Actual Conditions at the Metro Manila MRT-3 during the Morning Peak Period: Focus on Passengers' Viewpoint

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Abstract: This paper presents the actual conditions at the Metro Manila MRT-3 during the morning peak period from the viewpoint of passengers using various data collection methods including observation surveys and a questionnaire survey. This includes outlining operations policies, passenger behavior and passenger perceptions, and measuring passenger demand, passenger density inside the train and total passenger waiting time (i.e. station access time and platform waiting time). It was found that passengers spend a long time waiting at the roadside due to the crowd control policy and inadequate capacity. Platform waiting time at the middle stations was found to be highly variable due to skip operations policy and full regular trains. It was also found that majority of respondents perceive their waiting time at the MRT-3 to be more variable than their commute using road-based feeder modes. This research provides basis for designing appropriate countermeasures to improve MRT-3's level of service.

Keywords: Metro Manila MRT-3, congestion, passenger queuing, platform waiting time, observation surveys, passenger perception

1. INTRODUCTION

Congestion and unreliability in public transit systems is a growing problem in many megacities. This is the case in the 16.7-km long Metro Manila MRT-3 in the Philippines, an urban rail line composed of thirteen stations (refer to Figure 1. It strategically runs along EDSA, the main thoroughfare and major central business districts (CBDs)). This line has become so crowded that passengers have to queue for a long time and wait for several trains before being able to board during the morning peak period. This implies that passengers suffer productivity loss, as well as anxiety and stress from waiting for a long and uncertain period of time (Osuna, 1985). Its weekday ridership exceeded its design capacity of 350,000 passengers per day in 2005, and daily weekday ridership has steadily risen since then to around 600,000 in 2014.

This problem is multi-faceted and encompasses financial, political and institutional barriers, but it is mostly attributed to insufficient capacity with respect to passenger demand. Significant changes in infrastructure and operations to increase its capacity have not yet been implemented. Urban rail fares had also been kept constant from 2000 to 2014 amid inflation and increase of non-rail public transport fares making urban rail travel relatively cheaper, thus contributing to the increase of rail demand beyond capacity and deteriorating level of service. Even with the recently implemented fare increase in January 2015, urban rail fares are still relatively more affordable than other modes especially for longer trips.

Figure 1. Metro Manila MRT-3 Alignment and Station Names (original map by DOTC, 2012; modified by the authors)

This paper aims to establish the extent of the congestion and variability problem in Metro Manila MRT-3 mostly from the passengers' viewpoint using a variety of data collection methods. This includes identifying the operations policies in place, measuring passenger demand, passenger density inside the train and total passenger waiting time and self-reported impacts on passengers. It intends to specify the problems and their probable causes, which may aid in formulating countermeasures that may alleviate them. Some studies on this research area focus on the effect of congestion and variability from the viewpoint of the operator, using primary and knock-on train delays as indicators (e.g. Carey and Carville, 2000), but this paper focuses on the delay experienced by passengers.

For passenger waiting time, the usual textbook assumption of taking half of the headway to be the average suffices when the capacity is adequate for the demand under a perfectly regular service as all passengers can always board he first vehicle. However, in congested and variable lines such as the MRT-3, passenger waiting time increases as the discrepancy between capacity and demand increases, thus it is imperative to include the probability of being refused service by the first vehicle. This has been the focus of several studies such as Lam *et al*. (1999a), Shimamoto *et al*. (2005) and Mijares *et al*. (2013).

Due to the extreme conditions at the MRT-3, the conventional definition of waiting time does not hold. We then define a term called "total waiting time" as the sum of two components: (1) station access time, and (2) platform waiting time. Station access time refers to the time spent queuing into the station from the time of arrival at the end of the queue to the time of arrival at the station turnstiles. Platform waiting time denotes the time spent waiting at the platform, from entry into the station turnstiles up to the time of boarding into the train.

Moreover, we would like to determine how the passengers perceive their commute in terms of commuting experience (crowding, predictability, variability, length of commute and service quality) and their effects (frequency of tardiness, commuting stress and satisfaction). This is important because passengers are the ultimate users of the system and their evaluation should be taken into consideration.

The paper is structured as follows: Section 1 gives a brief introduction on the background and objectives and presents some previous studies; Section 2 describes the data collection methods; Section 3 presents the results of the surveys; and finally, Section 4 summarizes and concludes the paper.

2. DATA COLLECTION

2.1 Platform Waiting Time Survey

A series of video observation surveys was conducted on five regular weekdays in 2013 (July 10, and September 16, 19, 24 and 26) during the morning peak period from 6:30am to 9:30am in the peak direction (southbound) at the most critical stations (first five stations as revealed by preliminary inspection) in order to determine the platform waiting time and determine the causes of the phenomenon. The surveys were done by recording the live streaming CCTV website operated by DOTC MRT-3 (2013). Each station has four CCTV cameras focusing on the platforms and ticketing areas for both northbound and southbound directions, but the surveys only focused on the southbound platforms. To obtain the platform waiting time according to arrival time, a passenger was tracked for every one-minute interval of arrival time until he or she is able to board the train. There are some limitations to this method due to the locations of the cameras, low video quality and the slow video buffering of the website. Nevertheless, we were able to obtain data that is accurate up to one minute. Headways and dwell times for the entire duration were also recorded.

2.2 Field and Video Observation Surveys

Field and video observation surveys were done in coordination with University of the Philippines National Center for Transportation Studies (UP NCTS) on October 1, 2014 (Wednesday; regular weekday) from 5:30am to 9:00am at the North Avenue and Cubao Stations. These consisted of total waiting time survey, passenger queuing, boarding and waiting behavior survey, and train operations survey.

2.2.1 Total Waiting Time Survey

A survey was conducted to determine the extent of total waiting time, which is the time spent waiting from the end of the queue into the station up to getting on the train. A surveyor was deployed as an MRT-3 passenger for every 15-minute interval from 6:45am to 7:30am at North Avenue Station and at 8:00am at Cubao Station, and he or she recorded the time spent completing every stage of queuing (e.g. arrival at the end of the queue, security check, ticket purchase, etc.). Surveyors were also equipped with a GPS tracker to track their exact location and how it changes over time.

2.2.2 Train Operations and Passenger Behavior Surveys

This survey aimed to summarize the policies implemented by MRT-3, identify the bottlenecks and record the train arrival and departure times through video recording and field observation. This includes listing the train arrival and departure times at the station, the number of boarding and alighting passengers, and number of refused passengers on the platform.

Passenger behavior while queuing, boarding and alighting, and inside the train was also noted.

2.3 Questionnaire Survey

A questionnaire survey was conducted in September 2014 in cooperation with UP NCTS to determine regular morning peak period MRT-3 passengers' travel information, perceptions and attitudes regarding their commute, and socio-economic characteristics. A total of 211 respondents answered the questionnaire which was mainly done online by spreading the survey link through news forums, social networking sites, online groups and e-mail blasts and also face-to-face survey for older passengers. The sample size was set to attain at least 5 respondents per indicator. An optional reward of PhP100 was provided in the form of cellphone pre-paid load.

2.4. Secondary Data

Secondary data was obtained from DOTC MRT-3 and its website, and surveys done for an undergraduate thesis (Ebia and Ramirez, 2014) at the UP NCTS.

3. ACTUAL CONDITIONS AT THE MRT-3

3.1 Policies in Place

As its ridership continues to grow alongside Metro Manila's population, the system becomes more and more overburdened. To address this, DOTC MRT-3 implements several policies that offer technical solutions given the system's limitations on its infrastructure.

3.1.1 Crowd Control Policy

As part of their crowd control scheme, the MRT-3 operator has been implementing the "stop entry" policy since December 2013, in which the number of passengers on the platform is limited to 500 passengers at a time. Security guards are deployed at certain entry points to control the entry of passengers, as seen in Figure 2.

Figure 2. Crowd control policy implementation at two entry points (left: main entrance; right: entrance from northbound platform

This policy aims to improve safety and passenger flow at the platform and into the train, and allows more passengers to board at subsequent stations. However, this has caused queues to extend onto the roadside especially at the northernmost terminal (North Ave. Station), as well as subsequent complaints from passengers. It was observed that there is inadequate space for queuing – stairs, northbound platform, pedestrian walkways and overpasses, and sidewalks – were used for queuing. This could be problematic from the viewpoint of safety prolonged standing load on stairs (which are generally designed for moving loads) and roadside queuing which forces passengers to occupy the sidewalks alongside vehicular traffic, which could cause prolonged exposure to air pollution and accidents.

Before this policy was implemented, the ticketing areas and station platforms were visibly more crowded (see Figure 3). After its implementation, platform crowding was reduced but this implied longer queuing at the roadside and stairways.

Figure 3. Comparison of platform queuing before and after crowd control policy implementation (left: September 2013; right: February 2015)

Given that crush capacity of an MRT-3 train is at around 1,200 passengers, this means that the trains would be full by the time it arrives at the third station. As there are very few (if any) alighting passengers at the first five stations, the trains are packed full until then, and many passengers at the third to fifth station have to wait longer at the platform.

In addition, tickets can only be used within 99 minutes from entry from boarding station turnstile to prevent passengers from overstaying in the station; otherwise, a penalty would have to be paid. However, there is a possibility that passengers' tickets expire due to the excessive platform waiting time.

3.1.2 Skipping Train Operations Policy

There are two kinds of trains that are dispatched from the terminal stations: regular trains and skipping trains. Regular trains stop at all stations, while skipping trains, as the name implies, skip the first two or three stations and starts loading passengers at the subsequent station. This demand-responsive policy intends to alleviate passenger queuing at downstream stations, but prolongs queuing for passengers at the skipped stations. There is no fixed daily schedule for the deployment of a "skipping train" because it is dependent on the conditions for the period in question. The MRT-3 management closely monitors the situation and dispatches a skipping train to congested stations as needed. Based on the surveys conducted in July and September 2013 and October 2014, "skipping trains" are deployed at different times of the day and roughly around every 30 minutes during the morning peak period ends, possibly depending on factors such as passenger demand at each station and availability of train sets. In a previous study, skipping train operations policy was found to increase equity of passenger overload delay by reducing the delay of overburdened passengers and increasing the delay of others, but reduces efficiency by increasing total passenger overload delay across the system (Mijares et al., 2013).

3.1.3 Train Speed and Headway Policy

The number of operating trains were increased from 18 to 20 trains in June 2014 to serve 2,364 more riders per hour. However, in August 2014, the train speed was decreased from 60kph to 40kph to address safety concerns that arose after an overshooting accident in the same month (Philippine Star, 2014). As a consequence, the published peak period headway was increased from 3 minutes to 4 minutes (DOTC-MRT3, 2014) and queues were reported to be longer especially at the northernmost terminal station. Dwell time was also published to be at around 20 to 30 seconds.

However, the observation surveys as well as secondary data (refer to Table 1) reveal that the actual headway and dwell times are significantly higher than the published values, which indicates lack of schedule adherence.

Table 1. Headway and dwell time during the morning peak period in the southbound direction

Variable	Average (*standard deviation*) in minutes		
	February 2014 (Ebia and Ramirez, 2014)	July and September 2013 (5 regular weekdays)	October 1, 2014
Headway	4.7 (*0.60*)	4.83 (*1.08*)	7.54 (*1.38*)
Dwell time at Cubao station	-no data-	0.87 *(0.35)*	2.00 (*1.27*)

3.1.4 Experimental Policies

With its existing infrastructure inadequate in servicing passengers, the MRT-3 management has begun looking into an alternative mode, the bus. While there are public utility buses running parallel to the MRT-3 alignment, they are generally more costly and less reliable so many commuters still prefer to use MRT-3. In March 2013, the MRT-3 management introduced an experimental bus system but was immediately stopped because of lack of coordination. This scheme was tried again in May 2014 with the use of an articulated bus that ran from North Avenue, made three stops along MRT-3, and continued to the Ninoy Aquino International Airport. Since road congestion is severe in Metro Manila, these schemes were not successful in funneling some of the MRT-3 demand onto the express buses. It illustrates that even with equal fare levels and long queuing time, passengers prefer riding the MRT-3 over buses because the overall travel time is still lower. Nonetheless, another pilot study of a new express bus scheme is scheduled to be implemented in March 2015, with trips originating from Fairview, Quezon City and ending at Ayala Avenue Station in Makati.

Moreover, it also tested an experimental policy called express train scheme in May 2014 as a prospective solution to improve passenger congestion and travel time. In this scheme, an express train run starts at the first station (North Avenue), serves the next station (alternating between Quezon Avenue, Kamuning and Cubao Stations), and then continues on to major destination stations (Buendia, Ayala, Magallanes and Taft). Less stops translate to lower dwell time and thus shorter in-vehicle travel time. A total of 15 express trains ran within the 7:00-9:00am period were deployed (later moved to 6:30-8:00am) and also during the afternoon peak period (5:00-7:00pm), and regular trains were dispatched in between express train runs. However, the scheme was cancelled after an experimental run of three weeks despite positive feedback (Rappler, 2014) and replaced again by the skipping train operations scheme discussed in Section 3.1.2.

3.2 Passenger Demand

Official ridership reports and observation surveys reveal that North Avenue (first station) has the highest demand in the morning peak period, with everyone heading southbound, and with most people getting off at the last three stations. Thus, focus is given to the southbound direction as it is the peak direction, although it is important to note that the northbound direction also experiences problems that are similar but not as severe.

Figure 4 shows the estimated passenger entries toward the southbound direction, with error bars indicating one standard deviation. It is based on official MRT-3 hourly ridership data for 22 regular weekdays in June 2013. The portion of passengers headed to the southbound direction was calculated based on O-D patterns derived from a previous study using stated preference survey data and gravity modeling (Mijares et al., 2013) and were calibrated using a previous MRT-3 boarding-alighting survey by Ebia and Ramirez (2014).

It should be noted that the official hourly ridership data only records entries at the station turnstiles (i.e. ticket gates) and does not account for roadside arrivals. As such, there is a time difference equivalent to the station access time between a passenger's actual arrival at the end of the station queue and his official arrival at the station. This implies that the official ridership data underestimates the real-time demand. Moreover, this can be thought of as the maximum capacity of MRT-3 under hyper-crowded conditions and given its constraints on supply (brought about by vehicle capacity, headway, policies, etc.).

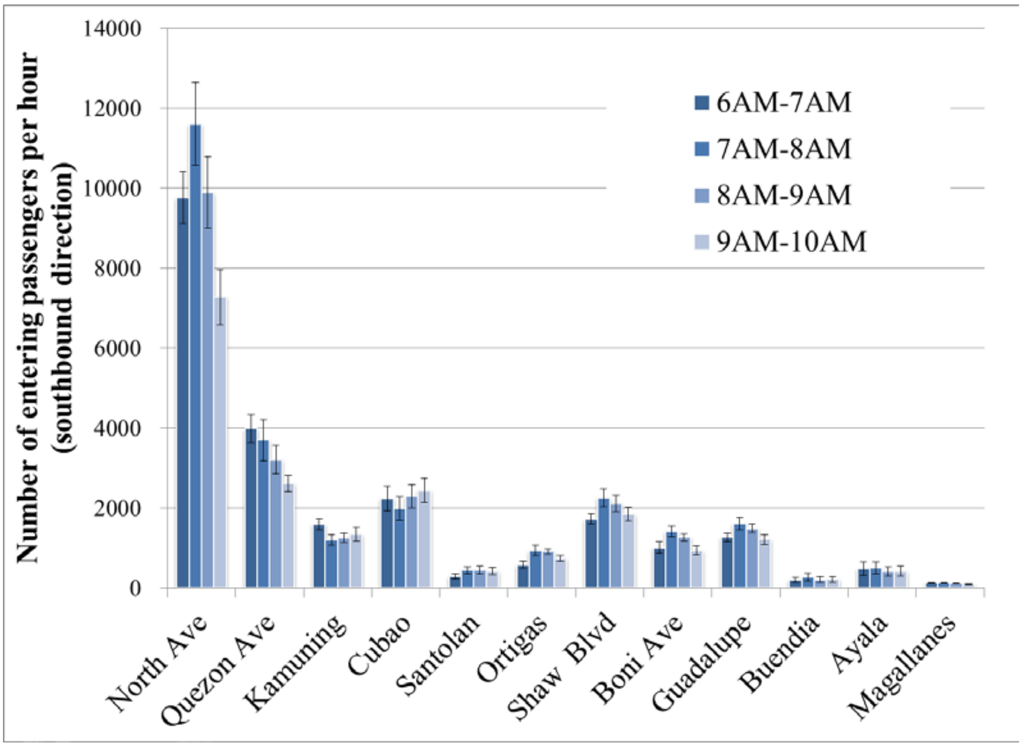

Figure 4. Estimated mean and standard deviation of station hourly passenger demand in 2013 (entries at the turnstiles headed to the southbound direction)

Figure 5 shows the boarding and alighting patterns on a regular (i.e. non-skipping) train during the morning peak period, while Figure 6 illustrates the passenger density inside one regular train car, which has a crush capacity of 394 passengers. Both figures are also based on the said survey by Ebia and Ramirez (2014). It can be noted from the Figure 4 that the first four stations have significant passenger demand, but there are significantly less boarding passengers in the third and fourth stations as seen in Figures 5 and 6. One contributor to this problem is that there are only a few alighting passengers at this station, which leads to heavy congestion inside the train. The regular trains are full of passengers until it reaches the first major destination station (6th station), where alighting passengers are replaced by new boarding passengers. It stays full until it reaches Ayala Station (9th station), which serve as a gateway to two major CBDs.

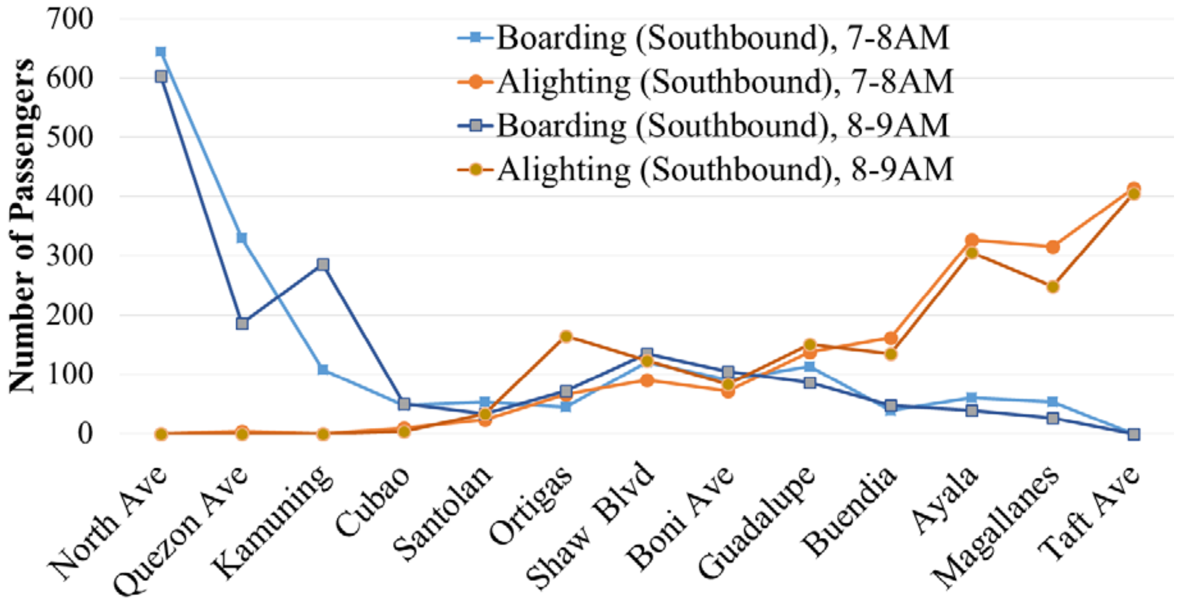

Figure 5. Boarding and Alighting Patterns of Southbound Passengers on a Regular Train from 7-9AM (based on Ebia and Ramirez, 2014)

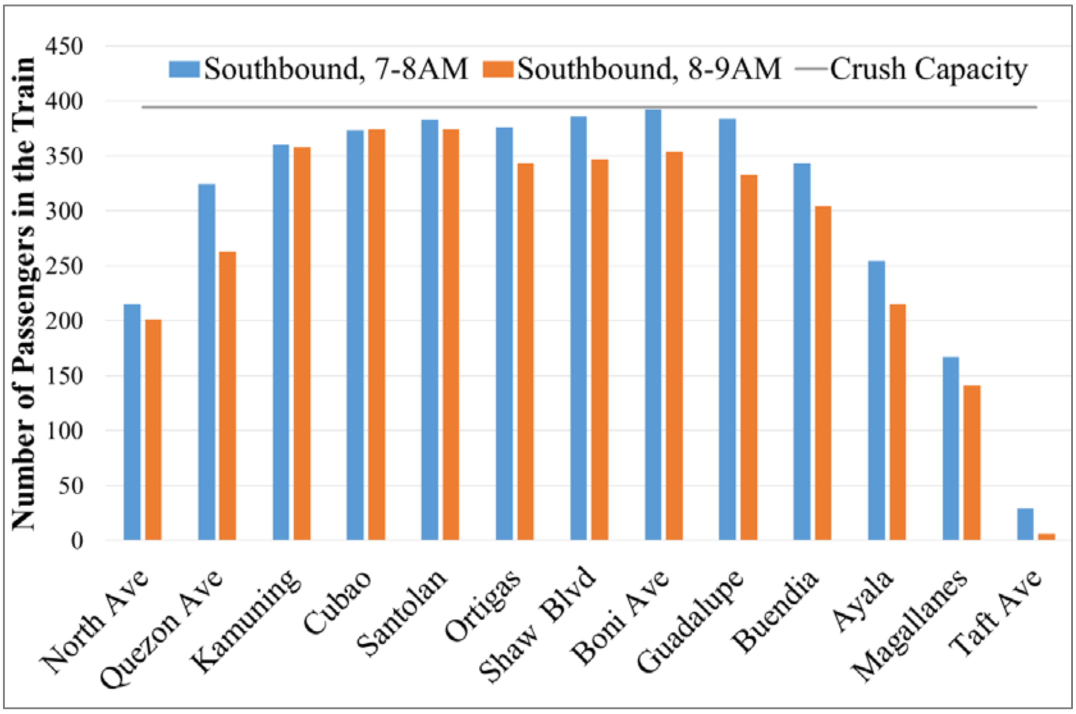

Figure 6. Passenger density in one train car (based on Ebia and Ramirez, 2014)

Figure 7 shows that the percentage of passengers arriving from 6 to 7AM has increased in 2013, based on a comparison of official MRT-3 hourly ridership data during the morning peak period between 2005 and 2013. Chi-square test was performed, and it was found that there is a statistically significant difference between 2005 and 2013 morning peak period station arrivals, implying that the morning peak period has spread earlier in all stations. This suggests that commutes are getting longer and more unpredictable, so more people are including a larger travel time allowance to ensure punctual arrival at the workplace.

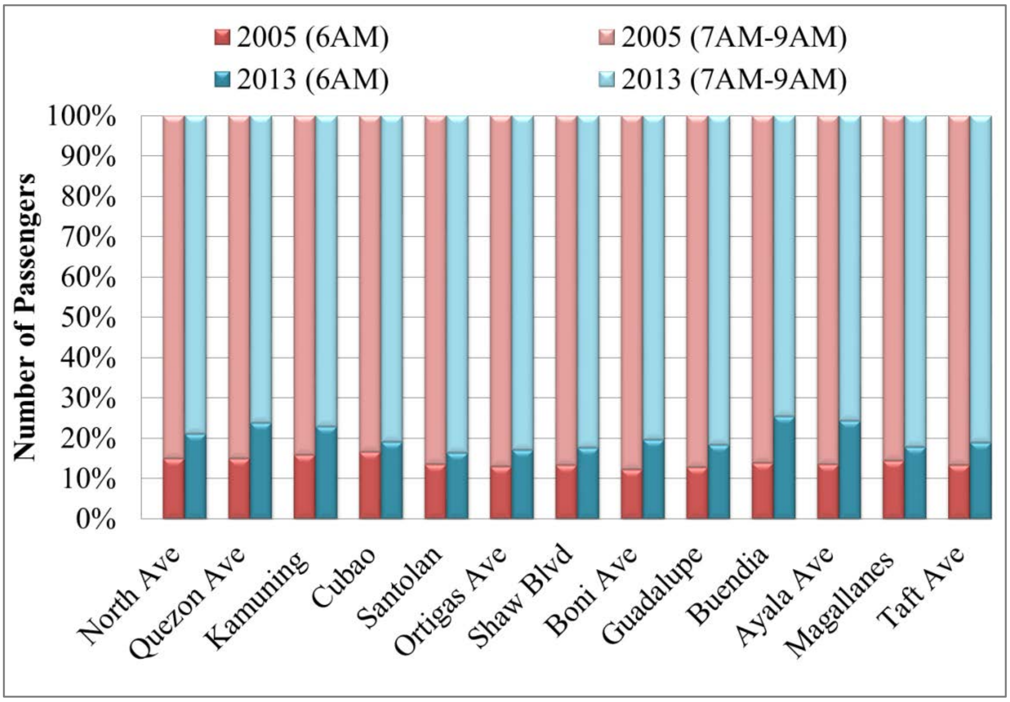

Figure 7. Comparison of Morning Peak Period Arrivals in 2005 and 2013

3.3 Queuing into the Station

Queuing outside the station was observed at both North Avenue and Cubao Stations, with the former having longer queues that extend up to the roadside. The length of roadside queues were deduced through site inspection and video recording surveys. It was found that there are a total of six queues merging into the station turnstiles, of which four queues are from the southbound direction of EDSA and two queues from the northbound direction of EDSA, as shown in Figure 8. The northbound queues fall in line in a covered walkway and need to cross a pedestrian bridge to access the station. On the other hand, the southbound queues are mainly exposed to heat or rain, with only a few large parasols spaced several meters apart to protect them. This also serves as a loading and unloading area for public utility buses and FXs, but because the sidewalk space is already being used by the passenger queues, vehicles were observed to unload passengers on the road itself.

Figure 8. Queuing extends up to around 500 m away from North Ave. Station, with people queuing at the roadside (northbound and southbound EDSA) and at the pedestrian overpass

Moreover, there is another queue that goes from the northbound platform to a pedestrian walkway leading directly to the southbound platform (meaning that they skip the southbound turnstiles and do not need to pay for another ticket) to make a "round trip". These passengers originate from downstream stations heading in the opposite direction. As it is less probable to get a seat at those stations, some passengers take the northbound train to North Avenue station, and then transfer to the southbound train; however, it is unclear whether all passengers on this queue are "round trip" passengers. At Cubao Station, queues also reached up to the roadside but only up to around 100 m at most. There are separate queues for men and women, probably to even out the distribution of the passengers on the platform because the first out of three cars can be used by women, while the other cars can be used by both men and women.

Figure 9 summarizes the total waiting time survey results (refer to Section 2.2.1 for the methodology) for North Avenue and Cubao Stations. Due to some limitations, only one surveyor was deployed for Cubao Station. Nevertheless, it is clear from the figures that a very long time is spent by passengers waiting from the roadside to the second level, with that waiting time component taking up the most time. GPS data shows that queues stop moving from time to time, which could be attributed to batch servicing (i.e. non-continuous) at the station entry points where they control passenger entries. As a result, passengers spend a disproportionate amount of time standing still at the sidewalks and staircases. Passengers are exposed to exhaust fumes as well as heat or rain, which may lead to exhaustion or more serious health impacts.

In addition, the queue length and total waiting time fluctuate during the period considered, depending on random factors such as passenger arrivals, train occupancy, and operator-side factors such as regular train and skipping train dispatch. On the other hand, there seems to be no problem with purchasing single journey tickets at both stations, probably because many regular passengers possess a stored value ticket and do not need to purchase one every time. Platform waiting time is also low for North Avenue Station because of empty regular trains. Meanwhile in Cubao Station, the surveyor was lucky that he arrived just in time for the skip train so he did not have to wait at the platform for a long time. However, it can be seen in the next subsection (Section 3.4) that platform waiting time at that station varies considerably. This means that his total waiting time would have increased had he arrived at a different time.

Figure 10 presents the cumulative roadside arrival and platform departure curves, which was estimated based on the queue lengths and assumed passenger density at the queue (based on the video survey: 4 passengers for every 3 m of queue length with a total of six queues) and calibrated using the total waiting time survey data presented in Figure 9. Calibration was performed using the fact that the k^{th} passenger who arrives at time t_h (x-axis) will board the train at a time specified the inverse function $D^{-1}(\mathrm{k})$, and the waiting time for a passenger that arrives at t_h is equal to $D^{-1}(A(t_\mathrm{h}))-t_\mathrm{h}$, where *D* represents departure and *A* represents arrival.

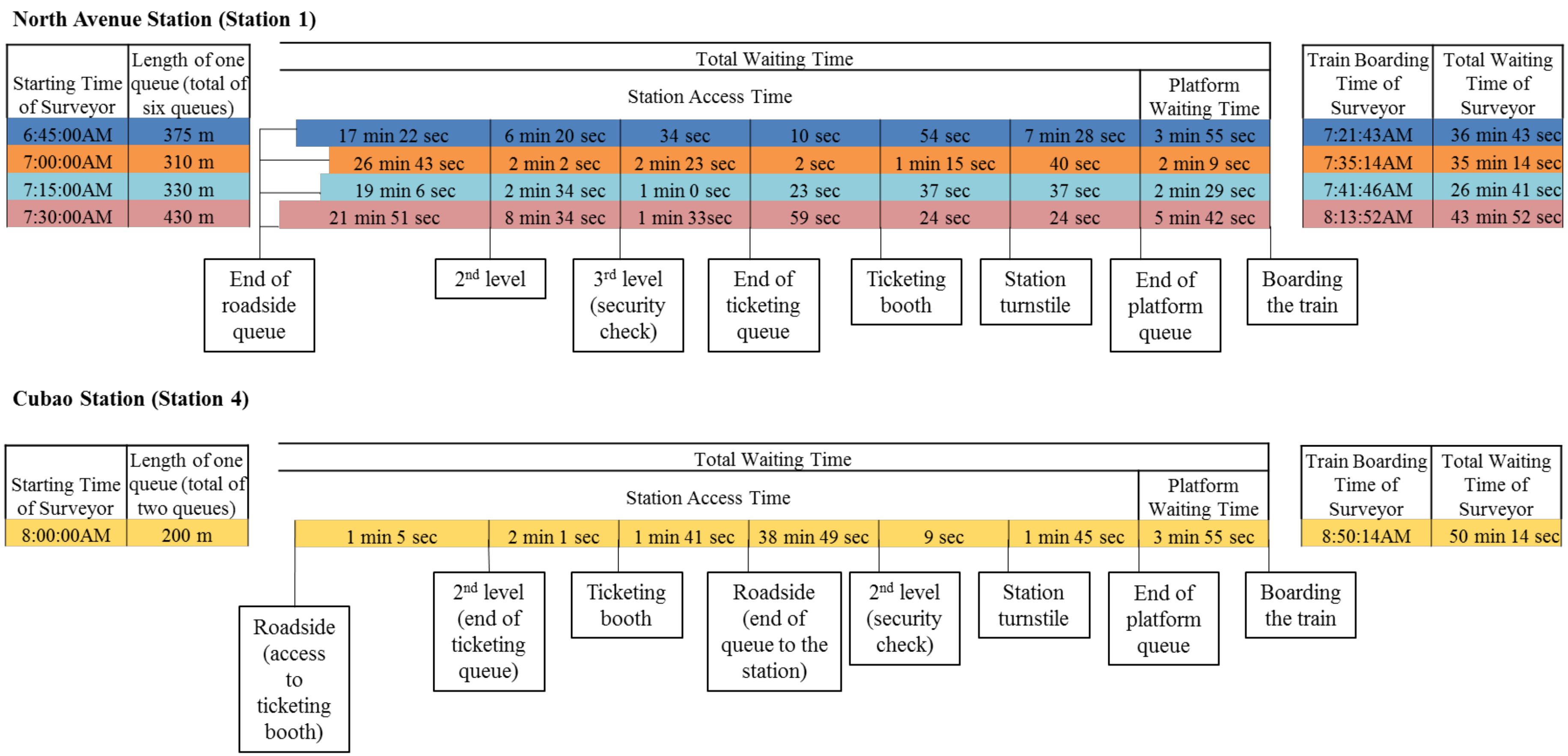

Figure 9. Total Waiting Time Survey Results at North Avenue and Cubao Stations (stages of queuing and corresponding time spent at each stage)

It shows that almost 12,000 passengers arrived at the roadside during the 90-minute interval, but only around 8,500 passengers are served, meaning that there is an average queue length of 3,500 passengers.

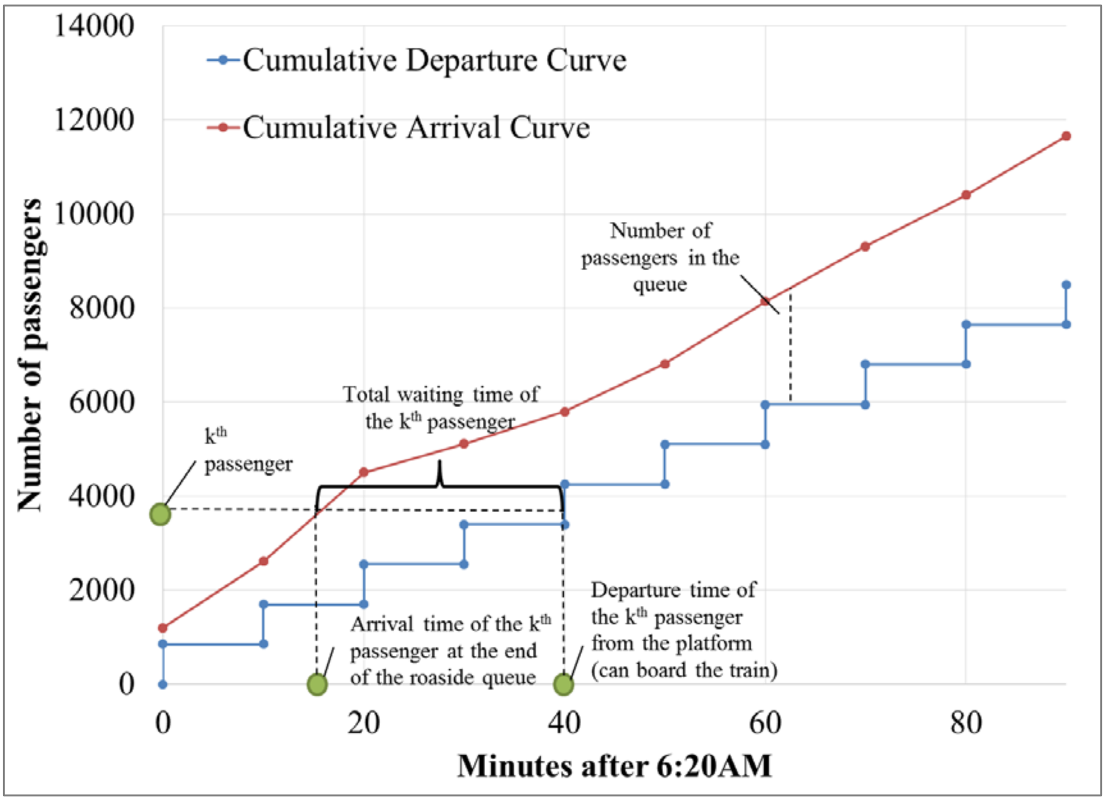

Figure 10. Estimated Cumulative Roadside Arrival and Platform Departure Curves at North Avenue Station

3.4 Platform Waiting Time and Its Variability

3.4.1 Survey Results in July and September 2013

The results of the video observation survey indicate that some stations experience highly variable and long platform queuing times and many missed trains. For the first two stations, platform waiting time and its variability were not as severe. Since the platform waiting time survey was conducted before the crowd control policy was put in place, it was observed that platform waiting time and crowding is excessively high for passengers boarding at Kamuning and Cubao Stations (3rd and 4th stations) as well as Santolan-Annapolis Station (5th station).

Figures 11 and 12 show the day-to-day variability of platform waiting time depending on the passenger arrival time (x-axis) for Kamuning and Cubao Stations. It can be seen that platform waiting time starts to increase for passengers arriving beyond 6:45am as more passengers arrive and trains become full by the time they reach those stations. It can be noted from Figure 11 that skipping train empties the platform at the Kamuning Station (3rd station). For example, the skipping train at 7:50 am on September 19 served passengers that arrived from 7:00am to 7:50 am, as denoted by the light blue dots. However, the same skipping train has a minimal effect on Cubao Station (4th station) because it is already full. Platform waiting time is seen to be highly variable as indicated by the standard deviation. This translates into many missed trains, which could make passengers weary and anxious.

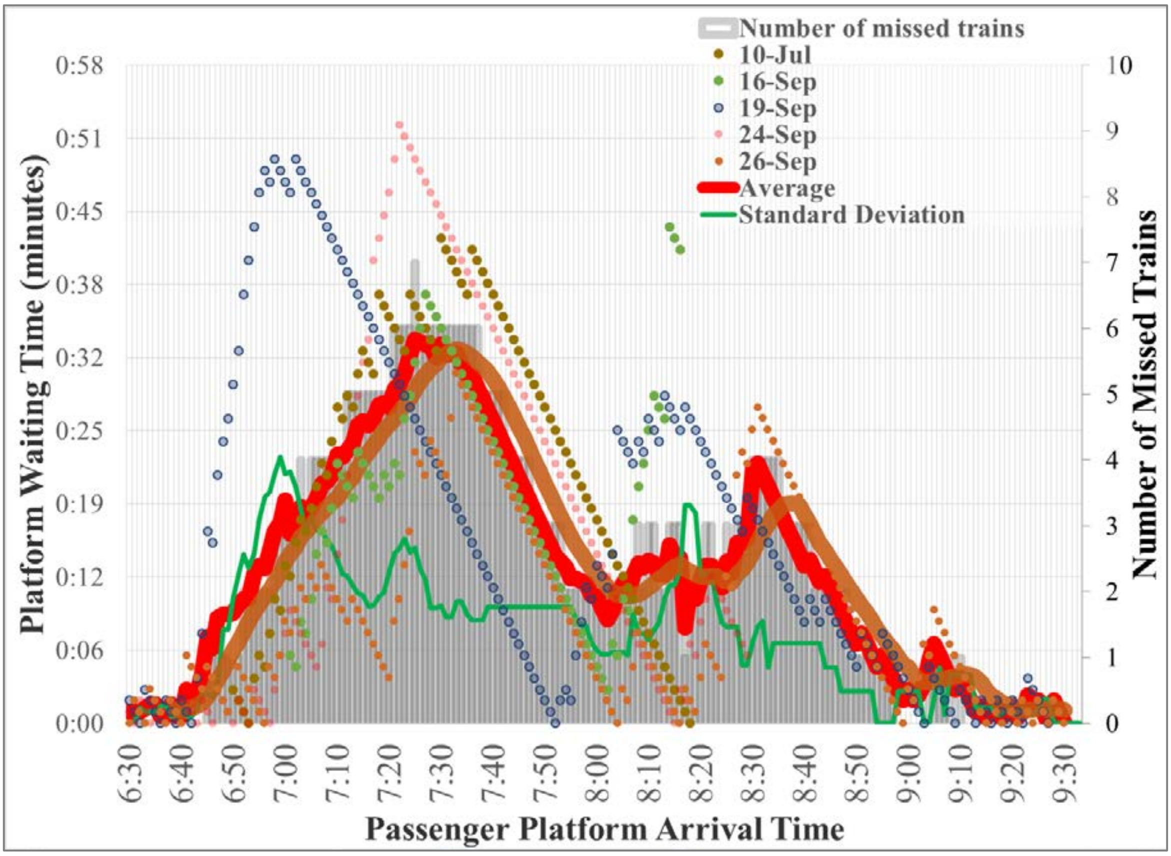

Figure 11. Platform Waiting Time at Kamuning Station in 2013 (3rd station; southbound)

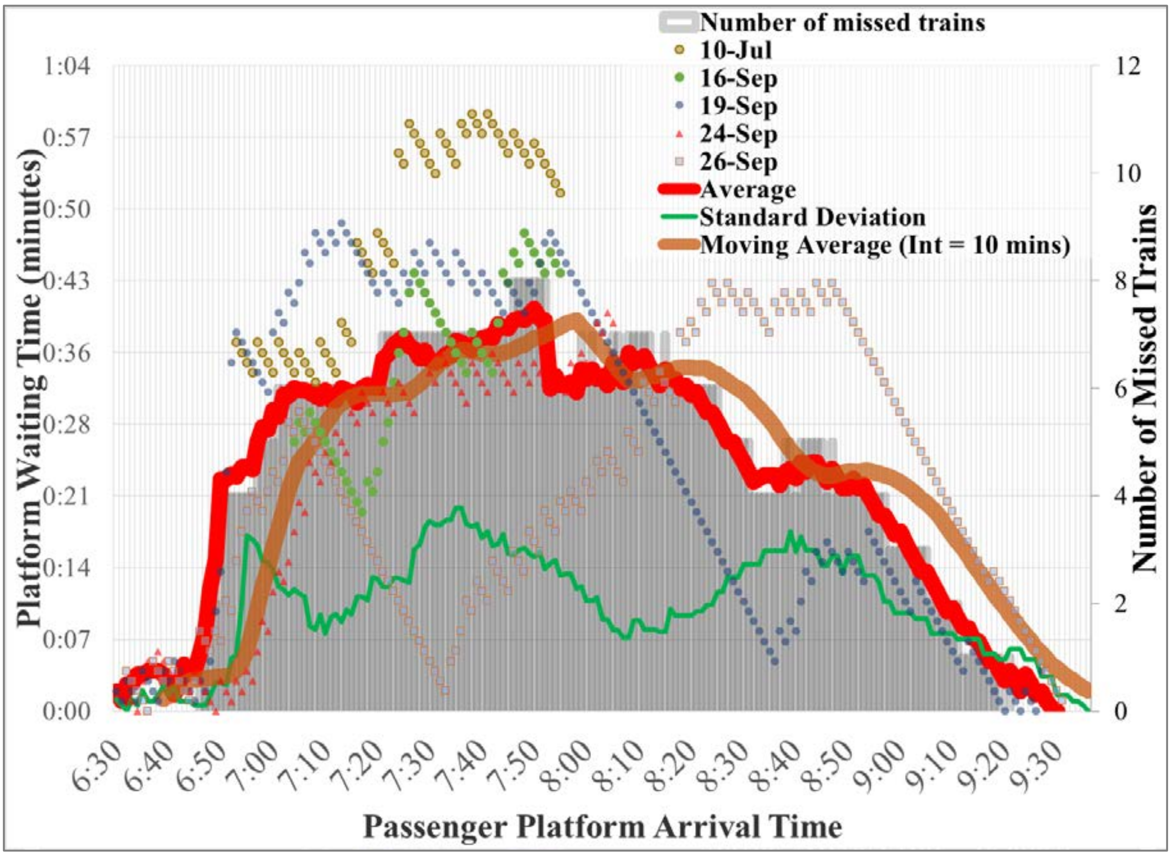

Figure 12. Platform Waiting Time at Cubao Station in 2013 (4th station; southbound)

The platform waiting times experienced by some passengers are very high considering that under a perfectly regular headway with adequate capacity, the average platform waiting time should just be equal to half the headway (around 2 minutes). In this sense, these passengers experience a passenger overload delay equal to the difference between actual platform waiting time and uncongested platform waiting time.

3.4.2 Survey Results in October 2014

Figure 13 shows the severity of the platform waiting time at Cubao Station as confirmed by the October 1, 2014 (8AM to 9AM) survey. It implies that the platform waiting time can range from zero (if one arrives at the platform exactly when the skipping train arrives) to as high as an hour, on top of the station access time. It shows that around 1,800 passengers arrived at the platform during the survey period, but only 1,300 passengers were served. Even though a train arrives every five to seven minutes, only a few passengers (around 1 to 3 people per train door; total of 15 doors) can board because the trains are full and there are almost no passengers alighting at this station, and around 30 people are left on the platform queue per door (refused passengers).

Only one skipping train arrived during the hour considered. It can be seen from Figure 13 that queuing at the platform dissipates after a skipping train arrives (7th train), however, queuing remains outside the station turnstiles. The trains that arrive after the skipping train are full and again, barely any passengers can board. In addition to the access time into the station (roadside queuing, buying tickets, etc.), passengers would have to wait for an invariable time (ranging from zero if there is no platform queue to up to almost an hour).

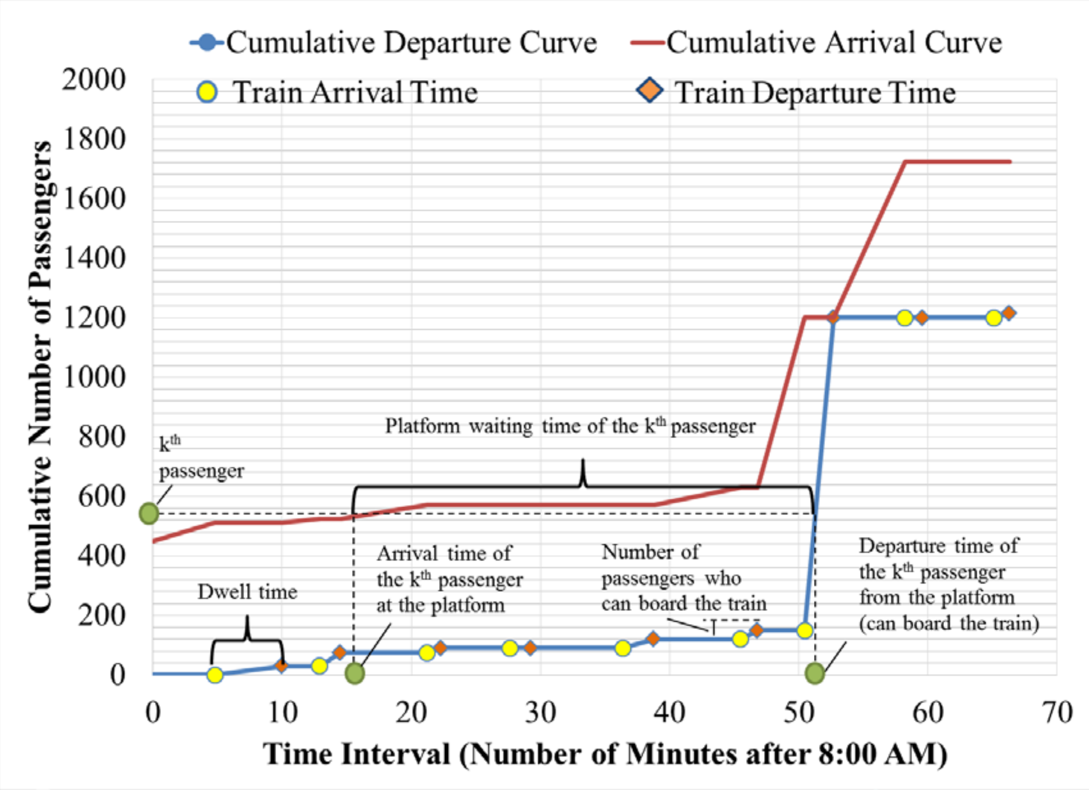

Figure 13. Cumulative Platform Arrival and Departure Curves at Cubao Station in 2014

Based on a sample of 115 passengers arriving during the survey period, it was estimated that the average platform waiting time at Cubao Station is 19.92 minutes with a standard deviation of 17.67 minutes. 38 people had zero platform waiting time because they were allowed to enter the platform just in time for the skipping train, but there were 15 passengers who had to wait for 45 to 55 minutes at the platform. This illustrates the wide variability among passengers on the same day, which was also observed in the platform waiting time surveys in 2013 (refer to Figure 11, 12 and 13).

3.4.3 Boarding and Waiting Behavior

First In, First Out (FIFO) queuing is observed during queuing at the roadside and platform, except for priority passengers such as persons with disabilities, elderly, children and pregnant women. However, it was observed that once the train arrives, some passengers push their way to the front by shoving others. At Cubao Station, it was noticed that it was very difficult for alighting passengers to get off the train because passengers by the door block the exit and do not give way to let them out, possibly because those passengers may not be able to board back in or they might also assume that no one is getting off at that station. This is unlike the case in Tokyo where passengers by the door usually get off to let alighting passengers out more easily.

It is also interesting to note that passengers behave differently when choosing to board the arriving train or not. Passengers at the northern terminal station, North Avenue Station, are guaranteed an empty train every headway interval (except for skipping trains). As such, it was observed that not all passengers board the first train to arrive even if there is still space and instead choose to wait for the next train in order to get a seat. It is also one of the main reasons why there are "round-trip" passengers who choose to go to North Ave. station. Comfort is more important for this type of passengers, as they are willing to trade off additional waiting or in-vehicle travel time for a secured seat. This was observed for around 20 minutes, and it was deduced that around 5 to 10% of passengers choose to wait for the next train, which implies that there are remaining passengers at the platform and that less than 500 people would be allowed to get on the platform from the roadside queue, making the other passengers' station access time longer.

In contrast, passengers in the middle station, Cubao Station, force themselves into the train even if there is no more space by the train door, and passengers inside the train are observed to resist being pushed into the train to avoid even more cramped conditions. In this case, the choice of whether to board the oncoming train or choose to wait for the next train does not exist because it is physically (humanly) impossible to board the train. It is observed that passengers in the middle of the train do not move even if there seems to be space inside, with many passengers staying near the door presumably to allow themselves to alight more easily and avoid being cramped in the middle. This situation is similar to the observations made by Evans and Wener (2007), who found that there are physiological effects associated with crowding and personal space invasion. This observation indicates that there could be unused space that could be utilized more efficiently, and has implications on train seating designs.

3.5 Passenger Profile and Perceptions

This sub-section presents some results of the questionnaire survey described in Section 2.3. The questionnaire especially focuses on regular morning peak period passengers who have been using MRT-3 for their daily morning commute for at least six months. Data screening was performed to eliminate unengaged respondents and outliers, and subsequently reduce the number of respondents to 211.

Among the 211 respondents, 119 (56.4%) are females, 84 (39.8%) earn below P20,000 a month and 130 (61.6%) are below 30 years old. 55 (26.1% of respondents) have been using the MRT-3 for their everyday morning commute for more than 5 years, while 48 (22.7% of respondents) have used it for less than two years.

Table 2 summarizes the commute characteristics of the respondents, with focus on the travel time components during their commute. It can be seen that passengers spend as little as five minutes to as large as 60 minutes, and in-vehicle travel time for an average distance of 7.03 stations (approximately 9.8 km) is approximately as long as waiting time at the station.

Table 2. MRT-3 commute characteristics of the respondents

Variable	Minimum	Maximum	Mean	Standard Deviation
Total waiting time at the MRT-3	5 minutes	60 minutes	29.99 minutes	15.16 minutes
Feeder access time (home to boarding station)	3 minutes	180 minutes	41.35 minutes	26.68 minutes
In-vehicle travel time at the MRT-3	4.5 minutes	40 minutes	28.11 minutes	10.92 minutes
Total trip time (home to workplace)	30 minutes	240 minutes	118.44 minutes	41.32 minutes
Number of stations traveled	1 station	12 stations	7.03 stations	2.73 stations

Only 17% of respondents can usually ride on the first arriving train, while 15% of respondents need to wait for four or more trains before being able to ride, as seen in Figure 14. Moreover, it was found that more than 60% of the respondents have been late to work for at least four times due to their MRT-3 commute, with 31% being late for more than 10 times, as illustrated in Figure 15. Given that 71% of respondents incur a monetary penalty for late arrival, this translates to lost salary as well as non-monetary penalties for late arrival such as poor reputation and lower productivity.

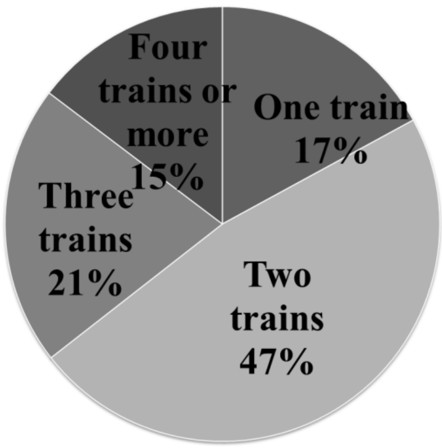

Figure 14. Average number of trains waited at the platform for before being able to board

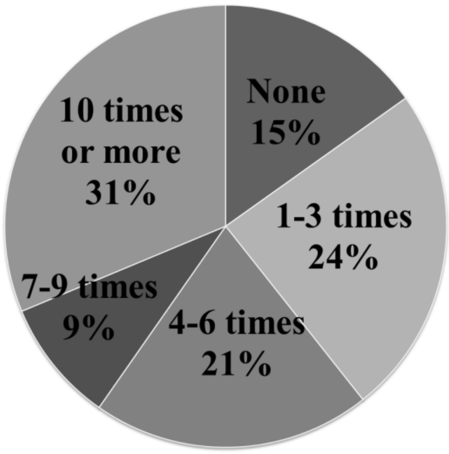

Figure 15. Frequency of tardiness in the past month due to MRT-3 commute

The questionnaire survey results also reveal that many passengers have already adapted physically by changing their travel behavior in one or more ways due to the severity of their morning commute – 90% have switched to an earlier departure time, 19% have changed their boarding station to a less crowded one, 19% have moved to another residence and 5% have moved to another workplace.

Figure 16 shows that feeder access time, which is affected by road congestion conditions and number of transfers, is perceived as less variable than total waiting time, indicating that the latter is more unpredictable and could thus lead to higher anxiety and loss productivity.

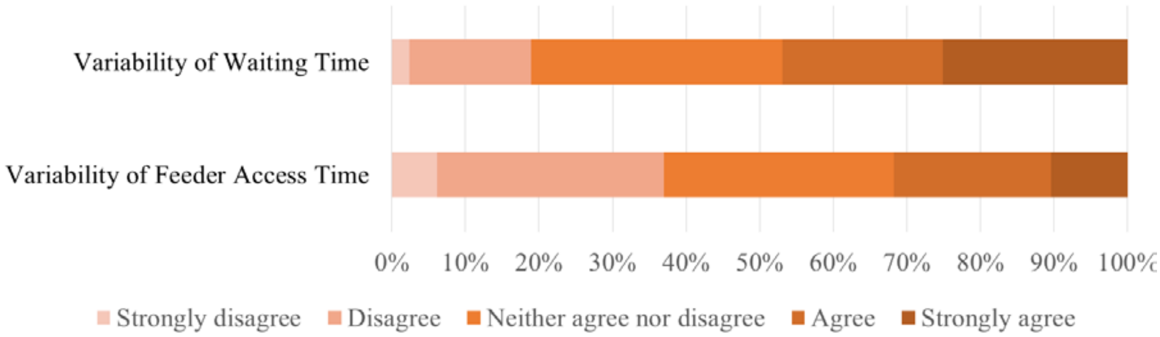

Figure 16. Perceived Variability of Feeder Access Time and Total Waiting Time

The questionnaires also asked about passenger perception about their commute using a 7-point Likert Scale. Figure 17 shows their perceptions about crowding, length of commute, predictability, commuting stress, service quality and satisfaction. It was found that majority of respondents find their commute long and crowded. The responses to the predictability indicators were mixed, indicating that several passengers may be used to this everyday situation and know what to expect. Most respondents are also mentally and physically exhausted due to their commute, and dissatisfied with the poor service quality of MRT-3.

4. SUMMARY AND CONCLUSIONS

This study presents a comprehensive overview of the congestion and waiting time variability problems in MRT-3. It establishes the actual conditions at the Metro Manila MRT-3 with focus on the experience and viewpoint of passengers, and presents the severity of congestion and unreliability problem at the MRT-3 and the effects on the passengers in terms of total waiting time, platform waiting time and subsequent impacts such as frequency of tardiness at the workplace. Defining and understanding the problem at the MRT-3 is an important first step in coming up with ways to improve the situation.

We have outlined the policies implemented at the urban rail line that aim to optimize train operations as well as regularity of headway and the corresponding implications. Even with these policies in place, congestion, variability and waiting time is still high because the demand greatly exceeds capacity. This gives a strong support to the argument that the problem would not be alleviated further unless an increase in capacity or drastic reduction of peak ridership occurs. In a previous study by the authors (Mijares et al, 2014), it was shown that the planned capacity increase by the government through additional train sets and lower headway would greatly reduce platform waiting time as long as the ridership increase does not exceed by 45% and the headway is perfectly regular. However, this was not evaluated for its effect on total waiting time. It would also be interesting to look into the effect of the recent fare increase in January 2015 on the ridership and operations at the Metro Manila MRT-3.

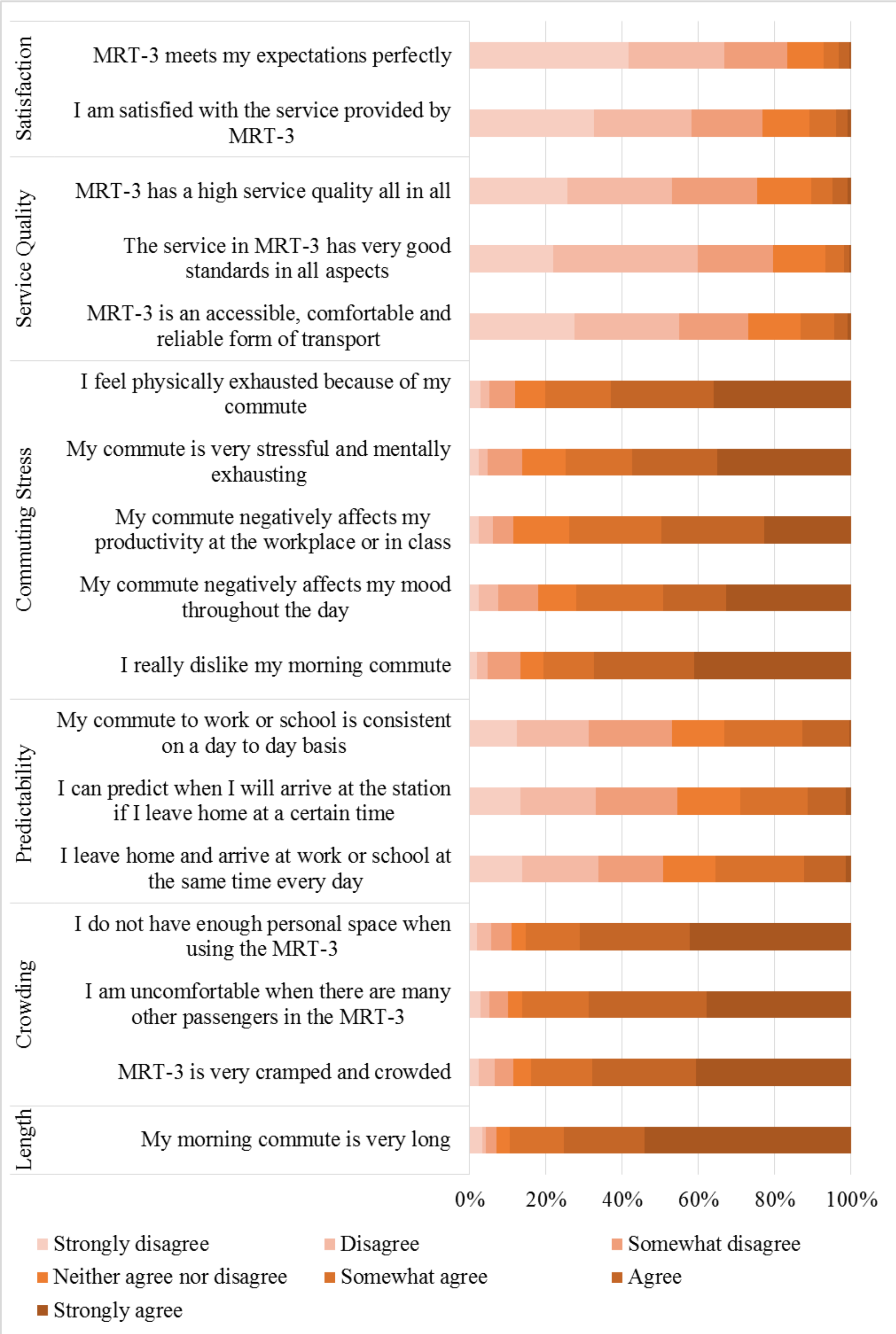

Figure 17. Perception on Crowding, Length of Commute, Predictability, Commuting Stress, Service Quality and Satisfaction

Another reason for the congestion and variability is the travel patterns of commuters. For instance, changing the O-D patterns by increasing short-distance trips especially within the first five stations would provide additional space for commuters. This can be done by changing land use patterns, for example, by building a major CBD at the north. Moreover, off-peak travel should be encouraged, which could be accomplished through peak period pricing or flextime working policies. The installation of a fully segregated BRT along EDSA could be a more affordable alternative to expanding the capacity of MRT-3. Upgrading of MRT-3 infrastructure and signaling systems should also be done to avoid accidents as well as to increase the running speed of MRT-3, allowing for lower headway.

Long waiting times and severe congestion are unacceptable from the viewpoint of safety and welfare of passengers and the rest of society, so it is imperative to provide adequate solutions. In other words, the negative commuting situation at the MRT-3 could have effects on productivity and overall well-being of passengers, and this point is addressed in subsequent research by the authors. This study could serve as a basis for drafting appropriate policies that would address the problems identified while taking into consideration the characteristics of its users.

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