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Designing an Integrated Public Transportation System for the Accessible Needs of Long-Term Care in Taiwan Using Service Design

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Abstract: In Taiwan, the numbers of the elderly population and people with disabilities are rising. Accordingly, addressing the accessible transportation needs of these groups is an important issue. Currently, long-term care bus services in Taiwan provide on-demand point-to-point shuttle services for people with disabilities and the elderly. However, these services are currently unable to meet the increasing market demand, resulting in lower administrative efficiency and unsatisfactory service quality. In response, the present study approaches the challenge of providing accessible transportation from a service design perspective, exploring the needs of various stakeholders, establishing a cooperative rapport between designers and core stakeholders, and ultimately delivering improvements to the long-term care shuttle system design. The designers first prioritize design concepts, then follow up with service improvement recommendations, and finally collaborate with service operators to implement the new system.

Keywords: service design; accessible transportation service; long-term care shuttle bus

1. Introduction

As the numbers of people with disabilities and the elderly population continue to increase, so too does the demand for accessible transportation. According to a 2016 report entitled, “Analysis on the Living Conditions and Needs of People with Disabilities,” published by the Ministry of the Interior of Taiwan, the most common reason for people with disabilities to leave their homes is to attend “hospital visits,” accounting for 51.86 percent of trips made using accessible transport. In their answers identifying the greatest challenges of a hospital visit, the three most common responses are related to transportation factors — 33.73 percent reported that hospitals are “too far away,” 32.23 percent reported that they do not have access to “convenient transportation,” and 22.85 percent reported that “they have no one to drive them to the hospital.” In response to the report’s findings, a nationwide long-term care shuttle service began its operations in 2017. However, due to a lack of standard

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operating procedures, passengers are unable to obtain immediate feedback when booking a ride, drivers do not receive up-to-date information about passengers, and administrators are faced with managing and interpreting large volumes of service data; all of these contribute to lower administrative efficiency and unsatisfactory service quality. This also creates an opportunity to improve the service. Service design is an emerging field of study that seeks to innovate and improve existing services from a holistic, interdisciplinary, and integrative perspective. The aims of service design are to increase service efficiency and feasibility while simultaneously addressing consumer needs and increasing organizational efficiency (Stefan Moritz, 2005). The purpose of this study is to approach accessible transportation from a service design perspective and to develop a cooperative rapport with various stakeholders by offering a new long-term care shuttle system with an improved riding experience, service quality, and administrative efficiency. The specific objectives of this study are threefold: (1) identify major issues with the current long-term care shuttle services using service design methodology and develop design recommendations based on the results; (2) assess the existing system with a heuristic evaluation and usability test to propose an alternative long-term care shuttle system; and (3) trial the new service concept with users based on the Kano model to determine the implementation priority of improvement concepts, which will serve as a useful reference for relevant organizations.

2. Background of the Research

2.1 An overview of the demand for accessible transportation in Taiwan

According to an estimate by the Ministry of Health and Welfare of Taiwan in 2018, the number of people with disabilities had reached 1,173,978 (5 percent of the population), of which more than 60 percent considered transportation to be the greatest challenge that they faced (The Ministry of Health and Welfare, 2016). While transportation has long been an issue for people with disabilities, accessible transportation is an important service for the elderly population as well. Zhang and Shih claimed that “fixed-schedule and fixed-route mass transportation services are unable to meet market demand. Instead, services featuring flexible schedules and routes must be developed as an alternative to serve the elderly and people with disabilities” (Zhang and Shih, 2015, p. 2). Table 1 is a comparison of existing accessible transportation services in Taiwan.

Table 1 *This table shows that long-term care shuttle and rehabilitative bus services are not only cheaper than accessible taxi rides but also more flexible alternatives than traditional bus services and the Mass Rapid Transit (MRT).*

Type	Service Coverage	Costs	Issues
Long-term care shuttle	~1,896 vehicles	Variation in eligibility for government subsidies (maximum of eight free trips per month)	No Standard Operation Procedure (SOP), low service quality
Rehabilitative bus	~1,912 vehicles	Half to one-third of the price of a normal taxi ride	Service shortage, high complaint rate
Accessible taxi	~700 vehicles	Expensive	Underprivileged individuals cannot afford taxi rides
Low-floor bus	40% of traditional bus services	Inexpensive	Fixed route, lack of flexibility
Railway/MRT	Varies by train types	Inexpensive	Fixed route, lack of flexibility

2.2 An overview of current long-term care shuttle services in Taiwan

In 2017, the Taiwanese government launched the “10-Year Long-Term Care Plan” as an initiative to implement a wide range of preventive measures to mitigate the challenges experienced by people with disabilities, including at-home hospice care and an on-demand point-to-point shuttle service, otherwise known as “long-term care buses.” To serve the large number of people in wheelchairs, every long-term care shuttle vehicle is equipped with a wheelchair lift, a ramp, and side walls, as shown in Figure 1. These vehicles can be utilized by elderly citizens with disabilities including those without a government-issued disability card, provided that they register with local long-term care management centers beforehand. Once approved, rides can be scheduled 1–3 days in advance (reservation periods vary by administrative district). As of the first half of 2018, there were 1,896 long-term care shuttle vehicles in service, offering upwards of 170,000 rides to those in need, according to statistics published by the Ministry of Health and Welfare.

Figure 1 A driver of the long-term care shuttle vehicle helping an elderly citizen on board with the wheelchair lift (photo provided by the authors).

2.3 Service design

Service design is an emerging field of study that seeks to innovate and improve existing services from a holistic, interdisciplinary, and integrative perspective. The aims of service design are to increase service efficiency and feasibility while simultaneously addressing consumer needs and increasing organizational efficiency (Stefan Moritz, 2005). Service design creates high-quality service environments, toolsets, and procedures for employees that can be tailored to a brand (Continuum, 2010). Addressing the lack of a unified definition for service design, Stickdorn and Schneider (2011) proposed the following five fundamental qualities: (1) user-centered, (2) co-creative, (3) sequencing, (4) evidencing, and (5) holistic.

3. Methodology

3.1 Research framework

The framework of this study is based on the Design Council's (2005) "Double Diamond" design process model that incorporates user experience research, design, and testing. The study was conducted in three stages, which include exploring and defining service designs, developing and implementing service design concepts, and evaluating the design concepts.

3.2 Research procedure

To meet the accessibility needs of long-term care stakeholders in Taiwan effectively, the integrated system is designed in three stages.

Stage I: Exploring and defining current service design: A pilot study was conducted to develop a preliminary understanding of current long-term care shuttle services, followed by field visits and interviews designed to identify the specific demands and challenges faced by various service stakeholders. In addition, quantitative results on long-term care shuttle services and service design tools, such as stakeholder and customer journey maps, were produced as a reference for design improvements.

Stage II: Developing and implementing service design concepts: Based on the results of Stage I, the designers proposed design concepts and recommendations to partner organizations, who developed a system prototype. The design team conducted a heuristic evaluation and a usability test on the prototype. A long-term care shuttle service platform that meets the needs of all stakeholders is designed.

Stage III: Evaluating service design concepts: Based on the analysis of Kano model, the design team evaluated the feasibility and user preferences of the new service concepts in the long-term care shuttle service platform to determine the implementation priority of the design concepts, which will serve as a useful reference for relevant organizations in developing future accessible transportation services.

4. Problem Definition

4.1 Field observation

Based on the results and observations of the pilot study, we classified stakeholder profiles into three layers: people, places, and competent authorities, as shown in the stakeholder diagram in Figure 2.

- **Service users:** The core users of long-term care shuttle services are people with disabilities and the elderly, among which the patients requiring rehabilitative care or dialysis form the majority. A companion is usually onboard with the patient (usually a foreign caretaker), while a family member is often responsible for making reservations.
- **Service providers and administrators:** Providers are front-line staff members who work in direct contact with passengers, including drivers and customer service representatives. Administrators, on the other hand, refer to managers and executives who oversee operations within the organization.
- **Service regulators:** The Ministry of Health and Welfare and local governments are responsible for supervising long-term care services, establishing long-term care management centers and serving as the regulator of long-term care organizations.

Figure 2 The stakeholder diagram includes an upper part (service users) and a lower part (service providers, administrators, and regulators). Blue and orange areas indicate core stakeholders.

4.2 In-depth interview

As mentioned in the previous section, there are three target groups in this study: service users (passengers, companions, family members, and caretakers), service providers (drivers), and service administrators (customer service representatives and executives). To obtain a fuller understanding of the challenges and issues presented by service situations, interviews were conducted with 31 stakeholders in total, comprised of eight long-term care shuttle service organizations, four executives, seven administrators, eight drivers, and four passengers as well as family members. The interviews were subsequently analyzed through a work activity affinity diagram (WAAD).

4.3 Customer journey analysis

To identify the key areas in which problems arise, the designers sought to understand the passenger experience better, envisioning a customer journey map consisting of three phases – “before the ride,” “during the ride,” and “after the ride” – as depicted in Figure 3. Through interviews and journey analysis, the designers were able to summarize the challenges faced by each stakeholder group.

- **Service users:** (1) Unable to book a ride, forget to book a ride, or forget the time of a ride; (2) no immediate feedback after booking and no subsequent ride reminders prevent passengers from staying updated on a ride booking.
- **Service providers:** (1) Unable to access passenger information, special needs,

and the optimal route immediately; (2) passenger signatures and payments are recorded on pen and paper, making record-keeping difficult.

- **Service administrators:** Vehicle dispatching procedures are complicated and large amounts of data must be sorted and processed by hand.

Figure 3 Areas shaded in red are the key areas in which issues arise. These include booking rides, dispatching vehicles (before the ride), recording mileage, collecting passenger signatures (during the ride), and processing service data (after the ride).

4.4 Quantitative survey on current services

To paint a fuller picture of current services, this study used a customer satisfaction (CSAT) survey and a Net Promoter Score (NPS) to gauge the opinions of the three stakeholder groups on existing long-term care shuttle buses. The satisfaction questionnaire includes a seven-point Likert scale. In total, the numbers of valid responses obtained are 15 from service users, 14 from service providers, and seven from service administrators. The results are summarized below:

- **Service users:** Figure 4 shows that passengers noted relatively lower satisfaction in service promotion, service eligibility, customer service, booking, and successful booking rate for long-term care shuttle services. This reflects several pre-ride issues behind: customer service representatives are required to process large amounts of information and are unable to provide immediate information regarding a reservation. To compound this issue, some passengers noted that they did not understand the service's promotional materials. Nevertheless, customer loyalty remains high (NPS = 73), suggesting that long-term care shuttle services are truly an integral part of the accessible transportation system.
- **Service providers:** Figure 4 shows that drivers were most dissatisfied with the workload, after which the issues of collecting signatures/payments and on-the-

spot assignments are highlighted. This reflects several issues identified in the pilot study, including the traditional method of collecting passenger signatures/ payments and a cumbersome record-keeping process. Furthermore, passengers often book or cancel trips on short notice, resulting in frequent on-the-spot assignments and an unstable workload for drivers.

- **Service administrators:** Figure 4 shows that similar to drivers, administrators were most dissatisfied with the workload, followed by regulations, lack of flexibility in dispatching vehicles and arranging shifts, and the large amounts of time devoted to processing large amounts of service data. In response to an open-ended question, a few participants suggested that a comprehensive system of regulations should be devised and that the introduction of an assistive technology (such as an automatic record-keeping system) would alleviate certain issues.

<i>Results of the customer satisfaction (CSAT) survey</i>									
Service Users (N = 15)									
	Overall service	Promotion	Eligibility	Booking	Driver's attitude	Vehicle cleanliness	Vehicle exterior	Booking success rate	Customer service
M	6	4.1	4.8	5	6.4	6.3	6.5	5	4.8
Service Providers (N = 14)									
	Overall service	Training	Scheduling	On-the-spot assignments	Record-keeping	Signature/ payment	Regulations	Job division	Workload
M	5.7	5.4	5.1	5	5	4.7	6.5	5.5	4.4
Service Administrators(N = 7)									
	Overall service	Training	Promotion	Reservation	Shifts	On-the-spot dispatch	Regulations	Job division	Customer complaints
M	5.4	4.5	5.2	4.8	4.8	4.2	3.5	4.8	4.8
	Workload	Case management	Reporting						
M	3.6	5	4.7						

Figure 4 Results of the customer satisfaction (CSAT) survey completed by service users, providers, and administrators.

5. Results

Through the pilot study, the designers identified four major issues in existing long-term care shuttle services:

1. **Incomplete management system:** Deficiencies were found in trip reservation and shift arrangement; completing paperwork is difficult in light of the growing demand for shuttle services.
2. **Poor communication:** Discrepancies were found in the information communicated to frontstage and backstage staff as well as customers.
3. **Human resource challenges:** Insufficient training and unclear job allocation to frontstage and backstage employees, particularly those working in remote areas.
4. **Incompatible regulations:** Standardized operating procedures and regulation were unclear of long-term care transportation services – resource distribution is incongruent with operational needs, and shuttle operators struggle to coordinate markedly divergent models of operation.

The design team met with people from partner organizations, various stakeholder groups, and three designers well-versed in service design (who have first-hand experience of the shuttle service) to discuss potential design concepts. The ultimate goal is to build a “safe, convenient, and accessible shuttle service” with a focus on designing a digital tool. As shown in Figure 5, the framework of design incorporates the actual needs of the three stakeholder groups:

- **Service users:** Three major needs are identified: (1) immediate and clear information on reservations and ride reminders, (2) a channel to submit and receive information on rides for family members, and (3) a safe riding experience.
- **Service providers:** Three major needs are identified: (1) a smooth channel of communication with administrators, (2) clear information for passenger pick up, and (3) a more comprehensive training program.
- **Service administrators:** Two major needs are identified: (1) a set of congruent regulations governing long-term care shuttle services and (2) prevention of financial loss.

Figure 5 As shown in the design framework, the researchers hope to approach the task from a service design perspective and establish a safe, convenient, and accessible shuttle service by connecting the three stakeholder groups through a digital platform.

6. Design and Evaluation

6.1 Heuristic evaluation and usability test on existing platforms

Based on the results of the pilot study, our research partner A produced the first prototype of the management platform for service providers and administrators, a system that is already in use by a number of service organizations. To enhance the user experience and communication channel aspect of the platform, the design team invited seven UI/UX designers to conduct a heuristic evaluation and usability test on the platform in six major areas – information architecture (IA) content, IA, flow, layout, interaction, and user interface. The experts were asked to examine whether the system complies with generally accepted usability principles. Finally, the design team compiled a list of 50 usability issues based on suggestions made by the seven experts.

6.2 Designing a new long-term care shuttle system

The prototype was revised based on the evaluation results to create a more holistic long-term care shuttle service system. The specific design concepts for each of the stakeholder

groups are described below:

- Service users:** A chatbot was developed for booking long-term care shuttle rides on the popular instant messaging app, “LINE.” In the pilot study, we found that more than 80 percent of passengers have a LINE account, making it the most suitable platform for booking rides and receiving ride reminders. The remaining 20 percent who are unfamiliar with digital products will be redirected to customer service to maintain a smooth and efficient user experience when booking a transport service. As shown in Figure 6, the current functions of the chatbot include a service introduction, simple reservation feature, clear contact information, ride reminders, ride tracking, payment notifications, and service feedback. These functions are designed to help passengers and their family members stay updated on information regarding upcoming rides.

Figure 6 The app interface for the “Long-Term Care Shuttle Booking Helper” LINE Chatbot

- Service providers:** A long-term care service provider app was tailor-made for the drivers, which aims to provide real-time information and reminders while drivers are working. Figure 7 shows the main functionality of the app, which includes ride reminders, route and schedule view, daily vehicle maintenance, tracking/navigation, arrival alerts, payment reminders, e-signatures, task lists, passenger notes, and mileage reports. The goal is to increase the effectiveness of communication among drivers, passengers, and administrators, digitize the record-keeping process, and avoid human errors as much as possible.

Figure 7 The app interface for long-term care shuttle drivers

- **Service administrators:** For long-term care shuttle service organizations and administrators, the “Long-Term Care Shuttle Bus Service Organization Management Platform” was developed with the goal of boosting work efficiency and service quality. As shown in Figure 8, the platform handles enterprise resource management, case management, reservation management, vehicle dispatching, real-time monitoring, smart reports, service feedback, and order history. It is expected that the platform will help administrators to arrange shifts, obtain driver locations, and process the large amounts of data generated.

Figure 8 The platform interface for long-term care shuttle service administrators

6.3 Priority of design concepts

The framework of this study is based on the Kano model proposed by Noriaki Kano and other Japanese scholars in 1984. Through visual presentations of design concepts in various service scenarios (see Figure 9), service users, service providers, and service administrators were asked to evaluate each functional module in the newly designed system. The Kano model categorizes customer satisfaction characteristics and helps corporations to decide

which customer needs should be prioritized (Matzler & Hinterhuber, 1998). There are six quality categories in the Kano model: *must-be requirement* (M), *one-dimensional requirement* (O), *attractive requirement* (A), *indifferent requirement* (I), *reverse requirement* (R), and *questionable requirement* (Q). Meanwhile, we used the NPS to construct a holistic understanding of user loyalty to the product and the Customer Effect Score (CES) to gauge how much the product simplifies and accelerates the workflow of service providers and administrators. In total, 31 valid questionnaires were collected from service users, 23 from service providers, and 16 from service administrators, the results of which are summarized below:

- **Service users:** Given that a large portion of passengers are intubated and unable to respond to the survey themselves, a majority of participants (58 percent) in this stakeholder group are family members. Based on the aforementioned Kano model, respondents were asked to rate the seven major functions of the “Long-Term Care Shuttle Booking Helper” LINE Chatbot. Statistics show that “simple booking,” “ride reminders,” and “ride tracking” are attractive requirements (A) and should be prioritized accordingly, as shown in Figure 10. The NPS is 55. In the follow-up interview, we found that participants with moderate to advanced computer skills consider booking a ride via the LINE app to be far more convenient than booking over the phone. In the pilot study, we found that long-term care shuttle users are loyal to the service, and we believe that the LINE chatbot provides a useful alternative to scheduling a ride every week.

“My husband needs a ride every week, meaning that I have to regularly call to book a ride. It’s a lot of hassle and I sometimes forget to do it. The LINE Chatbot offers a convenient alternative, and I am more than willing to recommend this service to my tech-savvy friends.” — C11

- **Service providers:** As illustrated in Figure 10, the 10 functions in the long-term care shuttle driver app were all scored as indifferent requirements (I), meaning that neither good or bad, it may have no effect, positive or negative, on customer satisfaction. The CES, on the other hand, is only 17. Through in-depth interviews, we learned that drivers do not have time to use their smartphones when they are between rides and that many older, more experienced drivers feel comfortable with the status quo and may even be averse to digital assistive tools. Some drivers told us that they are indifferent to using a pen-and-paper system or digital software, as long as it is fully integrated and does not increase the workload. With this, we conclude that providing sufficient training, establishing a standard operating procedure, and building the professionalism of drivers are more important than introducing a digital platform.

“Our job is to take passengers to their destinations in a safe and timely manner. I am not against mobile apps, but they must be easy to operate for them to be useful. To put it frankly, it doesn’t really matter that much whether we have or don’t have a software system in place.” — D3

- **Service administrators:** Participants in the service administrators group generally identify themselves as moderate to advanced users of digital tools. Among the nine functions of the “Long-Term Care Shuttle Bus Service Organization Management Platform,” only “smart report” is classified as a *one-dimensional requirement* (O), meaning that the implementation of this design concept is positively correlated with user satisfaction and vice versa. By contrast, “real-time monitoring” and “booking history” are classified as *attractive requirements* (A), as shown in Figure 10. The CES is 63. The follow-up interview revealed that participants hold favorable opinions towards the platform as it consolidates large amounts of data, minimizes manual labor, and increases service efficiency and quality. However, in terms of shift arrangement, participants still prefer the traditional pen-and-paper system as it offers more flexibility than the digital platform, which did not include the “smart scheduling” function at the time.

“The strength of the platform is its robust data processing power, which dramatically reduces my workload. However, in terms of flexibility, I still prefer using pen and paper. At the end of the day, both systems have their benefits and drawbacks.” — A1

Figure 9 Following visual presentations of our design, based on various service scenarios, participants are asked to express an opinion on the new platform. On the left-hand side is an illustration of the scenario; on the right-hand side is a partial screenshot of the interface; at the bottom, a photo of the actual service scenario is included.

Kano analysis results										
Long-Term Care Shuttle Booking Helper LINE Chatbot										
Concept	Service agreement	Simple booking	Clear contact info	Ride reminders	Ride tracking	Payment notification	Service feedback			
Classification	I	A	I	A	A	I	I			
Long-Term Care Shuttle Drivers App										
Concept	View schedule	Daily vehicle inspection	Tracking & navigating	Ride reminders	Arrival notification	Payment reminder	E-signature	Task list	Passenger notes	Mileage report
Classification	I	I	I	I	I	I	I	I	I	I
Long-Term Care Shuttle Bus Service Organization Management Platform										
Concept	Promotion website	Resource management	Appointment management	Reservations management	Dispatch management	Real-time monitoring	Smart reports	Service feedback	Booking history	
Classification	I	I	I	I	I	A	O	I	A	

Figure 10 Results of the KANO analysis among Long-Term Care Shuttle Bus Chatbot, App, and platform.

7. Conclusions and Recommendations

7.1 Conclusions

The purpose of this study is to analyze accessible service scenarios in transportation from a service design perspective. By collaborating and co-creating solutions with designers and various social stakeholders, the present study seeks to improve the riding experience, service efficiency, and quality of long-term care shuttle bus services. Based on the research and design of this process, this study draws the following two conclusions:

1. The service design perspective is effective in redesigning public transportation:

Public transportation services involve a wide range of stakeholders. A service design perspective can create a cross-channel system that integrates the resources of various stakeholders, allowing the reinvention of a public transit system with better efficiency. The present study provides a prime case study on the application of service design in a public transportation system.

2. The service design methodology helps designers resolve transportation issues faced by the underprivileged:

The stakeholder diagram and the customer journey map highlight the intricate issues of public transportation services, which involve complicated concepts and high infrastructure costs. To address this, the designers prioritize effective service design concepts by evaluating them according to the results from Kano model using visual presentations of service scenarios, which assists the designers in preliminary planning prior to the implementation of the new system.

We will continuously collaborate with two long-term care shuttle organizations in Taiwan, Taichung and Yilan, to implement the service design project in local communities. In the near future, we expect that the potential results of the study could provide significant value both socially and economically. In terms of social value, the study could enable local governments to consolidate resources and build a network based on “the disadvantaged taking care of the disadvantaged,” addressing the often-neglected social needs of the elderly and people with disabilities. For economic value, this study could enable coordination between government, taxi dispatchers, and long-term care shuttle service organizations to achieve an accessible transportation service model that is efficient and sustainable.

Apart from applying service design to public transportation services, this research corresponds with the points of Inclusive Design as stated by Clarkson, Coleman, Keates, and Lebbon: “A key aspect of the inclusive approach is to expand the target group of a product or service to include as many users as possible, without compromising the business goals of profit and customer satisfaction” (Clarkson, Coleman, Keates & Lebbon, 2013, p. 10). Additionally, apart from designing for the physically disabled, we have expanded our field of design to include passenger associates, such as family members, drivers, and administrators. We also consider user habits and behaviors throughout the design process so that users are able to achieve their goals with greater flexibility. Ultimately, “design for all” is the core value of this research.

7.2 Recommendations for future research

In light of its research findings, the present study would like to make the following three recommendations concerning the direction of future research and application:

1. The core issue of long-term care shuttle services is that government policies are incongruent with actual market needs. However, the present study does not address the process of communication and coordination with the government. It is recommended that in the future, designers working with public services should establish a channel of communication with the government so that user feedback and user needs are relayed to the responsible authority, thereby increasing the impact of the design.
2. The present study identifies the lack of standardized operating procedure and regulations as the cause of inconsistent service quality and the rising number of customer complaints. We suggest that future designers draft a standardized service agreement with relevant stakeholders to influence policymakers to establish standard operating procedures that can be easily duplicated in other locations.
3. Future designers interested in constructing similar multi-channel service platforms are advised to approach their designs from an all-inclusive perspective with individual consideration given to various touchpoints in actual service scenarios to elicit genuine feedback from participants.

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