Comprehensive Inclusive Design for Public Transport System in Shanghai

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ABSTRACT

Recently, inclusive design is one of the most significant principles involved with design for urban public facilities, and urban public transport system(PTS), as a public facility, normally need to cover different types of users, which forced them to promote the inclusiveness in its service. This led the mainstream design tendency to concentrate on ergonomics of marginalized users. Despite the traditional inclusive design strategy, this paper outlines the evaluation on the other two aspects, which included systematical design and product experience, to complement the current inclusive design in current PTS of Shanghai. In this case, the purpose of this paper is probe the affecting factors related to the systematical issues and the product experience in the public traffic service. Literature study and online questionary concerned with PTS in Shanghai, are the main approaches in this study, which ultimately indicated the issues from the systematical angle and a more comprehensive model of inclusive design system for PTS in Shanghai.

Keywords: Public transport system in Shanghai, system theory, product experience, inclusive users' needs hierarchy.

INTRODUCTION

Public bus system (PTS), as one modality of public transporting, is often designed with the aim of providing adequate services, which intended to cover users with diverse physical and cognitive preconditions. In this case, as a routine, inclusive design is a design tenet with the principle of considering the needs and capabilities of different users as much as possible (J Clarkson et al., 2010). Consequently, the traditional inclusive design or universal design constantly emphasized the significance of eliminating physical and cognitive barriers, in order to generate "an inclusively designed product that only exclude the user that the product requirements exclude" (S. Keate and P. J Clarkson, 2003). Hence, these outcomes always engender great inclusiveness within the product using process with its modification or promotion laying on the functional improvements in tangible products.

As a stereotype thinking, the current public bus service could be upgraded through inclusive design approach as well. In fact, an increased numbers of developing countries started to switch their service concentration regarding public transport. In some countries with large amount of traffic congestions and commuters, the government had implemented some novel tackles to show their care to the abnormal user group, such as bus rapid transit with dedicated facilities, to cover more people. Indeed, some cases had demonstrated the benefits from inclusive design, which was obviously in consequence of considerable efforts on facilities' upgrading. In this case, the extended inclusiveness in facility design stems from additional physical assistance for marginalized users; hence, better tangible facility design and special equipment had been the effective method of optimizing one system from normal

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to inclusive.

However, despite the current effort they had made, the intangible reason for “exclusiveness” should be considered as well. According to the study of previous researchers, it indicated that the fit from the products to a person is dependent on far more than the physical or cognitive usability, and the users should be considered holistically as people, the ones who have diverse emotions and psychologies. (P. W. Jordan, 2000). From this point of view, the users in PTS, especially the handicapped users, should be respected more profoundly rather than providing the simple physical or cognitive assistance for them. Even if this paper will not interpret the significance about design for the handicapped, but at least, Jordan’s study could be treated as a complementation, and reminded the designers to think more holistically rather than focusing on specific or superficial issues.

Similarly, as a complicated service system that consists of multiple components, the PTS in Shanghai contains numerous of variables in terms of travel efficiency, service accessibility, temporal accuracy etc., this requires a comprehensive conduction from a systematical perspective rather than superficially concentrating on isolated tangible facility design. In this case, despite the emotional requirements, a systematical thinking would be another valuable complementation to inclusive public service. This paper will elaborate the inclusive design from these two perspectives- product experience and the system analysis, which are the substantial factors relate to product inclusiveness as well, but always being neglected.

Shanghai, as one of the biggest metropolis in mainland China, is confronting the deterioration of the urban public traffic environment. Optimizing the transport efficiency and maximizing the utilization ratio for its PTS are the two potential approaches to fix the terrible situation, thereby release the pressure for public spatial resource. In this study, the PTS of Shanghai was served as critical case to support the evaluation.

The overall study was conducted with the precondition that regarding the service as a holistic system, and it contain three phases. Firstly, the paper initiated the study from elaborating the whole system and the mutual effects among the components, in order to probe the deficiency caused by unreasonable systematical arrangement. Secondly, the result of online survey indicated people’s attitudes on this deficiency. At last, a model of inclusive PTS was built, with the assumption in this model; it will be easier to find the substantial requirements of users. In this case, being inclusive is no longer just staying on the issues superficially.

THEORETICAL FRAMEWORKS AND RESEARCH DESIGN

The Theory of System Design

As a type of framework that enabled people to cope with complex situation more holistically, system thinking was playing a crucial role in the design process (R.L Flood et al., 1993). The isolated concentration on single structural component could not comprehensively reveal the essential matter of existing issues. Likewise, when people encountered particular situation that blocked their traveling experience, they often traced the issues backward to the facilities closest to them. In fact, the more substantial causes sometimes were associated with the system structure or arrangement it belonged to, rather than the superficial issues caused by unsuitable product design.

According to the study of R. L Flood, a system was defined as an aggregation of structural elements, their mutual relationship, the boundary and the attributions of each element. In this case, from a design perspective of view, the public bus system can be therefore deconstructed as a combination of different tangible products and intangible services, in addition, the customers and the bus companies play a critical role as a wider system. Likewise, the external influential aspects, like commuter population or transportation amounts, can serve as the environment that enclose and affect the internal system.

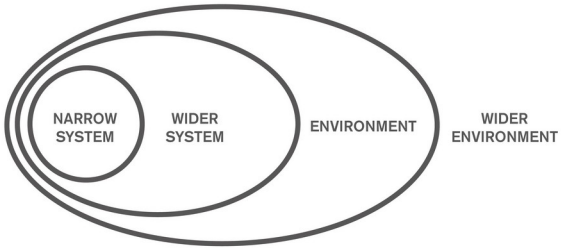

Figure 1. The definition of a complex system (R. L Flood et al. , 1993)

Based on the study of Flood, a complex system always comprised of narrow systems, wider systems and an outside environment that enabled the components to directly exchange material, information and energy. While, other influencing factors that affected the system indirectly via the environment had formed the wider environment. Hence, most of the public traffic system can refer to this model, and deconstruct into these four clusters.

The Jordan's Hierarchy of Needs in Product Experience of PTS

Despite systematical approach, coverage of users' emotional experience is the other blind point within the domain of inclusive design in PTS. Traditional product inclusiveness often emphasizes on the factors in terms of physical and cognitive capacities for marginalized users. However, the inclusive design should be able to engender greater experience concerned with users' psychological needs, for instance, social status, the dignity etc.

In this case, Linden and Brendle (2012) indicated that the emotional design can positively influence the development of products that promote inclusion. There is an extreme case which is that some normal users, who cannot afford to private vehicles, will encounter frustration as the usages of public transportations represent their social classes.

Whereas some dedicated equipment in PTS has been delivered to support the special users, this assistance still contains lack of cares on users' psychological level. In order to comprehensively fit users; need through inclusive design, the product should fulfill user's needs in different psychological levels. P. Jordan(2000) revealed the hierarchy of customers' needs that comprised of functionality, usability and pleasure, later Linden and Brendle added dignity into the hierarchy as a holistic structure of users'.

At the top of Jordan's hierarchy of customers' need (P. T Jordan, 2002), the pleasure extracted form products can be subdivided into four categories. Normally, in product design, there are hierarchically multiple needs arise from the interaction between the products and users. Generally, all these needs can be fitted by different types of product experience, and experience can be convinced as a key factor that impacts the attractions of bus system. Moreover, basing on the study of P. Desmet and P. Hekkert (2007), product experience can be defined as a change in core affect that attribute to human- product interaction. In this case, the pleasure can be treated as a positive emotional reaction arises from the interaction between users and products.

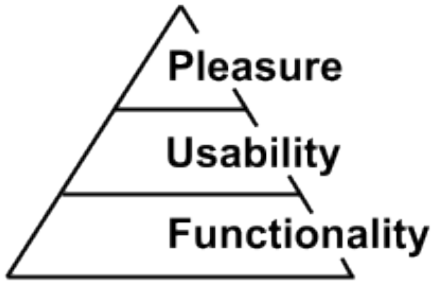

Figure 2. Jordan's hierarchy of customers' needs

Normally, users and their private product can establish some special emotional association, which is able to enhance the relationship between the products and its users. Moreover, this emotional association is not extracted from the functional satisfaction, rather the additional satisfaction in psychological level. One idealized situation is fulfilling

all the needs within this hierarchy, in other word, generating underlying psychological functions for user is a mainstream strategy for product design development.

In addition, inclusive design does not mean more cost or additional investment, it is a process of rearrangement or optimization, which requires design to balance the profit of diverse groups. Similarly, making a product or service be inclusive, can be also considered as a reasonable allocation for people's needs within different aspects in this hierarchy.

Jordan's need hierarchy would be a significant fundamental detector or reference to probe the distribution of users' needs in different level. The inherent attribute of different products has determined what type of requirements the product would or should fit. It also means, in the real context, different types of product have different purpose, in converse, users have different anticipations as well, according the natural attribute in the product. Hence, this distribution of need would clarify the speciation of inclusive design, and specify the purpose of design.

The Research Design of Entire Study

According to these theories, the whole study in this paper contains three major phases. Initially, the study would describe and analysis the current PTS service in Shanghai, through the theory achieved from literature study in terms of system design. The consequences of the first part could be the input to devise the online questionary, which aimed to probe influencing factors that affect users' experience in PTS service. Then, the result would be refined, and it indicated the underlying relationship between the influencing factors and system arrangement in PTS as well as the significance of each factors that ranked by customers.

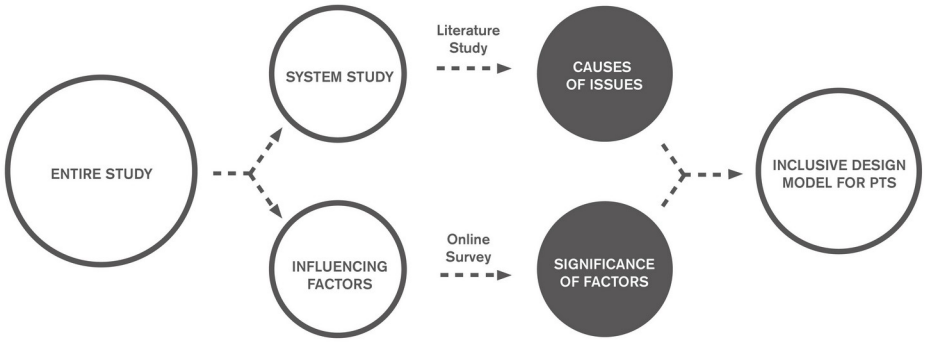

Figure 3. The research design for entire study

Ultimately, a model has been established based on the analysis and discussion of the result, which has demonstrated the components of inclusive PTS design, the significance of each components and the reasonable situation the product experience would be.

THE PUBLIC TRANSPORT SERVICE SYSTEM IN SHANGHAI

The Elaboration on Current Service with Systematical View

The following figure reveals the structural elements of PTS in Shanghai and their corresponding relationship. As the dominated prerequisite concerned with macro planning and developing strategy, the environment plays the most critical role in dealing with initial scope in which the system should be. Consequently, the existing transport system was established depending on complicated inherent situations, such as the urban structure, population, residents' distribution, routes arrangement etc. Within the entire transport system, different transport modalities are working in parallel, which can be regarded as two main sub-systems with distinct boundaries. In fact, this boundaries lead passengers to switch their motilities constantly, since people have to transfer into another system and overcome the barriers.

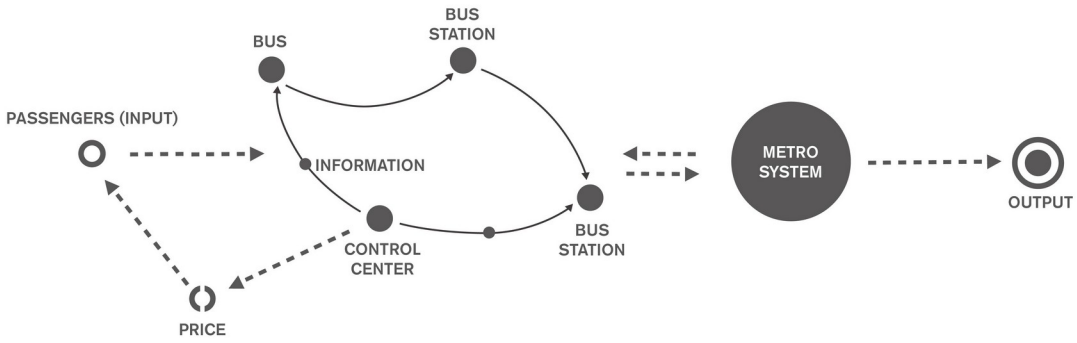

Figure 4. The system map of the public transport service in Shanghai

When it comes to the public bus system, the environment determines passenger's location and their destinations, and this leads them to ask for navigation from service center. Subsequently, transportations convey the passengers to the right place. Through this relationship, the bus line, bus stations, information service and transportations construct a narrow system, and each of the elements can be conducted with some particular principles. Moreover, the passengers and the bus companies, as external variables, always impact this narrow system as well, and these external variables can be thought of as the components of a wider system. In fact, the narrow system is a media that converts the service to passengers, conversely, passengers often generate feedbacks to the companies, which forced the companies to adjust relevant variables and promote passengers' experience, such as ticket price and temporal options. These iterations proceed with its constituents' interacting mutually. However, due to the complexity of the real PTS, this is an idealized status, the real system are more complicated than it showed in this figure.

Thus, the public transport system can be thought of as an integration of structural elements which forms the system with particular principle, and in converse, their relationship generates the effects and interaction within a dynamical ensemble. In that case, there are two main advantages of systematical perspective of view. On one hand, the issues in particular appears in real life can be regarded as specific reflections from essentially systematical issues, which enables the researchers achieve holistic comprehension; on the other hand, customers often encounter some issues concerned with product due to the incomplete service arrangement, and systematical thinking enables the people to relieve such issues with boarder horizon.

The Existing Issues in Public Transport System

Nowadays, the development of public transport is becoming crucial increasingly due to the limited urban spatial resource. The local government is enhancing the investment on public traffic system. In fact, as Ximing Lu (2001) indicated, since most commuters are living in the suburban area where they would be able to get the accommodation with cheaper rent, and the commuters always work in the central city. Hence, the unbalanced distribution results to a fact that the commuters require large numbers of transit service, but in Shanghai, the coverage of current PTS cannot totally extend to the suburban area where the unlicensed cobs or other transit modes have occupied the market. Most of the people prefer to or have to use unlicensed cobs rather than the regular public transportation which is not able to provide good service punctually.

According to the previous study, current public transport service is losing its customers due to the bad service quality and bad impression, particularly in the suburban area. There are many structural factors concerned with negative experience that could be elicited from literature study and user interview, some representative issues could be modified in order to reconstruct better identity by fixing each points that repress users' experience in real life.

Some countries are implementing inclusive bus system with adding additional equipment, which covers more users, in particular the handicapped users. In Bogota, the capital city of Colombia, government achieved cogent improvement from the establishment on inclusive BRT system, which enabled the novel bus system to include the people with different degrees of impairments (Wu Yaguang et al., 2010)..

However, sometimes being over inclusive would lead the product to a situation which may be accessible to disabled people, but in practice unusable (A. F. Newel et al., 2010). In this case, making sure the usability and attractions for normal users should be prioritized.

Moreover, in the existing traffic issues of Shanghai, the inclusiveness may not be the most critical causes of the declining attraction of public bus system, rather the bad user experience for common users, including the special users as well. Through the previous study of the authors, the investigation has unveiled the influencing factors relate to user experience, but modifying all the deficiencies cannot be the key to attract customers' preference. In order to achieve more holistic inclusiveness, study should extend its scope to the concrete types of experience that users really need.

THE FACTORS ASSOCIATED WITH USER EXPERIENCE IN URBAN PUBLIC BUS SYSTEM

Based on the systematical description and relevant theoretical study above, a questionary was devised for the subsequent study. This online survey was initially conducted in order to achieve people's basic attitude on current public transport service. The authors' previous study had indicated the factors that affect user experience in PTS. However, that brief consequence only outlined the factors roughly, but it did not revealed the importance of each aspect, or clarify if the factor were significant or trivial.

In fact, the effect from each factors are different, and the public bus service, as a complicated sharing products, is difficult to cover all the needs in terms of functionality, usability and pleasure. In other words, achieving better experience does not equal to fitting all the needs in Jordan's hierarchy with fulfilling all the pleasures for passengers.

In this paper, the online survey was introduced only for comparing the weight of functionality, usability and emotional requirement in current PTS. The consequences will be merged into the model later involved with inclusive design for public transport system.

The Online Survey on Traveling Experience with Public Transport System

The online survey was named with *The Investigation of Residents' Attitude on Public Traffic Network of Shanghai*, and the questionnaires were delivered through online survey website. The question of this survey consisted of three phases. The first phase was aimed to comprehend generic information about people's attitude on current PTS, the second phase was probing users' real need. The last purpose was exploring the current physical and cognitive barriers in PTS. Based on the three purposes, the researchers has subdivided the survey into six categories: the daily traveling experience, the initial attitude on Shanghai's traffic network, the possible physical and cognitive barriers, the anticipation in the future and the personal information of interviewees.

Initially, this survey were concentrated on residents in Shanghai as its interviewees, moreover this online survey were initiated since March 2013, and finished on May 2015. Ultimately, the survey had received 124 samples that were available. The diagram of the original data of subjective questions had been indicated in a previous investigation. In this case, this paper will skip the interpretation on the overlapped content in previous study. Combined with the purpose of this paper and its referenced theories, the result will be analyzed from another perspective of view, which aimed at discussing the significance of each type of user needs from the objective views in customers' eyes, and then discuss how to improve positive factors as well as avoiding negative factors with the entire system.

The Result of Online Survey

The result of the questions on interviewees' daily traveling experience had mainly indicated four aspects which concerned with interviewees' common transport modality, their transport combination and the respective time cost, the critical factors involved users' decision making and the idealized time cost on alternatives.

1) About Users' Traveling Experience

Based on the result of first question, it demonstrated that bus and metro system were the dominated public traffic mode for residents' daily traveling. Moreover, according to the temporal distribution on these two transport modes, the result indicated that people always spent more time on metro than bus, and the concrete data showed that people often spent 40 to 60 minutes on metro, but only 10 to 20 minutes on bus.

When it involved the factors that determined passengers' decision making, five factors were provided as candidates , and it included cost (money cost), comfort in vehicle, convenience (easy to use), accessibility and traveling time. At last, the outcome showed that convenience and traveling time were the most two crucial factors.

The last question revealed that the idealized traveling time were less than 40 minutes and there was another contrast, which was people were more glad to take metro instead of buses when going for long-term traveling.

2) Initial View On Public Traffic System

With the four aspects mentioned above, the second segment assessed the degree of satisfaction in terms of comfort, convenience, accessibility and time cost. Concerning with time cost, people thought taking metro were more time saving than bus. However, bus system has overwhelming advantages involved with money consuming, as most interviewees thought public bus is a cheaper mode of public transportation..

Obviously, the accessibility reflects the network's coverage in PTS. Based on users' feedback, bus network was able to provide adequate coverage rather than metro network. Moreover, passengers thought normally taking metro enabled them to get more comfort.

At last, consequences showed that the difficulty in transferring mobility was one crucial bad experience for the passengers.

3) Physical and Cognitive Limitations Caused by Public Traffic System

The most representative cognitive limitation is information comprehending for users, and the physical barriers always blocks users to perform necessary actions, such as checking in or getting off the stairs. In this phase, the questions consisted of three aspects included relevant information, comfort for luggage carried people and the physical blocks for handicapped people.

Due to the flourish of Internet and relevant applications on mobile phones, most interviewees thought they could, without any barriers, comprehend the traffic information and make corresponded planning for their traveling. However, the passengers with luggage, and the passengers with physical impairments were not allowed to use the bus service easily. However, the information in terms of metro was more accurate than bus. Moreover, in bus system, the dedicated facilities for disabled people are not adequate, hence, most interviewees thought current bus system were not suitable for handicapped passengers to take.

4) The Decision Making of Both Transport Modalities

These questions were supposed to probe the importance of each factor, through a method of changing precondition in each situation, and then asked the users if they preferred to take the transportation under new conditions. In the result, people showed obvious contrast when their home was changed from uncovered are to covered area by PTS. However, the giving the transportation more comfortable or not cannot generate obvious variation. The last two attributes were the convenience of switching among different mobility and the information service, and the passengers just showed limited enthusiasm on it.

5) The Result of Open-ended Questions

In the additional open-ended part, there were few aspect mentioned regarding the money cost, the route arrangements, line arrangements, mobility transfer, definiteness of bus stations and the stability on bus. The most representative issue was that people have to combine many traffic lines for traveling, and it demonstrated the issues or negative experience stem from unreasonable arrangements.

RESULT

The Causes from Unreasonable Arrangement

As the survey suggested, the most critical issue in public traffic system was the barrier or inefficiency of mobility changing, because bus system and metro system were running in different modes. As passengers, a type of flowing medium within the system, have to spend additional cost on converting themself from one system to another. In that

sense, these additional expense or cost always makes people annoyed.

Hence, unifying the system arrangement with both of bus system and metro system would make the passenger transit more efficiently, and it will reduce the additional cost. Previously, the entire public transport system was defined as a wider system which included different sub- systems, like bus system, metro system etc. Basing on CATWOE mode (P. Checkland, 1999), the passengers will be the benefit achievers as well as the transformation in this system, and the cooperation among different traffic modalities could be defined as the actors who performed the activities. Therefore, combined with the result of online-survey, there are three main essential causes stem from systematically chaotic arrangement in current service.

Firstly, the obvious boundary between two systems has blocked the passengers' transformation. As the previous cases demonstrated, most of the people felt difficult to change their mobility, particularly for the long-term traveling. Since normally people resort to the combination of diverse transportations, which means they have to spend additional effort for transport changing..

Secondly, people do not have other alternatives to take the place of current public transportation. In the wider system, it did not have bridge media to link diverse transport modalities. The temporal arrangement, which means the instant information about the transport schedule, could be an approach to help the system accelerate its work efficiency, and benefit the passengers as a navigation and time arrangement. However, current system does not contain this capacity, which means the media that links and enhances different sub-systems.

At last, the information, such as time and bus position, were not able to be shared instantly, which means the owner of the system cannot achieve the feedback from the passengers in advance to adjust or conduct the system. In other words, the media of getting feedback were blocked, and in converse, the passengers cannot fluently get the right information as well. In that case, this mutual negative affects deteriorated the issues of current system.

The Distribution of Users' Need in PTS

User experience could be comprehended as the objective reflection on products, and later, the users convert this experience to psychological variations. Normally, people prefer to have positive experience as much as possible, but for some products, people do not contain so much anticipation. For instance, concerning with the public transport service, some customers only care about if the product could grantee the punctuality and the efficiency of transit, instead of emotional task or social tasks. In this case, for the design of PTS, pursuing to fit the higher level pleasure or need is not an efficient strategy in product development.

Moreover, in the result of the online-study, the passengers did not expect much need of the comfort. In the product experience hierarchy of Jordan, normal passengers only have the needs of functionality and usability, and few of them expected the comfort. However, there was another fact that people prefer to have more comfort in long-term traveling.

On one hand, there are some different aspects on products' inherent feature. Actually, the purpose of public transport system is sample, which just aims to fit people's needs on functional level. The initial purpose is traveling, and this locates on the basic level in Jordan's hierarchy. On the other hand, product experience will increase its affect with the use time growing.

DISCUSSION

The Comprehensive Inclusive Design Mode for PTS

According to the study above, the analysis of products' inclusiveness is no longer staying on the superficial level.

The following model demonstrates the three components model for the comprehensive inclusive PTS design. The survey has demonstrated the fact that the main issues within PTS were caused by the systematical deficiency rather than concrete physical design. In this case, in order to reach more inclusiveness in public service, highly integrated system should be optimized. Hence, this study merged the systematical thinking and product experience into this model to from a more holistic inclusive design approach for PTS. Moreover, the rank and different scope of importance can be showed in the middle of figure as well.

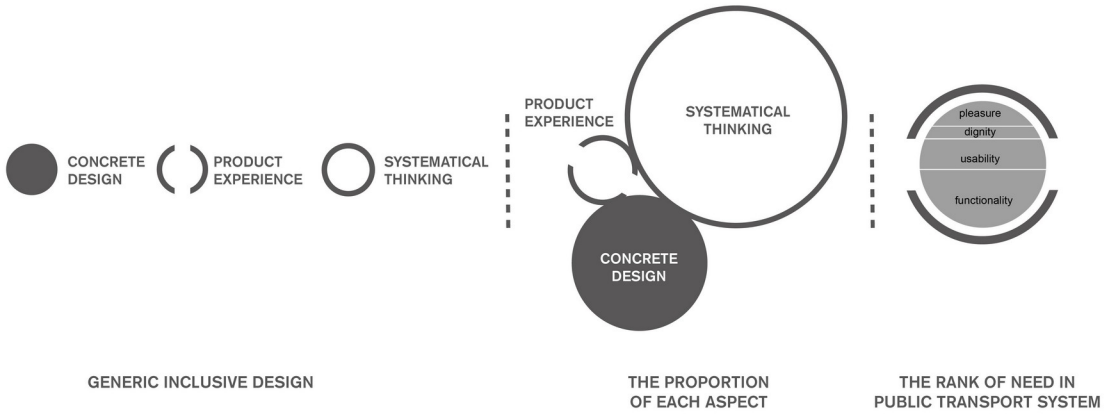

Figure 5. The model of comprehensive inclusive PTS in Shanghai

In addition, most customers care the basic functions rather than the higher level requirements, these factors are the accessibility, usability and punctuality, which belong to the functionality and usability in Jordan's hierarchy of needs. The figure in the middle has showed the proportion for each aspect within the design for PTS. In fact, systematical thinking plays a crucial role in the beginning of product design development, and extremely affects the subsequent concrete design, such as facilities and hardware. Compared to the other aspects, the effect of product experience is limited, at least in the case of PTS.

The last figure indicates the significance of the four types of needs, the basic hierarchy was introduced from Linden and Brendler (2012). In the context of PTS, the most critical need is functionality, which fulfills the basic needs regarding daily travel. Moreover, usability has the same significance as functionality, since it performance determines if the customers could use it conveniently. However, users' psychological requirement has less effect on customers' decision making.

Therefore, despite the better ergonomic design in tangible facilities, here are some additional recommendations in this paper, which is the complementation for comprehensive inclusive design in terms of PTS.

1) First, the service system that does not contain too much sub systems could be a way to reduce the barriers for passengers' mobility , and the integration of sub- systems will relieve the barriers caused by boundaries among different sub- systems..

2) In the product design phase, the priority of the basic needs, like functionality and usability, would be an effective approach to reach the reasonable target, rather than allocating effort on generating pleasure for users' underlying needs.

3) The circulation of feedback/feed forward should be enhanced, like the information bout instant road condition, departure/ arrival time of public transportations.

This model is generated basing on the study of PTS in Shanghai, the study cannot grantee that this model is able to fit other public facilities. Through the empirical study, the proportion of each aspects will be changed belong to the inherent features and location of the products. The more complex the service is, the more systematical thinking it requires. However, since the literature study was limited and the survey was not completed, so this model still contains some limitations.

CONCLUSION

As above information suggested, traditional inclusive design always focused on physical facilities that were close to users, rather than thinking from a larger perspective. This paper added two other aspects as complementation to the design for inclusive PTS in Shanghai. Through conducting this research, the paper achieved the more holistic comprehension of how current system worked, then discussed the three aspects and found their substantial relationship.

However, the consequences of the study need further developments. According to the study of Linden and Brendler (2012), the psychological need, such as dignity, has not been evaluated so far, since this study did not focus on this area. Moreover, the concrete studies on special people have not been implemented, which could be the content of further study.

After all, the systematical approach and product experience play a critical role in generating better experience in public transport service. In this case, we should broad the horizon for designers and make their thinking more holistic when the people are working with inclusive design approaches.

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