# 運輸場站無障礙電梯使用狀況調查：以臺北捷運為例

# AN OBSERVATION ON ACCESSIBLE ELEVATOR USERS IN TAIPEI MRT SYSTEM

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## 摘 要

無障礙電梯為身心障礙人士、推娃娃車等族群使用公共運輸過程中不可或缺的重要設施，隨著近年運輸場站逐漸往高架、地下化垂直化發展，以電梯連結月台、跨越軌道的需求與日俱增。然而無障礙電梯雖以無障礙為名，實際係為通用化設計之實現，換言之，此一設計理念意味該項設施可能同時被非必要的族群使用，進而造成真正需要使用電梯的族群在使用上必須面對較長等候時間的狀況，並致生「電梯是否不足？」之疑慮。

因此，為更進一步了解無障礙電梯使用狀況，本研究以臺北捷運為例，選擇 10 個位於轉運站的月台電梯進行使用狀況觀察與資料蒐集，研究過程共計完成 20 小時現場調查，並記錄 604 個電梯班次、2,413 位使用者的等候狀況。研究結果發現，使用輪椅、推娃娃車族群所佔比例相對極低，但其等候電梯的機率卻高於其他族群，其主要原因為一般旅客缺乏禮讓文化，僅有 24%的使用者會願意禮讓輪椅、推娃娃車族群先行進入電梯，且此一狀況在各月台電梯皆然，並未因運量差異、同一月台電梯數而有所差，顯見推動捷運電梯禮讓文化刻不容緩。

本研究為無障礙電梯使用狀況之初探，長期而言，主管機關應進一步擴大調查範圍，增加運具、月台類型之多樣性，同時考量不同時段使用者特性，以期更完整了解無障礙電梯之使用狀況，作為現有場站改善管理策略及未來新場站設計之參考。



**關鍵詞：**

無障礙電梯、捷運、月台、通用化設計、羅吉斯迴歸。

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**ABSTRACT**

Accessible elevator is a vital access-free equipment for people with disabilities in public transportation stations, which ensure their equal right of economic and social activities. However, the accessible elevators is built based on the concept of universal design and viable to all users. People with disabilities sometimes may encounter difficulties and long waiting time when reaching for elevators. Thus, some may question about the sufficiency of elevators in public transportation stations. To ease the usage of accessible elevators for people with disabilities, this study conducted a field observation in Taipei MRT system for collecting the using behavior regarding the elevator users' characteristics and their behavior patterns. In total, 604 elevator trips and 2,413 elevator users were observed from ten elevators of four transfer stations. Frequency distribution of ridership patterns among different elevators and time periods are constructed. Two logistics regression models regarding occurrences of users waiting and courteous behavior were estimated. Results of this study suggested that the users using wheel chairs or baby carriages may encounter difficulties and wait longer when using elevators. It is largely resulted from low percentage of courteous behavior. Once the courteous behavior is needed, only half of the occurrences in which users are willing to let other users who use wheel chairs or baby carriages to enter elevator first. Therefore, in conclusion, it is clear that promoting courteous culture might be a better way for improving using experience of accessible elevators. More effort should be invested to identify the user characteristics in different stations, time period and transportation mode.

*Keywords*: Accessible elevator, Public transportation station, Logistics regression

**INTRODCTION**

Providing an access-free environment is one of the vital requirement as a modern city. An ideal access-free environment should include considerations for possible access difficulties in daily life as more as possible. Explicitly, it should ensure all citizens' basic right of movement and allows them to participate the social activities *(1, 2)*. The access-free design or barrier-free design was firstly proposed in mid-20$^{th}$ century. This concept originally aimed at providing suitable facilities or equipment to remove the barrier of moving for people with disabilities. Then in the late 20$^{th}$ century, the concept of barrier-free design evolves to universal design, which is a suitable product and environmental design for all people at maximum possible range in gender, age or ability *(3-5)*. Provided that the facilities or equipment are accessible to people with disabilities, they should also accessible to other populations.

Regarding the field of public transportation, issues of access-free design or universal design are even more critical owing to its role in social welfare system. Public transportation satisfies people's basic need of transportation and facilitates their social, economic or other activities. More importantly, it allows them to travel independently without relying on other people in relatively low price. Hence, providing a good and reliable transportation service is one of the vital goal that government should achieve. Previous research indicates that convenience, safety and respectfulness are the key factors affecting their intention to use public transportation *(6, 7)*. Apparently, access-free environment is an important resolution for this issue.

Among all viable options regarding the access-free equipment and facilities, accessible elevator is the most frequently used one *(8)*. Especially in public transportation stations, passengers are often required to use underground or elevated passageway with the purpose of crossing the rail tracks or going to platforms. Hence, in order to protect and secure their equal rights, Taiwan's People with Disabilities Rights Protection Act clearly stated that, for the convenience of people with disabilities, access-free equipment and facilities shall be planned and established in public transport *(9)*. Specification and requirement of accessible elevators is also specified in Design Specifications of Accessible and Usable Buildings and Facilities *(10)*.

However, although regulations and guidelines are issued and practiced, people with disabilities still face difficulties when trying to use elevators. Chen *(8)* conducted an experiment of measuring mental pressure when power wheel users using elevators. The result shows that the pressure level of using elevators is relatively higher than other accessible equipment, probably owing to low quality and usability. In fact, although the terminology of "accessible" is used, the accessible elevators are designed based on the concept of universal design. Since the elevators are viable for all users, including those who are also fit for stairs or escalators, people with disabilities sometimes may encounter difficulties and long waiting time when reaching for elevators. This situation could be more serious in subway or metro stations since the train headway is relatively short and large amount of users appear in batch patterns.

To ease the usage of accessible elevators for people with disabilities, more detail information regarding the elevator users' characteristics and their behavior patterns should be clarified. Hence, important questions worthy further discussion arise. 1) Who are the users using accessible elevators? 2) Do people with disabilities have difficulties when using accessible elevators?

In this study, a field observation of accessible elevator behavior is conducted in Taipei MRT (Mass Rapid Transit) system. Users' characteristics including gender, disability level and courtesy behavior are collected. Finally, discussions and recommendations regarding of cases including in this study are made.

## DATA

### Ridership Pattern

Taipei MRT is an important public transportation in Taipei and New Taipei City. The system operates of 108 stations and 7 routes, including 5 main routes (Wenhu "Brown" Line, Tamsui-Xinyi "Red" Line, Songshan-Xindian "Green" Line, Zhonghe-Xinlu "Orange" Line, and Bannan "Blue" Line) and 2 branch lines (Xinbeitou branch and Xiaobitan branch). The length of revenue track is 131.1 kilometers (81.5 miles). In 2017, the total ridership of Taipei MRT is 746 million passengers. In average, the system served over 2 million passengers per day *(11)*. Regarding the user type, 2% of the passengers used "charity and companion cards" (for people with disabilities and their companions) and 5% of passengers used "senior card".

To further explore the ridership characteristics in hour basis, this study used the ridership data of a weekday and weekend in 2016 to illustrate the ridership patterns in one day. As shown in Figure 1, it shows two ridership peaks in one day, which are eight to ten o'clock in the morning and five to eight o'clock in the evening. This pattern is in line with the expectation that going to work in the morning and going home in the evening are the two main purposes of urban transportation in weekday. As for the passengers using senior card and charity cards, although the peak level is less significant than ones using ordinary card, the figure still shows similar patterns that most of them use metro in the morning peak.

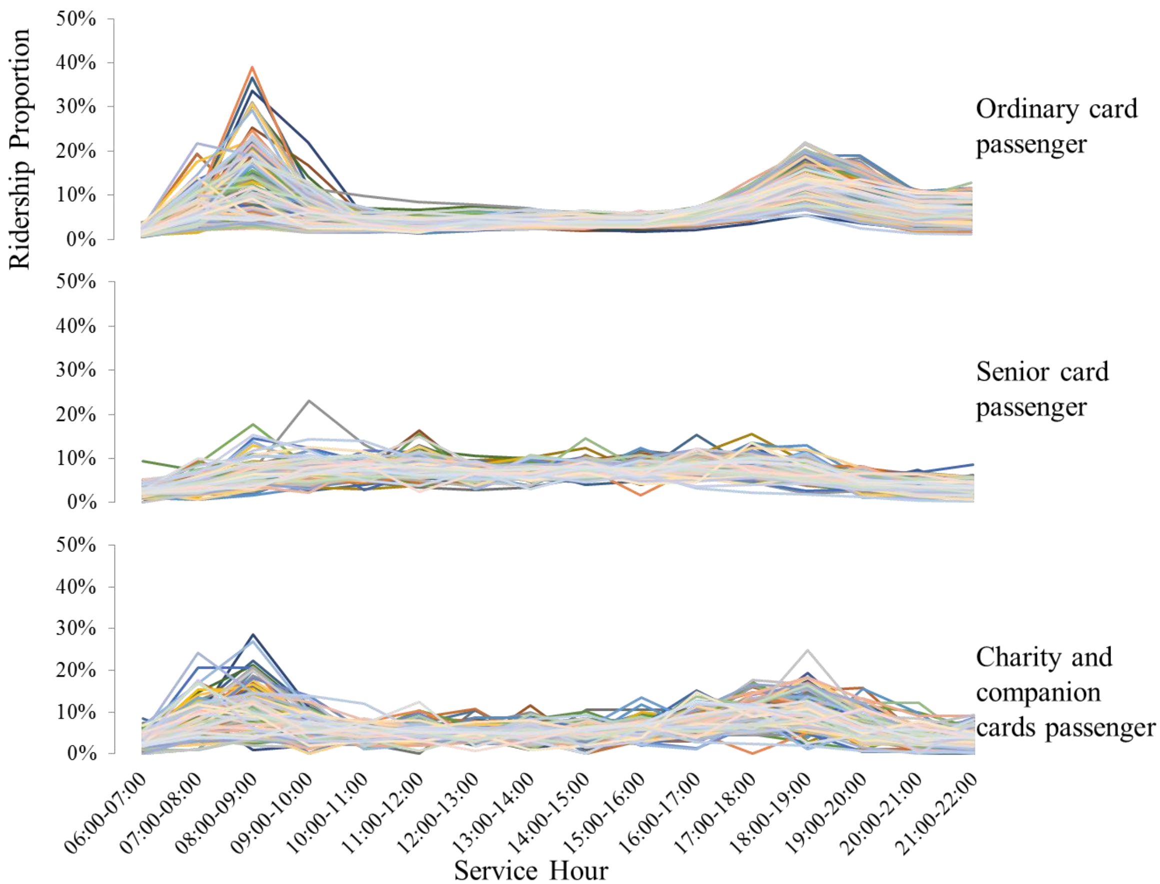


**FIGURE 1 Ridership distribution of Taipei MRT by hours and stations in weekday**

Regarding the ridership pattern in weekend, as shown in Figure 2, the ridership proportion of each service hour for most stations are below 10%. Comparing to the result of weekday ridership illustrated in Figure 1, the ridership peak is less significant. Only in a few stations, approximately 10 to 20% of passengers using senior card or charity card would use Taipei MRT in nine to ten o'clock in the morning and six to seven o'clock in the evening.

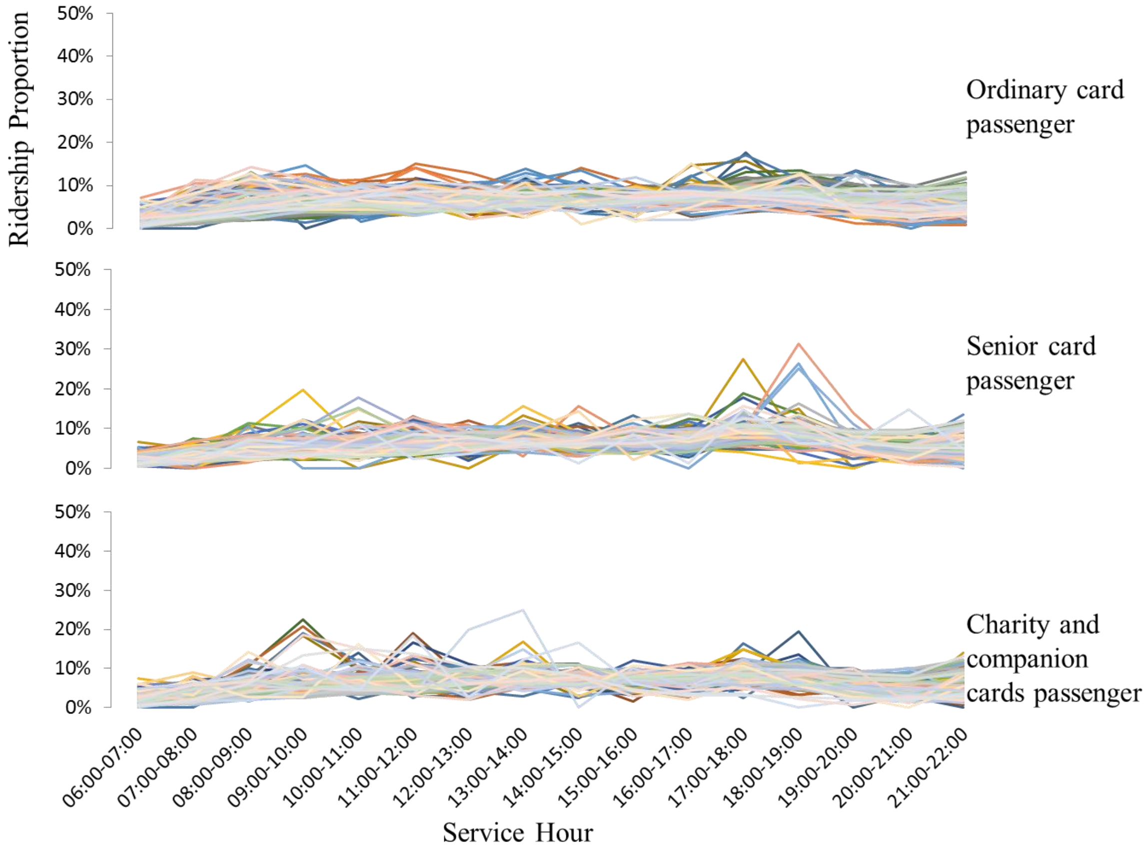


**FIGURE 2 Ridership distribution of Taipei MRT by hours and stations in weekend**

Summing up the result of ridership analysis, the distribution of ridership is different in weekday and weekend. The pattern in weekday shows relatively evident peak hours in morning and evening. Moreover, regarding the users using ordinary and charity cards, the morning peak is even more obvious than evening peak probably owing to the situation that most people should arrive their office before nine o'clock in Taiwan. On the other hand, patterns of passengers using senior card, who are usually retired from work, do not show evident peak hour.

## Field Observation and Data Collection Procedure

### *Data Collection*

To explore the characteristics of accessible elevator users and their behavior, this study conducted a filed observation in Taipei MRT stations for data collection. Investigators were sent to the designated platforms to collect data of elevator users' behavior, including number of users in each elevator trip, number of trip for which each user waits before entering the elevator, and occurrences of requiring users showing courtesy toward users in need to enter the elevators first (the courtesy behavior).

Moreover, based on the ridership analysis, this study focuses only on the morning peak (eight to ten o'clock in the morning) in weekday. Ten elevators (different entrances of the same elevator are considered different ones) of four transfer stations were included in this study. Considering that passengers getting off the trains would appear on the platforms and reach for elevators in batch patterns, this study observes only the using behavior of elevator users moving from platforms towards other platforms or station gates. In the following sections, characteristics of user populations and elevators are described.

*User Populations*

The elevator users are classified into three types based on the level of difficulties when using stairs or escalators. Referring to the user classification in Yang (*4*), Table 1 shows the definition of the elevator users.

**TABLE 1 Capability of using stairs, escalator and elevator**

| User Type | Capability of using stairs, escalator and elevator | | |
|---|---|---|---|
| | Stairs | Escalator | Elevator |
| Type *D* | Impossible | Impossible | Capable |
| Type *C* | Difficult | Difficult | Capable |
| Type *O* | Capable | Capable | Capable |

The first type of user (Type *D*) is defined as one who is not able to use stairs or escalators, including people with physical disabilities, wheelchair users, people pushing baby carriages, or others who have difficulties using stairs or escalators. To type *D* users, accessible elevators are the only choice for them to move between floors. The second type of users (Type *C*) is defined as one who has difficulties using stairs or elevators, including users carrying travelling cases, suitcases or trunks. To Type *C* users, using elevators is more convenient than using stairs or escalators. Besides Type *D* and *C* users, the third type of user (Type *O*) are the ordinary people who are totally capable of using stairs or escalators.

*Elevators*

The field observation was conducted at ten accessible elevators located on eight platforms of four transfer stations. Table 2 shows the description of the elevators included in this study.

**TABLE 2 Elevators included in field observation**

| Station | Platform | Abbr. | No. of levels | Location |
|---|---|---|---|---|
| TM | B | TM_B | Bottom level of a 2-level elevator | Center of platform |
| | R | TM_R1 | Bottom level of a 2-level elevator | Center of platform |
| | | TM_R2 | Bottom level of a 3-level elevator | South side of platform |
| ZX | B | ZX_B | Bottom level of a 3-level elevator | Center of platform |
| | O | ZX_O | Middle level of a 3-level elevator | North side of platform |
| ZS | G | ZS_G | Bottom level of a 3-level elevator | Center of platform |
| | R | ZS_R | Middle level of a 3-level elevator | Center of platform |
| MW | R | MW_R1 | Top level of a 3-level elevator | North side of platform |
| | | MW_R2 | Bottom level of a 2-level elevator | Center of platform |
| | O | MW_O | Bottom level of a 3-level elevator | Center of platform |

Number of levels is one key factors characterizing different elevators. Time between two trips of elevator would increase with number of level that the elevator serves. In this study, elevator

TM_R2, ZX_B/O, ZS_R/G and MW_R1/O are 3-level elevators, of which waiting time would be longer. Moreover, on platform B of station TM and platform G of station MW, there are two elevators provide service on one platform. It is expected to ease the traffic on platform or between different levels.

## RESULTS

Totally, this study conducted the field observation for 20 hours, in which 604 elevator trips and 2,413 elevator users were observed. Following sections outline the frequency distribution of elevator users' characteristics and courteous behavior. Chi-square test was conducted for clarifying the differences between different elevators and different time periods. Then, two logistics regression models were estimated for exploring the key factors affecting occurrences of users waiting for elevators and users showing courtesy toward other users in need.

### Frequency Distributions

Table 3 shows the frequency distributions of users' characteristics. In general, the chi-square tests show significant differences among elevators. It suggested that different stations or platforms with different characteristics, total ridership and platform alignment may create distinct patterns of using elevators.

Among the 2,413 observations, female users shared 75% of the ridership in average. It is slightly higher than ratio of the female public transportation user in Taipei and New Taipei City (*12*). Moreover, as for the user type, the ordinary users (Type *O*) shared 75% of the ridership while users with luggage or trunks (Type *C*) and users with physical disabilities or baby carriages (Type *D*) each share 15% of the total ridership.

Regarding the average number of elevators trips that users wait before entering the elevators, 94% of the users wait only one trip and only 6% of them wait for more than one trip. It shows that most elevator users did not have difficulties using elevator in Taipei MRT. However, the cross analysis between user types and number of elevator trip that users wait reveals more insight that different type of users may face different situations at the elevators. In fact, 15% of the type *D* users had to wait for two or more elevator trips before entering the elevator. The percentage increased to 31% when using elevator MW_O. Undoubtedly, users with difficulties, using wheel chairs or pushing baby carriages, which require more space in elevator, are primary users that the accessible elevators were designed to serve. Unfortunately, they are also the ones who spent more time waiting.

Moreover, among the 604 trips observed in this study, as shown in Table 4, occurrences of requiring users to show courtesy, only occurred 69 times (approximately 15% of the total trips). Particularly, to elevator MW_O, 46% of the elevator trips require users to show courtesy. Yet, under such circumstances, there only 24% of the occurrences in which all type *O* and type *C* users showed courtesy towards type *O* users. Meanwhile, 27% of the circumstances shows partial courteous behavior, which means that only partial users showed courtesy toward type D users. That is to say, in the situation that courteous behavior is needed, almost half of the chances that users did not let the users in need, to whom the elevator is the only possible choice, to enter elevators first. Additionally, the frequency distribution of showing courtesy was not significantly different between elevators. Even in elevator TM_R2 and MW_R2, where only two and three trips required users to show courtesy, most users still chose not to show courtesy to others who use wheel chairs, push baby carriages or have other physical disabilities.

**TABLE 3 Frequency Distribution of Elevator Users' Characteristics among Different Elevators**

| | TM_B | TM_R1 | TM_R2 | ZX_B | ZX_O | ZS_G | ZS_R | MW_R1 | MW_R2 | MW_O | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Number of user –User type**** | | | | | | | | | | | |
| Type O | 128 (49%) | 160 (57%) | 116 (76%) | 99 (57%) | 177 (69%) | 135 (75%) | 257 (79%) | 222 (83%) | 57 (74%) | 347 (79%) | 1698 (70%) |
| Type C | 84 (32%) | 80 (29%) | 13 (8%) | 49 (28%) | 31 (12%) | 20 (11%) | 35 (11%) | 15 (6%) | 0 (0%) | 27 (6%) | 354 (15%) |
| Type D | 48 (19%) | 39 (14%) | 24 (16%) | 26 (15%) | 50 (19%) | 25 (14%) | 32 (10%) | 29 (11%) | 20 (26%) | 68 (15%) | 361 (15%) |
| **Number of user –Gender**** | | | | | | | | | | | |
| Male | 64 (25%) | 95 (34%) | 37 (24%) | 50 (29%) | 49 (19%) | 55 (31%) | 72 (22%) | 52 (20%) | 22 (29%) | 105 (24%) | 602 (25%) |
| Female | 196 (75%) | 184 (66%) | 116 (76%) | 124 (71%) | 209 (81%) | 125 (69%) | 252 (79%) | 214 (80%) | 55 (71%) | 337 (76%) | 1811 (75%) |
| **Number of elevator trips for which the users wait before entering the elevator**** | | | | | | | | | | | |
| 1 trip | 251 (89%) | 266 (95%) | 150 (98%) | 171 (98%) | 234 (91%) | 176 (98%) | 313 (97%) | 262 (98%) | 77 (100%) | 386 (87%) | 2266 (94%) |
| 2+ trips | 29 (11%) | 13 (5%) | 3 (2%) | 3 (2%) | 24 (9%) | 4 (2%) | 11 (3%) | 4 (2%) | 0 (%) | 56 (13%) | 147 (6%) |
| **User type & Number of elevator trips for which users wait before entering the elevator** | | | | | | | | | | | |
| Type C* | | | | | | | | | | | |
| 1 trip | 67 (80%) | 74 (93%) | 12 (92%) | 47 (96%) | 28 (90%) | 20 (100%) | 33 (94%) | 15 (100%) | 0 (-%) | 22 (81%) | 318 (90%) |
| 2+ trips | 17 (20%) | 6 (7%) | 1 (8%) | 2 (4%) | 3 (10%) | 0 (0%) | 2 (6%) | 0 (0%) | 0 (-%) | 5 (19%) | 36 (10%) |
| Type D** | | | | | | | | | | | |
| 1 trip | 39 (81%) | 35 (90%) | 24 (100%) | 26 (100%) | 40 (80%) | 23 (92%) | 27 (84%) | 27 (93%) | 20 (100%) | 47 (69%) | 308 (85%) |
| 2+ trips | 9 (19%) | 4 (10%) | 0 (0%) | 0 (%) | 10 (20%) | 2 (8%) | 5 (16%) | 2 (7%) | 0 (0%) | 21 (31%) | 53 (15%) |
| **Total –users** | 260 | 279 | 153 | 174 | 258 | 180 | 324 | 266 | 77 | 442 | 2413 |

**: $P < 0.05$ **: $P < 0.1$

**TABLE 4 Frequency Distribution of Elevator Trips from the Perspective of Courteous Behavior among Different Elevators**

| | TM_B | TM_R1 | TM_R2 | ZX_B | ZX_O | ZS_G | ZS_R | MW_R1 | MW_R2 | MW_O | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Occurrence of requiring users to show courtesy toward *Type O* user**** | | | | | | | | | | | |
| Not required | 74 (88%) | 67 (91%) | 42 (93%) | 59 (100%) | 47 (78%) | 41 (85%) | 62 (86%) | 46 (82%) | 45 (96%) | 32 (54%) | 515 (85%) |
| Required | 10 (12%) | 7 (9%) | 3 (7%) | 0 (0%) | 13 (22%) | 7 (15%) | 10 (14%) | 10 (18%) | 2 (4%) | 27 (46%) | 89 (15%) |
| **Show courtesy toward *Type O* user** | | | | | | | | | | | |
| Yes | 3 (30%) | 1 (14%) | 1 (33%) | 0 (-%) | 3 (23%) | 2 (29%) | 2 (20%) | 3 (30%) | 0 (0%) | 6 (22%) | 21 (24%) |
| Partial | 0 (0%) | 0 (0%) | 1 (33%) | 0 (-%) | 7 (53%) | 1 (14%) | 4 (40%) | 4 (40%) | 0 (0%) | 7 (26%) | 24 (27%) |
| No | 7 (7%) | 6 (86%) | 1 (33%) | 0 (-%) | 3 (23%) | 4 (57%) | 4 (40%) | 3 (30%) | 2 (100%) | 14 (52%) | 44 (49%) |
| **Total -trips** | 84 | 74 | 45 | 59 | 60 | 48 | 72 | 56 | 47 | 59 | 604 |

**: $P < 0.05$ **: $P < 0.1$

**Elevator Users' Behavior in Different Time Periods**

This study divided the time periods between eight to ten o'clock into four periods in every 30 minutes. The frequency distribution of users and elevator trips was presented in Table 5.

**TABLE 5 Frequency Distribution of Elevator Users' Characteristics and Courteous Behavior among Different Time Periods**

| | 8:00-8:30 | 8:30-9:00 | 9:00-9:30 | 9:30-10:00 | Total |
|---|---|---|---|---|---|
| **Number of user –User type**$^{**}$ | | | | | |
| Type O | 590 (78%) | 472 (76%) | 315 (63%) | 321 (60%) | 1698 (70%) |
| Type C | 90 (12%) | 77 (12%) | 99 (20%) | 88 (17%) | 354 (15%) |
| Type D | 73 (10%) | 77 (12%) | 89 (17%) | 122 (23%) | 361 (15%) |
| **Number of elevator trips for which users wait before entering the elevator**$^{**}$ | | | | | |
| 1 trip | 710 (94%) | 606 (97%) | 468 (93%) | 482 (91%) | 2266 (94%) |
| 2+ trips | 43 (6%) | 20 (3%) | 35 (7%) | 49 (9.2%) | 147 (6%) |
| **Total –users** | 753 | 626 | 503 | 531 | 2413 |
| **Occurrence of requiring users to show courtesy toward *Type O* user** | | | | | |
| Not required | 133 (82%) | 130 (88%) | 127 (89%) | 125 (83%) | 515 (85%) |
| Required | 29 (18%) | 18 (12%) | 16 (11%) | 26 (17%) | 89 (15%) |
| Show courtesy toward *Type O* user | | | | | |
| No | 11 (38%) | 9 (50%) | 7 (44%) | 17 (65%) | 44 (49%) |
| Partial | 12 (41%) | 5 (28%) | 4 (25%) | 3 (12%) | 24 (27%) |
| Yes | 6 (21%) | 4 (22%) | 5 (31%) | 6 (23%) | 21 (24%) |
| **Total –trips** | 162 | 148 | 142 | 151 | 604 |

$^{**}$: $P < 0.05$ $^{**}$: $P < 0.1$

Although type *O* user shares highest proportion in all of the four time periods, its percentage slightly decreases after nine o'clock. In the same time period, percentage of type *C* and *D* users increases. Similar result can be found in the frequency distribution of number of trips for which users waited before entering the elevators. The Chi-square test also supports the trend and shows significant differences among different users types and time periods. As for the occurrence of requiring courtesy behavior and occurrence of users showing courtesy to type *D* users, the chi-square does not show significant difference among time periods. Moreover, viewing from the perspective of number of users that wait for more than one elevator trip, Figure 3 shows that 8:00-8:30 and 9:30-10:00 are the two periods in which more users, particularly the type *D* users, spent more time to wait for elevators.

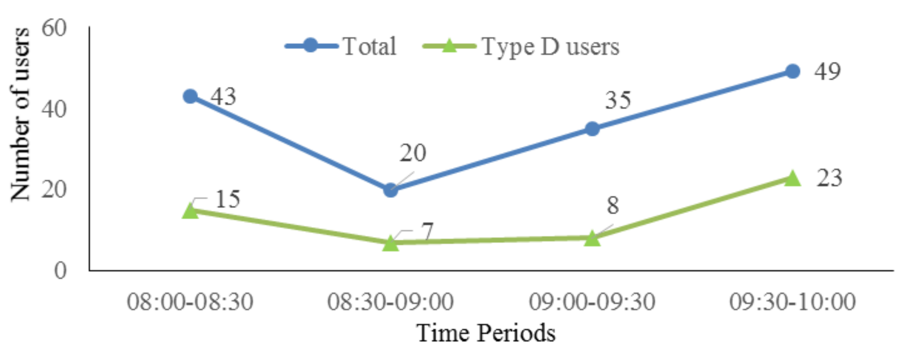


**FIGURE 3 Number of Users Waiting for More than One Elevator Trip**

## Logistics Regression Model of Waiting Elevator Occurrences

In order to identify the key factors affecting probability of users waiting for elevators, this study constructed a logistics regression model, in which the dependent variable is whether a user wait for more than one trip before entering the elevator. The independent variables included in this model are,

- $Time_{0830}$, $Time_{0900}$ and $Time_{0930}$: Dummy variables; equate to one if the user was observed in time period 8:30 to 9:00, 9:00 to 9:30 and 9:30 to 10:00, respectively.
- *TypeC* and *TypeD*: Dummy variables; equate to one if the user was classified into Type *C* and Type *D*, respectively.
- *3-Level*: Dummy variables; equate to one if the user was observed in the elevator which serves three levels.
- *ZX, ZS, MW*: Dummy variables; equate to one if the user was observed in station ZX, ZS and MW, respectively.
- *Male*: Dummy variable; equate to one if the user was male.

The estimation result was shown in Table 6. In the first step, all variables were included and then excluded based one backward elimination process. Finally, six variables are found significantly related to the probability of users waiting for more than one trip of elevator.

**TABLE 6** Logistics Regression Model for Occurrences of Users Waiting Elevators

| | *Significance level (p*-value) | | | | | Step 6 | |
|---|---|---|---|---|---|---|---|
| | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Coefficient | *P* value |
| *Constant* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -3.52 | $0.00^{**}$ |
| $Time_{0830}$ | 0.03 | 0.01 | 0.01 | 0.01 | 0.00 | -0.72 | $0.00^{**}$ |
| $Time_{0900}$ | ~~0.92~~ | - | - | - | - | - | - |
| $Time_{0930}$ | 0.35 | 0.31 | 0.31 | ~~0.31~~ | - | - | - |
| *TypeC* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.31 | $0.00^{**}$ |
| *TypeD* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.57 | $0.00^{**}$ |
| *3-Level* | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.65 | $0.00^{**}$ |
| *ZX* | 0.44 | 0.44 | 0.30 | 0.29 | ~~0.28~~ | - | - |
| *ZS* | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | -0.96 | $0.00^{**}$ |
| *MW* | 0.87 | ~~0.86~~ | - | - | - | - | - |
| *Male* | 0.67 | 0.67 | ~~0.67~~ | - | - | - | - |

$^{**}$: $P < 0.05$ $^{**}$: $P < 0.1$

According to the estimation results, users would be less likely to wait for more than one trip of elevator only in time period 8:30 to 9:00, which is the time that number of type *O* users decrease while other user have not yet appeared. Moreover, in station ZS, the probability of users waiting elevators is significantly lower than other stations.

As for the characteristics of elevators, estimation result shows that 3-level elevator increase the probability of waiting occurrences, probably owing to the longer operation time between two elevator trip. In addition, the model also suggests a significant result that type *C* and type *D* may have more chances to encounter the circumstances that they have to wait for next trip. More importantly, between these two types of users, type *D* users, who are the intended users of accessible elevators, are even more likely to face difficulties using elevators.

## Logistics Regression Model of Courteous Behavior

The second logistics regression model was constructed to identify the key factors affecting probability of users showing courtesy toward type *D* users. The dependent variable of this model is whether the users waiting in line let those users in need (type *D* user) to enter the elevator first.

In this section, the courtesy behavior includes fully courtesy (all users show courtesy) and partial courtesy (only part of the users show courtesy). The independent variables included in this model are,

- *TotalUser*: A continuous variable representing the total number of users waiting for the elevators.
- *TypeD*: A continuous variable representing the total number of type *D* users waiting for the elevators.
- $Time_{0830}$, $Time_{0900}$ and $Time_{0930}$: Dummy variables; equate to one if the circumstances requiring courteous behavior were observed in time period 8:30 to 9:00, 9:00 to 9:30 and 9:30 to 10:00, respectively.
- *3-Level*: Dummy variable; equate to one if the elevator serves three levels.
- *ZX, ZS, MW*: Dummy variables; equate to one if the circumstances requiring courteous behavior was observed in station ZX, ZS and MW, respectively.

The estimation result was shown in Table 7. Same with the logistics regression model in previous section, the backward elimination was conducted. In the final step, two variables are included, which are number of users and number of type *D* users. It shows that people are more willing to show courtesy when there are more users, particularly ones with wheel chairs or baby carriages, waiting. However, it also shows that the courtesy behavior would not vary in different time periods, stations or different types of elevators. It could lead to a speculation that courtesy culture is not a unique issue in certain situations or place. It might be a universal issue in Taipei MRT or even in all transportation modes.

**TABLE 7** Logistics Regression Model for Courteous Behavior

| | *Significance level* (*p*-value) | | | | | | | Step 8 | |
|---|---|---|---|---|---|---|---|---|---|
| | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 | Coefficient | *P* value |
| *Constant* | 0.33 | 0.29 | 0.28 | 0.28 | 0.28 | 0.24 | 0.38 | -1.17 | 0.16 |
| *TotalUser* | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.03 | 0.18 | 0.05$^{*}$ |
| *TypeD* | 0.13 | 0.13 | 0.13 | 0.13 | 0.11 | 0.11 | 0.10 | 0.65 | 0.09$^{*}$ |
| *Time0830* | 0.94 | ~~0.92~~ | - | - | - | - | - | - | - |
| *Time0900* | 0.69 | 0.64 | 0.65 | 0.65 | ~~0.64~~ | - | - | - | - |
| *Time0930* | ~~0.98~~ | - | - | - | - | - | - | - | - |
| *3-Level* | 0.39 | 0.39 | 0.39 | 0.23 | 0.18 | 0.16 | ~~0.33~~ | - | - |
| *ZX* | 0.91 | 0.91 | ~~0.90~~ | - | - | - | - | - | - |
| *ZS* | 0.49 | 0.49 | 0.49 | 0.30 | 0.2 | ~~0.2~~ | - | - | - |
| *MW* | 0.80 | 0.80 | 0.80 | ~~0.81~~ | - | - | - | - | - |

$^{**}$: $P < 0.05$ $^{**}$: $P < 0.1$

## DISCUSSION

The key issue which this study tries to clarify is the efficiency of accessible elevators in public transportation stations. To answer this question, this study conducted a field observation in Taipei MRT and collected the patterns of all types of users using elevators. Result of this study may lead to a conclusion that the level of service may not be convenience enough for those users using wheel chairs or pushing baby carriages. However, the result also suggests a better solution by improving the management strategies rather than increasing the number of elevators.

In fact, the elevators are used mostly by the users who are also capable of using stairs or escalators. Only 6% of the users (type *D* users) are the ones for whom the elevators are the only choice. However, the estimation of logistics regression model shows that those type *D* users were more likely to wait for more than one elevator trip. This situation resulted largely from the low percentage of users willing to show courtesy to users in need. When there are type *D* users waiting for elevators, 49% of the chance that no other users show courtesy. Developing the courteous culture is a necessary way for improving the using experience of accessible elevators, particularly to those necessity users.

Moreover, some may claim that new elevators may be one of the methods to ease the traffic on platform. In this study, some of the elevators, such as TM_R2 and MW_R2, did play the role as a secondary access to other levels and showed relatively low ridership and waiting opportunity, comparing to other elevators. However, the logistics regression model shows that probability of users willing to show courtesy was not significantly different among elevators, stations or time periods. That is, although a new elevator could ease traffic and decrease the opportunities of users waiting for more than one elevator trip, once there are people waiting in front of the elevators, type D users may still encounter the same situation of waiting. In the long term, the ridership of those new elevator would increase with the total ridership of the Taipei MRT.

To develop the safety culture, knowing the characteristics of users is a vital step. Through the observations, female users were found as a major population using elevators. Moreover, waiting occurred in different time period may result from different user compositions. For example, in the time period after nine o'clock in the morning, number of users carrying luggage increases, which could cause difficulties of using elevators for type D users. All in all, these analysis of user characteristics should be taken into consideration when promoting the courteous culture.

Finally, this study conducted a field observation in only ten elevators in Taipei MRT. Small sample size may lead to unstable conclusions and representing only partial aspects of elevators using behavior. More effort is needed to be invested in conducting studies in other situation, such as investigations in evening peak or weekend. Also, other type of public transportation stations is worthy for further research.

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