRT project is designed to attract more citizens to select public bus more than others. As more people get the benefits from the BRT service, the more people will accept and join BRT service.

Jiang stated the segregated BRT lane did not reduce other automobile’s running road; actually, Changzhou reconstructed the road with increased width and segregated the BRT running way.

Backbone network structure design: According to Zhang Jian, an operation officer, that Changzhou public transport’s success benefits from the public transport backbone network planning. The Changzhou BRT’s network structure covered the high density
areas of the city, as well as “many other passenger gathering points, such as schools, health center, commercial centers, and tourist attractions.” Areas within 500 meter of the BRT network covered population and jobs of approximately 291,000 and 258,000 respectively, which accounted as 14.7% and 20.3% respectively of total amount in Changzhou (Jianchen, 2009). It covered many high demand distribution points, such as bus terminal, train station, CBD, universities, hospitals and major tourist attractions. Furthermore, the branch lines enhanced the BRT network coverage and bus lane utilization.

**Semi-closed network design:** Changzhou BRT system adopted a ‘semi-closed network model’, which combined advantages of ‘closed network model’ (high service quality) and ‘open network model’ (high flexibility) (Figure 3). It optimized the use of multiple routes, that branch line could access the main corridors easily. This model design fully considered the objective urban traffic reality in Changzhou, where the land resource constraint in the city center and difficult to transform. Letting branch lines running mixed with social vehicles quite minimize the difficulty of implementation and guaranteed the service quality.

### 4.4.2. Facilities design

**Vehicle:** Changzhou BRT fleets were all international co-designed environmental-friendly fleets. Take 18-meter articulated City bus YS6180G as an example. It was co-developed by SCANIA (Sweden) and Alfa (China) companies with the following advantages:

- **Environmental protection:** This fleet used ‘SCANIA DC9-18 EFI’ engine, which the emission level reached to Euro-4 emission standards.
- **High standard:** It used ‘SCANIA N310UA 6x2/2’ City-Bus chassis, which increased the safety and comfort features. The embedded ‘Hubner’ electronically controlled hinged plate and electronic height control valve (ELC 3.0), strengthened the function of anti-rollover and rapid increase or decline respectively.
- **Low-flow boarding:** Convenient for old people, children and disable people to get on bus.
- Electronic: Chassis fitted with the new ‘CAN’ system, which improved the troubleshooting and integrated other functions into the system, such as, voice station reader, multimedia display equipment, inside monitor and so on.
- High reliable: The key parts of the fleet chassis were mainly transplanted from heavy-duty truck, which contains the features of superior durable and overload capacity (Alfa Bus, 2009).

**Bus refueling process design:** To optimize the BRT fleets refueling process, CZTG built a skid-mounted bus gas station. The skid-mounted bus gas station only contained 60m² areas, while the oil supply capacity could be comparable with an ordinary gas station. The storage capacity reached over 20 tons, which could meet 65 vehicles of BRT fleets’ refueling requirement. Assume one refueling process could save 10 miles driving, only BRT corridor 1 could save 237,000 miles’ driving, equals to 116 tons’ energy consumption or 1 million CNY (≈ 1 million SEK) cost. In another way, it reduced the BRT drivers’ working intensity.

**Pavement Quality:** As the BRT fleets required high quality of pavement, the entire roads alone the BRT corridor 1 and 2 had been reconstructed, only with one exception of Dongfang East Road. The frequent bus braking, heavy weight of the bus, the roads shown different levels damage, some intersection shown untimely destruction, even fatigue cracking and serious rutting (Li and Zhao, 2008). As repairing the road condition is necessary, CZTG used a less impact construction method. Such reconstructed roads used a structure form of laying fiberglass grille to eliminate the differential settlement between the new and old roadbed under the asphalt seal coast with lie-fly ash (ibid). Meanwhile, CZTG reinforced concrete in docking area in stations to ensure the strength and durability of the pavement.

4.4.3. **Station design**

**Central Right-side station:** The Changzhou BRT stations were designed as the central right-side stations, which contained two considerations. Firstly, there are many road crossings (37), entrances and exits (124) from residential, business and shops alone the BRT corridors, which means the roadside station design would impact on other motor vehicle access and BRT operation. Secondly, CZTG considered the future road expansion possibility, that then the BRT station would need to be reconstructed.
For the right-side station design, according to Sun Luming, it was because that can integrate normal bus and BRT fleet within same station.

**Safe and Comfortable Stations:** The Changzhou BRT stations were all standard designed (3 m * 60 m), with two parking positions. The steel forms with fiberglass shell BRT station design contained the aesthetics of modern construction, more importantly, had the function of weather protection. Furthermore, all the BRT stations equipped matched sliding doors with BRT fleet doors. Such sliding doors reduced the risk of accidents and prevent passengers from entering the station in unauthorized locations (Jianchen 2009).

**Pedestrian Access:** The combination of good pedestrian access is important for a well-designed BRT station. Three access approaches had been used in Changzhou, including at-grade crossing, pedestrian bridge and underpass. Changzhou mainly preferred at-grade crossing, which needed less investment and easy to construct. Meanwhile, Changzhou BRT system also adopted the other pedestrian access methods, where constructed pedestrian bridge in XiXin Bridge station, and 4 underpasses in Yanling Road section, with the purpose to achieve a stereo-access form.

**Universal Access:** Changzhou BRT station designed wheelchair passing gate and tactile ground surface indicators leading to all stations. It facilitated accessibility to all special needs customers.

**Stations Set Back from Intersection:** Changzhou BRT stations were mainly located close to intersections (48/51), that passengers entering and leaving the station could be combined with crosswalks and pedestrian lights, which, on the other hand, saved construction cost. Considering the operation process, majority stations (35/51) were located at least forty meters from intersections to avoid BRT travel delays (Zhang et al. 2012).

**Average distance of stations:** The average length of BRT stations was mostly longer the length of normal bus stations, which between 0.46km (the shortest) and 0.98km (the longest) (Zhang et al. 2012). The design of Changzhou BRT station distance combined two concepts that: 1) the station distance in main line was longer than
branch line; 2) the station distance in city center was longer than city margin (See Table 7). The fundamental issue is to enhance the BRT service speed in urban area.

4.4.4. Services design

Fare policy: Changzhou BRT adopted a low fare policy, that each time only cost 1 CNY (≈ 1 SEK) for using BRT service (Table 3). Some groups of passengers (e.g. people using IC card or student IC card) could have extra discount and some groups of people (army, disabled people and people over 70-years old) could enjoy a free boarding service. The price design had much competitive advantages, which attracted many private car users became BRT commutes. As Miss Liu, a local resident, said,

Normally, I prefer to take bus (BRT), as my majority transport method. You can imagine that 1 CNY could travel 20km. If you drive a car, it will cost more. And you still need to find parking place.

Table 3. Boarding fare policy of Changzhou BRT (Xinchun 2009).

<table>
<thead>
<tr>
<th>Ticket fare</th>
<th>Cash fare</th>
<th>IC card fare</th>
<th>Student fare</th>
<th>Elderly fare</th>
<th>Other free boarding group fare</th>
<th>Same direction transfer fare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>1 CNY</td>
<td>0.6 CNY</td>
<td>0.3 CNY</td>
<td>0.2 CNY</td>
<td>free</td>
<td>free</td>
</tr>
<tr>
<td>IC card</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Student</td>
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<td>Elderly</td>
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<tr>
<td>Other free boarding</td>
<td>free</td>
<td>free</td>
<td>free</td>
<td>free</td>
<td></td>
<td></td>
</tr>
<tr>
<td>group</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

(Note: 1 CNY ≈ 1 SEK)

However, the free boarding policy for certain groups, such as older people, also aroused some problems. According to Sun Luming, some office workers complained that sometimes they were hard to get on the BRT in the morning time, because many ‘free users’ traveled frequently. So the CZTG also planned to use other policy to release this conflict, such as switching the ‘free boarding’ policy to ‘limited (times or time period) boarding policy.

Off-board Fare Collection: Changzhou BRT used pre-boarding fare collection for all the stations, which reduced boarding time and improved customer experience. Such BRT stations used ‘barrier-controlled’ approach that customers passing through a gate by paying boarding fare (either coin or bus card), with an inspector monitored in every station.

Passenger Information: Changzhou BRT fleets all embedded with GPS equipment, thus all the fleets’ location information would send to the BRT control center and show on the passenger board in every BRT station. Together, a BRT network map
posted in the top of the bus information marked with different colors, which facilitated customers to find their way to destinations. More than that, the information board also contained the psychology function that made customer feel comfortable. As Sun Yanhua, a tourist from Danyang (Jiangsu province, China), said,

The timetable really makes me comfortable. Then I could know whether the bus is gone or would come soon. Furthermore, the distance of the bus (from the station) would also show on the board, which is quite good.

**Platform-level Boarding:** Changzhou BRT stations were all designed 34cm higher than road surface, where passengers could smoothly enter or exit BRT compartment to achieve the ‘Horizontal boarding’. Such BRT station side used ‘Kassel curbs’ to reduce the gap between buses, which needs no extra equipment.

**Multi-doors Boarding:** Changzhou BRT fleets mainly used multi-doors (4-doors and 2-doors) boarding approach, whereby contributed for the fast boarding time and partially guaranteed the fast boarding time.

**Hours of Operations:** The operation time design need to balance the consideration of external factors (e.g. service target groups) and internal factors (e.g. operation cost). Considering the high operation cost, the Changzhou BRT operation time started quite early, around 5 o’clock in the morning, till around 9 o’clock in the evening for both weekdays and weekends (Appendix 8). Although the BRT system did not provide the night service, as Hu Lin said, the daily last time BRT service forbidden to arrive to ending station in advance, which guaranteed the night time passengers, or who wanted to catch the last bus, could ride on the bus.

**Peak Frequency and Off-peak Frequency:** The frequency of bus coming during peak or off-peak travel times is a good proxy of quality of service. The frequency of Changzhou BRT service during peak and off-peak time was approximately between 5-min and 15-min respectively (Appendix 8). Compared with ITDP’s BRT standard (ITDP, 2012), it was in the moderate level.

**Intersection Treatment:** By using coils, microwaves and other detection equipment, Changzhou BRT control center could get the real-time information of BRT fleets and transfer to signal control system to implement the strategy of ‘signal priority’ of BRT
service. It included two ways of signal priority measures: green light delay and green light in advance, which guaranteed the BRT service quality of punctual, fast, comfortable and efficient operation features.

### 4.4.5. Management approaches

**Control Center:** CZ Transportation Command Center set a BRT control center to monitor BRT operation, identify and rapidly respond to problems. By assessing all kinds of traffic information, such BRT control center strengthened the transport management capacity, as well as changed the traffic dispatch and management ideology.

**Improved evaluation rules for employees:** Since the bus service was operated by national owned company, then the employees’ salary did not link to the bus companies’ financial performance rather to their own performance. Against this, as Hu Lin said, “corporation (CZTG) launched a ‘five-star’ employee performance assessment to motivate employees’ enthusiasm, that higher performance level would link to higher bonus”. From ‘one star’ to ‘five star’, there existed five evaluation levels. The evaluation approach consisted knowledge examination and professional skills assessment, both all would be evaluated once a year. The knowledge test was a computer-based examination, while the professional skills assessment was a daily assessment. The questions in the examination were based on the daily operation problems that employees would learn by personal and shared experience. For the professional skills assessment, the operation mistake and special contribution has strong influences on the final judgment. According to Sun Luming, until 2012, there only had two BRT drivers reached to “five star” level, additionally, only continually high performance can make this honor stable. Beside the performance measurement function, it also has another function of changing employee’s behaviors, attitude and value to their work.
4.5. Contribution and future development

4.5.1. Contribution brought by BRT system in Changzhou

**Public transport network:** During five years development (2006-2010), the bus routes increased more than 6 times, from 25 to 161; the average network density reached to 0.57 km/m².

**Public transport capacity:** BRT system in Changzhou increased the public transport commute volume and reduced the city blocking rate. Until 2009, the ridership reached to 782,000 person-times/days, and the bus travel sharing ratio reached to 30% among all the transport methods. Meanwhile, until the end of 2010, the serious periodical blocking rate in Changzhou reduced to only 0.3%, and the average peak hour motor speed reached to 29.2 km/h, which both indicators all achieved China ‘National Smooth Traffic Project’ A-level requirement. Thus, Changzhou had been ranked as the ‘National Model Traffic Management City’ for its high traffic management level.

**Customer satisfaction:** Changzhou BRT, with the advantages of fast, punctual, comfortable, delivered quality traffic service to customers and received the public’s praise. Relate to the Changzhou BRT satisfaction survey, 90.2% customers responded “satisfy” with the construction of BRT, and 91.55% customers responded “satisfy” with the BRT service.

**Energy consumption and CO2 emission:** According to US Energy Foundation (cited in Xinchun 2009), BRT is a less pollution and less energy consumption public transport method (Table 4). Through implementing eco-friendly vehicle technology and optimizing operation system, BRT system in Changzhou annually saves 8,559,560 liters of fuel, which equals to reducing 6137 tons of CO₂, comparing with conventional bus system.

Moreover, more residents selected to use BRT as a travel method rather than private car. Since BRT system launched in Changzhou, it cumulative reduced motor vehicle (motorcycle and automobile) travel 25.9 million person-times, and reduced non-motor (bicycle and electronic bicycle) travel 42.64 million person-times. It increased the efficiency use of land, as well as reduced variety of pollutions, such as traffic sound pollution, electric bicycle abandoned battery pollution.
<table>
<thead>
<tr>
<th>Pollution elements</th>
<th>Small car (CO2(t))</th>
<th>Taxi (CO2(t))</th>
<th>Normal transmit (CO2(t))</th>
<th>BRT (CO2(t))</th>
<th>MRT (CO2(t))</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2(t)</td>
<td>140.2</td>
<td>116.9</td>
<td>19.8</td>
<td>4.7</td>
<td>7.5</td>
</tr>
<tr>
<td>NOx(kg)</td>
<td>746.0</td>
<td>662.0</td>
<td>168.4</td>
<td>42.0</td>
<td>17.5</td>
</tr>
<tr>
<td>Gas(t)</td>
<td>49.2</td>
<td>41.0</td>
<td>6.9</td>
<td>1.6</td>
<td>2.6</td>
</tr>
</tbody>
</table>

**Social cost savings:** The operation of BRT system saves the travel time, which is another social cost. Theoretically, the benefits of travel time savings should consist by work travel time and leisure travel time, and the formula could be set as following way (Jianxin, 2008).

\[
B = Q \times T \times \frac{G}{2}
\]

(B= Benefits of travel time savings, Q= annual quantity of BRT passenger volume, T= Time saved per passenger, G=average Gaining per person per hour. Based on international practice, the value of leisure time as 25%~75% value of working time, so this formula select 1/2 for general measurement.)

According to Changzhou Statistical Bureau (2011), in the end of 2010, the Changzhou household population is 3.608 million, the average annual salary is 43634 CNY (≈ 43634 SEK). The annual volume of BRT passengers is 388 million person-times, average travel distance is 6.68km, average speed of BRT is 22km/h, and average speed of normal bus is 12km/h. So average per passenger saves time as 6.68/12-6.68/22=0.253 h (Zhang et al., 2012). Then it can calculate the travel time benefits saved by BRT in Changzhou are 21.39 billion CNY (≈ 21.39 billion SEK) per year.

**Land use value:** The BRT’s direct effect on land value increasing was hard to measure. However, there was a trend that more real estate companies used “close to BRT corridor” as an important sales point in their advertisement. According to Changzhou Daily (2012), more than 80% of Changzhou citizens agreed “close to BRT corridor” were one consideration element in apartment buying decision.

4.5.2. Shortage of BRT services operating in Changzhou

**Low capacity of bus station:** According to Wang Ming, a BRT bus driver, stated, when BRT launched in Changzhou, the passenger volume increase quickly. However, the fixed standard station design could not meet public demand, especially in city center and peak hours.
Low active customer interaction: The development of BRT system in Changzhou mainly focused on the provision of sufficient facilities firstly. Customers in Changzhou still did not fully proactive to the BRT service.

4.5.3. Future development

Bicycle-sharing integration: To increase the accessibility of transport service, the bicycle-sharing program was admitted (Appendix 9). After the renting points’ extension, it would bring convenience to passengers’ last one mile’s trip.

Metro integration: Until 2012, Changzhou got the permit to launch Metro in the city. Based on its plan, if everything goes well, Changzhou will have its first Metro line in 2016 and second one in 2018. The preliminary plan consists of five Metro lines with total length of 170km (Zhang et al. 2012).

Passenger information through mobile app: CZTG had decided to co-develop a mobile app with China Unicom to deliver transport information through the smart phone. Based on that, customers could design the best way to achieve their destination.

Multifunction transportation hub: In 2010, the control center of BRT corridor-I had moved from edge of the city to the city’s heart position, which could better facilitate the bus service operation and coordination. According to Zhang Jian,

Corporation (Changzhou Transit Group) upgrade the disk storage that video record period extends from 6 days to 20 days. Through the big monitoring screen (in dispatch command center), the working staff can achieve real-time monitoring of all sites within BRT corridor. Those enhance the emergency events handle capability.

This two-floor parking platform could achieve normal bus and BRT’s “Seamless Zero Distance Transfer”, which also facilitate the “P+R” integrated transmit model.
5. Analysis and discussion

This chapter answers the research questions about how could sustainability drive service innovation in the public transport sector, and the means of service innovation to SPT, based on the empirical study of Changzhou BRT.

5.1. Sustainability as a driver for service innovation in transport sector

The sustainable development concept emphasizes the development should consider not only economic, but also social, environmental aspects, which influences people and organization’s behavior and value judgment (Kates et al. 2005). The concept of sustainability has been adapted to address very different challenges, ranging from the planning of sustainable cities to sustainable public transport (ibid). The creative ambiguous sustainability concept guides the development plan should meet the intergenerational needs, while different organizations could develop their individual sustainable development plan based on complex diversity of human societies and natural ecosystems around the world (ibid).

Although there does not have a universal definition, the comprehensive definition of sustainable public transport (SPT) reflects such transport department should design a sustainability plan to achieve three main sustainable goals synchronous over the long run by increasing the transportation system efficiency (Litman and Bruewell 2006). Such sustainable plan assumes the each travel mode can be useful. It means bicycle, bus, Metro can have similar important position that the sustainable transport plan is to use the each mode as it is the best (ibid).

The sustainability of public transport system is often be measured by some indicators to catch the development trend, evaluate transport policies and set targets (Litman and Burwell 2006). However, one critical thing is some indicators have important impact but hard to measure, some easy-to-measure indicators have less impact. So, it is helpful to set the hard-to-measured sustainability goals as the target, and focus on the easy-to-measure objectives or impact to achieve that. Following the sustainability objectives, public transport authorities could recommend the transportation objectives, with the transportation solution to support (Litman and Burwell 2006). Such solutions
could be either based on innovative way of management or technology and new resource application. In other words, such solutions could be viewed as service innovation opportunities, with which to improve the transportation service quality and efficiency either incrementally or radically. All in all, such sustainability goals drive service innovation in the public transportation system to contribute the sustainable public transport development.

5.1.1. Environmental sustainability as a driver

Environmental sustainability includes the goals of ecological integrity and human health. Against the ecological integrity goal, several sustainability objectives (followed by related SPT objectives) could be set, such as ‘reduce climate change’ (related to ‘reduce climate change emissions’), ‘preserve habitat’ (related to ‘reduce impervious surface’), and ‘reduce pollution’ (related to ‘reduce harmful vehicle air and water emissions’) (Litman and Burwell 2006). Those sustainability and SPT objectives drive the PTA to search and find innovative transportation solutions to implement public transport service.

The carbon dioxide emissions reduction is critical to perform in order to tackle the climate change (IPCC 2007). According to CST (2005), sustainable transport system should “limits emission and waste within the planet’s ability to absorb them” (p.6), use renewable and non-renewable resources in a planned way. Rather than reducing the consumption of nonrenewable and renewable resources, Nidumolu et al. (2009) claimed, to achieve sustainability, companies or organizations could also developing “sustainable sources of raw materials”, increasing “the use of clean energy sources” (e.g. wind and solar power) (p.6). Another issue is to better use of land resource and minimize the habitat impacts. The higher-density multifunction parking construction is recommended. Better use of original road material when constructing the new road is important not only for less impact on road, but also for less construction cost. Thus the new road conserve technology and optimized parking management is required to minimize the land resource impact.

Against the human health goal, sustainability objectives and SPT objectives could be set as ‘reduce injuries, reduce pollution exposure, increase exercise’, and ‘reduce traffic accidents, emission controls, increase active transport’ respectively (Litman
and Burwell 2006). ‘Safety and health’ is one important common indicator for the public transport service, which refers to the needs from individuals, companies and societies to have a safety and health trip through public transport services (CST 2005). New technology within the bus fleet design is recommended, such as anti-rollover and shockproof features. Turing to the pollution related human health problems, according to World Bank (2002), in the developing countries, the death caused by transport-relate air emissions death account half a million each year. The pressure to reduce air pollution emissions not only comes from social, environmental groups, but also comes from the government policy (Berry and Ronddinelli 1998). Many country have set their emission standard, such as Euro VI, U.S. 2010, to reinforce car manufactory to innovative apply eco-friendly technology when designing vehicles to reduce the vehicles’ environmental impact. In another part, sustainability transport plan assumes the sustainability transportation system is the best use of different transport modes (e.g. motorized transport and non-motorized transport methods), which means, better integrate different transport modes is helpful for the entire transportation system development. Thus PTA could admit some bicycle renting company to operate their business around some bus stations to optimize customers’ travel process. Integrating the Metro, train, and BRT system with a sign in different transfer points is also helpful for customers to co-create value by rolling into the SPT service. The requirement for “safety and health” motivated the service operators to co-design the sustainable services offering that is appropriate to the customer’s needs and wishes (Sebahtu et al. 2011b; Gebauer et al. 2010). In addition, the safety and health services would benefits the trust relationship construction between companies and customers, by which would lead to good reputation and long term revenues.

5.1.2. Economic sustainability as a driver

The goal economic sustainability in public transport sector could be viewed as to enhance of economic welfare (Litman and Burwell 2006). This goal drives several objectives like consumer mobility, business productivity, and public investment productivity (ibid).

Against such sustainability goals and objectives, the STP objectives should be set as ensuring adequate public transport services, providing multiple mobility choices,
reducing traffic congestions, and upgrading transportation facility to ensure service efficiency (Litman and Burwell 2006). Increasing the mobility of the public transport service is the primary target for the public transport, which involves ensuring adequate road capacity, increasing the frequency and quality of the public transport service, increasing the operation time, and faster delivering speed. In other words, the fundamental facilities and infrastructure or even service delivery process may need to redesign to improve pervious performance. Several possible approaches could be used, such as developing higher capacity vehicles with segregated road (Downs 2004), applying ITS technology to ensure the smooth transport process (EC 2009), improving the walking and cycling condition linked between public transport station with communities (Litman and Burwell 2006).

In the same vein, to increase the business productivity, innovations relate to transport process and acquired facilities could be helpful. Such innovations could be like designing an integrated system between bus service and air freight, high speed rail service (EC 2009), balancing the requirement between stakeholders and designing efficient land-use plan (Kennedy et al. 2005), applying transportation demand and management approach (Litman and Burwell 2006).

Turning to the public investment productivity, it refers to the acquired transportation facility to support the delivery process efficiently. Then the innovation opportunities could include devising infrastructure with better combination of digital and physical staff. Such investment productivity could be shown either higher service efficiency or lower consumption and impact (Litman and Burwell 2006). Innovation could be embedded within the application of eco-friendly raw material, low environment impact construction form, and transport planning and management for efficiency (ibid). Inevitable, such process and services design innovation requires and may cause the customers’ and managers’ paradigm changes. Which means, managers should maximum motivate the customer to use their knowledge and skills to active use of the transport service (e.g. designing their travel way based on the customer information, combining different travel modes), with the guarantee service provided by employees’ active using of their knowledge and skills (e.g. traffic monitory, quick response to traffic accident).
5.1.3. Social sustainability as a driver

Social sustainability in public transport sector reflects the goals of equity and social welfare, which drives the sustainability objectives as horizontal equity and vertical equity, community livability, and human capital development. (Litman and Burwell 2006).

Equity has several implications for sustainable public transport policy making, which include the horizontal equity and vertical equity thinking. The horizontal equity implies the bus service fare needs to involve not only the fuel cost, but also the road and parking fee, maintenance cost, pollution treatment cost, and many other external costs. On the other hand, it implies that the public transportation should reduce the externalities, such as reducing pollution emissions and accident risk, or compensating to those who bear these external costs (Litman and Burwell 2006). Then the vertical equity refers to the public transport service should affordable for majority of residents, especially to those socially, economically and physically disadvantages (ibid). It motivated the vehicle companies to apply eco-friendly technology and use clean energy to reduce the pollution emission to the environment.

As a livelihood engineering project, creating social benefit is the priority target for PTA through public transport service (Jianchen 2009). Community livability includes the local community environment quality, quality of community interaction, and the ability to satisfy the residents’ basic needs (Litman and Burwell 2006). Community environment is quite critical for the community livability, thus to control the air pollution, noise pollution, sound pollution in a low level is important. So the transport system design should consider the community personal life, for instance, the open space availability and accessibility, walkability, pedestrian friendliness (CST 2005). More than that, the resident’s mobility within neighborhoods required PTA to innovative design the road mix that facilitates residents’ travel ability. One critical thing to improve the community livability is the smart design of public transport service fare price. Control the travel cost within a certain level is what the SPT required (Hull 2008). Adopt the low fare policy is an effective and obvious way to deliver benefits to social residents (ibid), which on the other hand increased the community livability.
Human capital development is one of the critical elements in sustainability concept, which covered the education, equal opportunity (Leiserowtz et al. 2004) and working condition (EC 2009). Competition and innovation of course provides positive effect on transport labor market. However, it is important to make sure the changing condition could be a source to create new job and employees could participate into the new work process or work condition (ibid). Thus career training, social dialogue, consultation all could be a method to ensure such restructuring. In other view, the education is a basic need of human being, and such education chance should equal to everyone. In addition, it must maintain and improve the working condition, which involves the human right, work intensity, and health working place (ibid). It may lead process innovation to optimize the working operation process and services innovation with the ITS application to reduce employee’s work intensity and work efficiency.

5.2. Service innovation in Changzhou BRT system and the Means to SPT objective

Innovation is essential for sustainable achievement (Nidumolu et al. 2009). Based on the empirical study of Changzhou BRT system, it could find the service innovation (consists of services, process, position and paradigm innovation), oriented by the sustainability ideology, has embed in the all the main components (running way, station, vehicle, service, route structure, fare collection, ITS) of the BRT service (Deng and Nelson 2011).

5.2.1. Services innovation

Services innovation stands for the changes in service offerings to end-users (DTI 2007). The vehicles innovation, in the present case, refers to the improvement of BRT fleets to meet the customers’ needs for safety, health and comfortable travel. The infrastructure innovation here emphasizes the function improvement of the transfer hub to facilities customers’ needs for accessibility of integrated transport service.

Vehicle innovation

The requirement for human safety and ecosystem health is the basic objectives of SPT (CST 2005). Related to Nidumolu et al. (2009), to meet sustainable development
target, companies need to discover which products are unfriendly to the environment, and provide eco-friendly offering to customers. In this stage, organizations could get ability with the help of new technologies applications to challenge conventional wisdom (ibid). In the present case, CZTG upgraded the public bus, especially the BRT fleets. Those BRT fleets were all adopted the technical innovation to achieve the features of low energy consumption and low emission. The emission level of such BRT fleets all reached to Euro-4 emissions standards. For example, YS6180G (Scania/Alfa) BRT fleets combined of lightweight design technology, by which it reduced the weight of 700kg compare to domestic similar type of vehicle, as well as lower emission.

Turing to the safety design ideology, the BRT chassis were transplant from excellent heavy-duty truck, with the feature of superior durable and overload capacity. Besides, the import ‘Hubner’ electronically controlled hinged also strengthened the functions of anti-rollover and shockproof.

Comfortable travel was another feature embedded in the BRT fleet design. Supplying comfortable transport solutions matches the need from customer, especially the people with reduced mobility (EC 2009). Low-flow boarding feature facilitates old people, children and disable people to get on the bus, and the chair material, air condition and shockproof design enhanced the customers’ riding experience.

**Means to SPT objective:** The new features (e.g. eco-friendly, safety and comfortable) embedded in the BRT fleet design just formed a value proposition, such potential value would guarantee the customer travel experience, while would only be released by customers in a certain situation (e.g. boarding and riding). It reflects the equity of providing accessible bus service to various groups of customers. On the other hand, eco-friendly technology matched the environmental sustainability requirement, which also met the residents’ health needs potentially.

**Infrastructure innovation**

Transportation should bring freedom to customers: freedom travel from one place to another, and freedom to choose travel mode (EC 2009). To meet such objective, such transportation system should enhance accessibility of travel service to customers, and
enhance integration with other forms of travel mode. Thus, the multifunction and high capacity infrastructure formed the foundation to meet such requirement, As Kennedy et al. (2005) argued,

It is imperative for sustainable transportation systems to include an extensive and well-integrated public transport system capable of providing adequate capacity and competitive levels of service that can accommodate and attract a large proportion of urban travelers (p.406).

To increase the bus service accessibility, Changzhou had built up multi-function and multi-layers’ transport station hub. It provided a smart parking and free transferring field that enhanced the BRT operation. Moreover, CZTG planned to construct more stereo style public transport station, which emphasizes a “Seamless Zero Distance Transfer”. Car parking dock and bicycle saving fields are all designed around the stereo transport station. The Changzhou citizens could take cars or bicycles to the transfer hub, park them, and switch to public transport services smoothly. Such transportation hub could be helpful to “form pedestrian-oriented environment” and “reinforce the use of public transportation” (Corbett 1993 p.200). The availability of multimodal stations where customers can easily transfer modes and quickly access information can saves customer’s time, thereby increasing customer experience (EC 2009).

**Means to SPT objective:** Transportation is a network industry that comprises several elements: infrastructure, vehicles, ITS application, operational procedures and so on. The ability to provide effective and efficient service relies on the well combination of various elements (EC 2009). Exploitation of such networks’ capacity that facilitates customers to optimize the use of different mode could reduce congestion, emission, pollution and accident (ibid). Such multifunction infrastructure could be viewed as a fundamental platform, which provided by the service providers to facilitate customers’ value creation process. Meanwhile, by operating such infrastructure (operand resource), it could increase the customer’s mobility, reduce pollution and injuries, which were emphasized by the SPT objective.

**5.2.2. Position innovation**

The definition of position innovation focuses the changes in the context in which the services are introduced (DTI 2007). The network innovation emphasizes a well-
maintained and fully integrated network, which would increase the accessibility of public transport service to customers. The price innovation emphasizes the equity consideration that internal and external cost should be considered, and on the other hand, the fare policy should be attractive to various groups of customers, especially to those economic and social disadvantages.

**Network innovation**

According to European Commission (2009), designing “a well-maintained and fully integrated network” is one of the policy objectives for sustainable transport. In this regards, for newly developed city, it could first develop a reliable single transportation mode and then integration its network with other transport system (Sebhatu et al. 2011).

The fundamental objective of SPT is to increase the accessibility of the public transport service, which normally started from the increasing of mobility of such transport service. The formed “cross + circle” BRT route structure, covered many high traffic demand areas, that facilitated the majority citizens’ travel needs. moreover, based on CZTG’s blueprint, Changzhou public transport was designed to facilitate customers’ travel needs, with short walking distance (less than 500 meters), low transfer time (less than 1.4 times), and high travel speed (Jianxin 2008).

Expand the traffic network to provide public transport service to the vulnerable groups in the society is a signal of equity. Thus the lower income suburban area around the city margin area should be considered. Following the urbanization expansion, Changzhou BRT network expanded service area till pervious margin areas. People live in rural area could reach to the central area with shorter time and continent way. As Kennedy et al. (2005) argued designing transit-friendly or pedestrian-friendly neighborhood conforms to regional sustainability target.

An integrated network and user-friendly system is an objective of SPT to facilities customers to have a seamless travel (EC 2009). In the case of Changzhou, BRT network integrated with normal bus network, pedestrian access, and the continue integration with high-speed rail network, bicycling renting network was planned to optimize.
Means to SPT objective: To increase the public transport service operation efficiency, Changzhou PTA optimized BRT system network through expanding and creating BRT routes in an innovative way. The backbone network design increase the consumers’ mobility needs; and the margin area service extension guarantees the customers’ equity needs for public transport service, both of which contributed for the increasing of accessibility of public transport service. Then integrated means of different transport modes can be viewed as the value propositions that provided by the suppliers. Customers, from urban area or margin area, could realize value by active combining different travel modes to meet their travel needs.

Price innovation

The fare design is a critical issue in SPT service planning. On one hand, some suppose the price should reflect all internal and external costs caused by users (Litmand and Bruwell 2006; EC 2009). In other words, the service fare may increase to compensate those who bear such external cost. On the other hand, to make public transport service equity, the service fare should be ‘affordability’ (Litmand and Bruwell 2006). Against this challenge, CZTG’s solution was adopted ‘affordable’ or low price policy, while got funding from government to pay for the externalities. As Kennedy et al. (2005) argued the efficient and stable funding support the SPT development.

The term ‘affordability’ emphasizes the public transport service fare should under a certain level compare to the GDP/capital (CST, 2005). CZTG designed the bus travel (including BRT service) fare all into 1 CNY/time (≈ 1 SEK/time). Passengers, like student or IC card holder, would get different levels of discount. Old people and army could even have a free transport service. These low fare public transport service could be viewed as a social welfare, which increased the community livability.

In addition, low fare cost is an effective way to mobilize customers to engage into bus service. Compared with the higher cost of private car transport method, many car users switched to BRT commuters, especially their journey was not far away alone BRT corridors. More importantly, as customer the more engaged into the public
transport service, the more they created value by using their knowledge and skills to design their travel method, solve problem by active self-service behavior.

On the other hand, PTA, local government, and society would get benefit when more customers using public transport service. High service value with low-cost features enhanced the advantages of BRT service (DTI 2007). As social oriented program, the public transport should ensure the provision of services for all especially the low income groups in the society (Sohail et al. 2006). Although the majorities of internal and external cost occurred from public transport service was paid by the CZ municipal government, the growing economy and growing land value would ultimately compensate into the government financial income as the form of tax. One another intangible issue is the more usage of bus rather than car would reduce the air pollution to the environment, as well as lower traffic accidents events.

Means to SPT objective: The low fare design of BRT service could be viewed as a social welfare that reduced the customers’ travel cost. Meanwhile, it was a sign of social equity that the price is accordable for majority of the residents. On the other hand, the ‘affordable’ fare price enhanced the social economic welfare, which refers to the business productivity and land value.

5.2.3. Process innovation

Process innovation stands for changing the ways of creating and delivering offerings (DTI 2007). The boarding innovation changed radical boarding process to be more effective, with collaboration to customers. The land-use innovation changed the traditional public transport delivering process into a high mobility and accessibility travel process.

Boarding innovation

To attract and keep customers, it is important to search for new and better ways to create value and differentiate the market offering (Edvardsson and Enquist 2008). Rather than sending value added service offering to customers, it is more make sense to collaborate with customers to create value that meet their dynamic needs (Prahalad and Ramaswamy 2000). Away from traditional boarding fare collection method,
Changzhou BRT embedded self-service off-boarding approach that let customers actively join into the BRT services. By which it facilitate the boarding process from single-door boarding into multi-doors boarding. That when the BRT vehicles arrive in the station, the four sliding doors would open that passengers could entrance and exit from multi doors that saves boarding time and promote the service fluency and bus punctuality. This indirectly saves social cost that contributes for the society economic sustainability as well.

**Means to SPT objective:** Such self-service and multi-door boarding process saved customers’ traveling time. In other words, it partially contributed to the economic. Calculated by Jianxin (2008), the travel time benefits saved by BRT system in Changzhou were 21.39 billion annually. On the other hand, fast boarding process improved customers’ mobility, which may lead to better travel experience.

**Land-use innovation**

As discussed by Cervero (2001), the land-use planning for accessibility is the key to developing sustainable public transport in the urban area. Suggested by ITDP (2012), the segregated right-of-way ensures the buses can move quickly and unimpeded by congestion. In the case of Changzhou BRT system, it used marking line and reflection spike to segregate the BRT running way, with cameras to strengthen the traffic management. These methods not only contribute better road landscape, but also more conductive to the play of the emergency channel function.

To support the transport accessibility objective, Changzhou Municipal Government improved the road quality by redesigned the pavement construction of BRT running way. The reconstruction method reflected sustainability concept that optimized the combination of original pavement rather than huge construction. It saved construction cost, in the same time minimized the environment impact.

As Kennedy (2005) stated, movement to sustainable urban transportation involves the provision of accessibility with safety environment, and the generation of wealth by cost-effective and equitable means. In order to facilitate passengers enter and exit the BRT stations safety, Changzhou BRT stations mostly set near the intersection, that passengers could access with crosswalks and pedestrian lights. On the other hand, it
also facilitates the land usage without occupying more road resource. Furthermore, to fill in the gap of road resource reduction, Changzhou expanded the road width before setting the segregated BRT way.

**Means to SPT objective:** Segregated right-of-way to BRT system was an effective and sensible way of increasing accessibility level of transport service to customers. The indirect potential effects contributed by such process include reducing traffic accidents, reducing harmful traffic air emission, reducing traffic accident chance, and improving mobility within neighborhoods. The reconstruction of BRT sunning way belong to the public investment, it potentially guarantees the traffic efficiency and travel security. Moreover, such road redesigning method controlled the environmental impact in a minimum way.

5.2.4. **Paradigm innovation**

Paradigm innovation means the changes “*in the underlying mental models which frame what the organization does*” (DTI 2007, p.66). The governance innovation refers to the political regulation of public transport service, which formed the fundamental policy basis for the customer oriented value proposition. The management innovation changed the management ideology that emphasized the operation of employees’ (or internal customers) knowledge and skills to enhance the service operation.

**Operation innovation**

The city is a complex system that the changes in one part may affect others in unanticipated ways (Bourne 1982). Kenndy et al. (2005) noted that “*urban transportation is a public domain in which policy has not been very effective*” and “*this often derives from a bad distribution of the responsibilities between the many parties involved*” (p.3). Thus, to success launch a good integrated land-use plan, most urban regions need to establish suitable governance to achieve this goal (Kenndy et al., 2005). In 2002, Changzhou Municipal Government integrated the regional administration that merged early Wujin country as a district, and unified public transportation governance. Before that, vicious competition between four main public transport operators caused the separatist market and suffered public transport service
efficiency. Meanwhile, the Changzhou Transit Group (CZTG) had been established as an integrated public transport operator to take responsibility of Changzhou public transport management. Eight sub transport companies took over market responsibilities such as planning services, tactical marketing, and providing transit services. The previous vicious competition had been replaced by partnering concepts.

Although transport deregulation ensures fair competition, viable of transport service in marginal areas and accessibility of various groups of people, vicious competition is not recommended. Actually, the Changzhou public transport service regulation was customer oriented, which emphasized the service quality assessment e.g. punctuality, grid density, network coverage, responsibility for complaints, and claimed the service efficiency needed to meet the national government requirement. Meanwhile, the unified governance enhanced the regulation power which facilitated land-use plan, backbone network structure design, low service fare policy, and other transport related policy that formed fundamental basis for CZTG to provide value propositions.

**Means to SPT objective:** The unified transport governance formed the fundamental basis to support efficient transport service operation, which could be viewed as the foundation of value proposition. Meanwhile, the traffic regulation switched into a customer-oriented way that created the customers’ required value propositions, such as punctuality, network coverage, accessibility of public transport service.

**Management innovation**

Most executives assume that creating a sustainable business entails rethinking the customer’s value proposition and figuring out how to deliver a new one (Nidumolu et al. 2009). Developing SPT system involves rethinking the original service delivering approach and to deliver service in a novel way (Loo and Chow 2006). Thus, new technologies could provide organizations with the ability to challenge “conventional wisdom” (Nidumolu et al. 2009, p.9). In Changzhou, a public transport service management platform had been developed to guarantee the service operation quality. By applying the ITS technology, employees and police could monitor the traffic service situation in order to manage the traffic order and dispatch vehicles effectively. With video surveillance facilities equipped in all the junctions in Changzhou, the 366
road junctions’ traffic situation could be seen in the control center. Through signal remote control and traffic guidance technology, it effectively increased the efficiency of technical based traffic management.

Furthermore, CZTG launched series activities to evaluated employees’ value, attitude and behaviors, such as created a ‘five-star’ performance assessment, improved working condition, provided continually employee education. Rather than improving the employees’ vocational knowledge and skills, it facilitated employees (internal customers) to operate such knowledge and skills to resolve problems during daily work, and achieving value by using such skills. The well-trained employees could facilitate the customer oriented service regulation. For example, teaching customers how to effective use of BRT service based on the traffic information, and to escape when BRT meet traffic accident. It could be viewed as operating operant resources (customers’ knowledge) by operant resources (employees’ knowledge). As Kim and Mauborgne (2005) mentioned, the success of the execution of service innovation not only need top authorities but everyone in the system.

Means to SPT objective: With the help of ITS applications and new management approaches, CZTG increased the traffic supervise and dispatch level that leaded to traffic efficiency in public transport sector. In other words, it guaranteed public transport service delivering efficiency in a manner of consistent supporting.

5.3. Summary

Sustainable development concept is a creative ambiguous concept (Kates et al. 2005), which requires the development should balance between environment, social and economic aspects. Using indicators is important to understand the situation, catch up the trend, and develop policy for sustainable development in public transport sector. Such form of indicators should include the hard-to-measured sustainability goals and easy-to-measured sustainability objectives (Table 5). To achieve such sustainability objective, the solutions that PTA created may need the incremental or radical changes compared with previous services design, service operation process, service position, and also service paradigm concept. Table 13 summaries the sustainability goals, objectives, as well as Changzhou BRT solutions and the related service innovation based on the case study.
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<td>Public investment productivity</td>
<td>Transportation facility and service efficiency</td>
<td>Multifunction parking lot</td>
<td>Services innovation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Central right-side station</td>
<td>Position innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High frequency</td>
<td>Process innovation</td>
</tr>
<tr>
<td><strong>Equity</strong></td>
<td>Horizontal equity</td>
<td>User pay principle</td>
<td>Reduce externalities</td>
<td>Services innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Government funding</td>
<td>Paradigm innovation</td>
</tr>
<tr>
<td>Vertical equity</td>
<td>Progressive pricing, mobility for non-drivers</td>
<td>Universal access</td>
<td>Services innovation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Platform-level boarding</td>
<td>Services innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low fare policy</td>
<td>Position innovation</td>
</tr>
<tr>
<td><strong>Social welfare</strong></td>
<td>Community livability</td>
<td>Improve mobility within neighborhoods, enhance the public realm</td>
<td>Regional integration</td>
<td>Position innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Backbone structure</td>
<td>Position innovation</td>
</tr>
<tr>
<td></td>
<td>Human capital development</td>
<td>Employee training, education and promotion</td>
<td>Control center monitories</td>
<td>Process innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>‘Five-star’ performance assessment</td>
<td>Paradigm innovation</td>
</tr>
</tbody>
</table>
6. Conclusion

In this chapter concludes and reflects how sustainability drives service innovations from social, environmental and economic aspects. It also includes the managerial implications, limitations and future study directions.

Sustainable development concept influenced the decision making within the public transport industry. The original emphasized of economic development and environment protection had broaden and deepen include human and social development (Kates et al. 2005). Rather than the concept, the sustainability concept played more like the drivers or guidelines for the transport service implementation. Although there did not have unified SPT concept, many transport service related indicators have been developed to catch the trend and development of the sustainable transportation (ibid). To achieve such ambitious target of sustainable public transport system, it is helpful for the decision makers to overlook the long-term impacts and goals, while focus on easy-to-measured objectives (Litman and Burwell 2006).

However, public transportation is a network industry that involve multiple elements: infrastructure, transport fleet, network, transport station, parking lot, ITS applications relate to on-board, network service, operational and administrative procedure (EC 2009). Similarly, public transport system involves various stakeholders with various interests (Enquist et al. 2011). Thus, the sustainability challenge in public transport sector is an integrated problem, that could not use decision-making practices, as one solution may improve one aspect while exacerbate others (Litman and Buewell 2006). Thus the multiple sustainability strategies and plans should be combined.

Follows national sustainable development requirement, Changzhou launched BRT system a main solution to improve the accessibility of public transport service to customers. Rather than the concept, the sustainability concept played more like the drivers or guidelines for the transport service implementation in Changzhou.

Environmental sustainability includes the goals of ecological integrity and human health (Litman and Buewell 2006). It motived Changzhou PTA to use eco-friendly
fleets to reduce vehicle harmful air emission, optimize the BRT network with innovative application of ITS technology to guarantee the delivery system, integrate the pedestrian and bicycle access to facilitate customer active use of public transport.

Economic sustainability refers the economic welfare development (ibid). It simulate Changzhou PTA to redesign the boarding process to facilitate customer’s easy boarding need, provide traffic information board to facilitate customer design their travel, create multifunctional BRT terminal station to enhance the various traffic modes integration.

Social sustainability includes the goals of equity and social welfare (ibid). It drives the Changzhou PTA to use low fare price design to increase the service scope even to social and economic disadvantage people, design the universal and platform-level boarding to provide comfortable transport solution to people with reduced mobility, extend the BRT network into urban margin area to increase the regional mobility, and create customer-oriented management approach to maximum motivate customers and employee activity to use their skills and knowledge to achieve value.

The sustainability goals drives the PTA to continue develop public transport solutions with either incremental improvements or radical changes, which all could be viewed as the service innovation. Such service innovation included: Services (vehicle innovation and infrastructure innovation); Position (structure innovation and price innovation); Process (boarding innovation and land-use innovation); Paradigm (Governance innovation, service and management innovation), all contributed positive effects on sustainable public transport development goals.

The sustainability is a dynamic concept that, with the technology and social development, a newly higher standard or regulation will be shaped. The service innovation is also a dynamic concept that with the development of era, the traditional approaches will collapse. To achieve the sustainable development goals, service innovation should more focus on how to create resource configuration opportunities to make such (operant and operand) resource facilitate customer to utilize and co-create value with suppliers.
6.1. Managerial Implications

From the case study of the implementation of Changzhou BRT system, several managerial implications could be drawn.

Firstly, service suppliers should effective motivate customers to engage into their service proceeding process and create value to meet customers’ various and dynamic requirements. Rather than provide value added service, service suppliers should learn to create value propositions to facilities customers to achieve value by value-in-context. Customers have various demands, and only if they active participate within the service process thus they could better realize and achieve certain value.

Thirdly, sustainable development pattern could be various based on different social context. Sustainable development concept is a creative ambiguous concept, every organization or company could have its own development way not only narrows into one form of indicators.

Lastly, material and technology will continue develop, thus current plan and design should easy to be combined by further development plan and design. In include two meanings, firstly, the infrastructure should have good quality and easy to install and uninstall; secondly, the one system plan should easy for other systems’ integration. For example, the BRT network in Changzhou covered the two main corridors, thus facilitated its integration with high-speed train and normal bus, but set barriers for further subway’s network design, as it should not located the same corridors with same functions.

6.2. Limitation and further research

The thesis has certain acknowledged limitation. Firstly, Changzhou is only a medium size city with relatively simple transportation structure. The success experience of Changzhou BRT operation could not generalize into common concept to guide other city’s public transport development. Secondly, literature suggests that the SPT development is highly embedded in the public service value network. The author suggests future research should extend the findings and analyze about the public service networks within the service innovation that strengthen the SPT development.
7. Reference


CORBETT, J. (1993). SAN DIEGO GETS A GRIP ON GRIDLOCK: CITY ORDINANCE HELPS REGION MANAGE GROWTH.


8. Appendix

Appendix 1. The Interview questions with officers in CZTG

How to implement priority develop public transport policy in Changzhou? What are the specific initiatives?
How does Changzhou Transit Group guide the planning and construction of BRT in Changzhou?
What is the basis to determine the direction of BRT lines?
What is the design philosophy of the BRT station in Changzhou?
What are the special measures to ensure the Changzhou BRT’s right-of-way without disrupt by other forms of transport mode on the road?
What are the special places in BRT operation based on the technical level of the vehicles?
What are the differences between traditional bus services and BRT services?
How could CZTG control the fuel and cost consumption?
How to maintain sustainable development in the future?
What’s the role of BRT systems in Changzhou’s future development?

Appendix 2. The Interview questions with customers

How often do you use BRT service in Changzhou?
Do you satisfy with the BRT service in Changzhou, and in which way?
Does BRT service brings positive effects in your daily life or not, why?
Do you have any recommendations for BRT service in Changzhou?

Appendix 3. Passenger volumes of major BRT systems in Asian (Zhang et al., 2012, p.36).
Appendix 4. Travel speed of major BRT systems in China (ITDP, 2012).

<table>
<thead>
<tr>
<th>Major BRT operation Cities</th>
<th>km/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chongqing</td>
<td>33.5</td>
</tr>
<tr>
<td>Zaozhuang</td>
<td>29.5</td>
</tr>
<tr>
<td>Xiamen</td>
<td>25.5</td>
</tr>
<tr>
<td>Dalian</td>
<td>25.5</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>22.0</td>
</tr>
<tr>
<td>Yancheng</td>
<td>21.5</td>
</tr>
<tr>
<td>Changzhou</td>
<td>21.0</td>
</tr>
<tr>
<td>Hangzhou</td>
<td>21.0</td>
</tr>
<tr>
<td>Beijing Line-1</td>
<td>20.5</td>
</tr>
<tr>
<td>Hefei</td>
<td>20.0</td>
</tr>
<tr>
<td>Zhengzhou</td>
<td>19.5</td>
</tr>
<tr>
<td>Kunming</td>
<td>19.0</td>
</tr>
<tr>
<td>Jinan</td>
<td>19.0</td>
</tr>
<tr>
<td>Urumqi</td>
<td>19.0</td>
</tr>
</tbody>
</table>

Appendix 5. Average boarding time comparison between BJ, HZ and CZ (Zhang et al., 2008, p.4).

<table>
<thead>
<tr>
<th>Major BRT operation Cities</th>
<th>Average boarding time/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing BRT</td>
<td>0.8</td>
</tr>
<tr>
<td>Hangzhou BRT</td>
<td>0.9</td>
</tr>
<tr>
<td>Changzhou B1</td>
<td>0.9</td>
</tr>
<tr>
<td>Changzhou B2, B21</td>
<td>1.2</td>
</tr>
<tr>
<td>Changzhou B12</td>
<td>1.26</td>
</tr>
<tr>
<td>Changzhou B11</td>
<td>1.27</td>
</tr>
<tr>
<td>Beijing NB</td>
<td>1.4</td>
</tr>
<tr>
<td>Hangzhou NB</td>
<td>1.9</td>
</tr>
<tr>
<td>Changzhou NB</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Appendix 7. Passengers travel time changes after BRT launched in Changzhou (Zhang et al., 2012, p.3).


<table>
<thead>
<tr>
<th>Line</th>
<th>Operators</th>
<th>Operation time</th>
<th>Peak frequency</th>
<th>Off-peak frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Bus No.5 Company</td>
<td>05:20-21:00</td>
<td>5min</td>
<td>10-12min</td>
</tr>
<tr>
<td>B11</td>
<td></td>
<td>05:30-20:30/05:45-21:10</td>
<td>6min</td>
<td>12-15min</td>
</tr>
<tr>
<td>B12</td>
<td>Bus No.3 Company</td>
<td>05:00-21:00/05:40-21:40</td>
<td>8min</td>
<td>12min</td>
</tr>
<tr>
<td>B13</td>
<td></td>
<td>05:10-21:30/05:40-22:10</td>
<td>8min</td>
<td>12min</td>
</tr>
<tr>
<td>B2</td>
<td>Bus No.1 Company</td>
<td>06:00-20:30</td>
<td>8min</td>
<td>10-12min</td>
</tr>
<tr>
<td>B21</td>
<td></td>
<td>04:40-20:40/05:05-21:05</td>
<td>7-8min</td>
<td>10-15 min</td>
</tr>
<tr>
<td>B22</td>
<td></td>
<td>05:30-21:10/05:54-21:34</td>
<td>8min</td>
<td>10-12min</td>
</tr>
<tr>
<td>B23</td>
<td></td>
<td>04:55-22:30/05:40-23:15</td>
<td>6min</td>
<td>10min</td>
</tr>
</tbody>
</table>

Appendix 9. Bicycle-sharing program launching companies in Changzhou (SINA, 2010).

<table>
<thead>
<tr>
<th></th>
<th>Changzhou Huabang intelligent bicycle co. Ltd.</th>
<th>Changzhou EVERSAFE Bicycle co Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle</td>
<td>Red color; No lock; Need to air inflation;</td>
<td>Green color; No lock; Airless Tire;</td>
</tr>
<tr>
<td></td>
<td>Height unchanged; Have parking pool.</td>
<td>Height changeable; No parking pool.</td>
</tr>
<tr>
<td>Renting</td>
<td>Electronic Pile;</td>
<td>Solar powered electronic pile;</td>
</tr>
<tr>
<td>equipment</td>
<td>Real name register, a person a card;</td>
<td>Real name register, a person a card;</td>
</tr>
<tr>
<td></td>
<td>07:00-19:00 renting time;</td>
<td>24 hours renting time;</td>
</tr>
<tr>
<td></td>
<td>Different location return.</td>
<td>Different location return.</td>
</tr>
<tr>
<td>Settle points</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Profit point</td>
<td>Awning advertising rental.</td>
<td>Bicycle itself advertising rental.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Changzhou Transportation Bureau</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changzhou Highway Management Office</td>
</tr>
<tr>
<td>Changzhou Channel Management Office</td>
</tr>
<tr>
<td>Changzhou Local Maritime Safety Administration</td>
</tr>
<tr>
<td>Changzhou Communications Industry Group</td>
</tr>
<tr>
<td>Changzhou Traffic Engineering Quality Supervision Station</td>
</tr>
<tr>
<td>Changzhou Traffic Technician College</td>
</tr>
<tr>
<td>Changzhou Airport Co. Ltd</td>
</tr>
<tr>
<td>Changzhou Transit Group</td>
</tr>
<tr>
<td>Changzhou Local Maritime Safety Administration</td>
</tr>
<tr>
<td>Changzhou Communications Industry Group</td>
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</tr>
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<td>Changzhou Traffic Technician College</td>
</tr>
<tr>
<td>Changzhou Airport Co. Ltd</td>
</tr>
<tr>
<td>Changzhou Transit Group</td>
</tr>
<tr>
<td>Changzhou Transport Association</td>
</tr>
<tr>
<td>Changzhou Transmit Group</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Changzhou Transit Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.1 Bus Company</td>
</tr>
<tr>
<td>No.3 Bus Company</td>
</tr>
<tr>
<td>No.5 Bus Company</td>
</tr>
<tr>
<td>Material Supply Company</td>
</tr>
<tr>
<td>Vehicle Repair Manufactory</td>
</tr>
<tr>
<td>Pengcheng Trading Company</td>
</tr>
<tr>
<td>Tourism Transport Company</td>
</tr>
<tr>
<td>Public Bus Co. Ltd</td>
</tr>
<tr>
<td>Public bus Renting Company</td>
</tr>
</tbody>
</table>

Appendix 12. The author interviews officers in CZTG.