Assessment of a Train Station Facility in Relation to Its Design Dimensions Affecting Passenger Experience

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Abstract

The rail industry is starting to focus on the improvement of the overall experience of their passengers which is not just limited to the ride experience but also includes their experience while in the line's facilities such as their rail station. To improve passenger experience, improving the facility's design and configuration based on the quality dimensions and factors affecting it will be vital. This study aims to assess one of the busiest stations in the Philippines, the Taft Station of the MRT-3 line along Epifanio De los Santos Avenue based on its quality dimensions. The quality dimensions identified through literature include accessibility, navigation, and comfort & convenience. The passengers' perceived experience of the station's quality dimensions was assessed, rendering unsatisfactory results. Gaps observed include the lack of standard and visible signage, information boards and markings, repair of equipment, physical obstructions on the walkway, and no proper infrastructure for persons with disabilities and the elderly. Design alternatives were then generated to improve the current facility in the aspects concerning quality dimensions. The study recommends implementing the generated design alternatives to improve the passengers' experience in MRT-3 Taft Station. A similar assessment method can be used for other train stations as well.

Keywords
Rail, Passenger Experience, Facility, Design, Train Station

1. Introduction
Railway transportation is one of the preferred means of transportation in urban areas due to its reliability, convenience, and efficiency. It is also one of the sustainable means of mass transportation which is why a lot of countries are focusing on expanding their rail network, especially in their urban areas and city centers. In the Philippines, there are currently four operational rail lines, LRT-1, LRT-2, MRT-3, and PNR with a total railway footprint of 77 KM that serve Metro Manila and neighboring provinces.

One of the busiest line transits in the Philippines is the Metro Manila Transit Line 3 (MRT-3), placing second to Manila Light Rail Transit Line 1 (LRT-1) in having the greatest number of train passengers in 2021 (Department of Transportation 2022). In recent years, the operations of this line transit have become problematic. Hundreds of service disruptions and unloading incidents from 2012 to 2017 occurred due to lack of good maintenance practices and failure to undertake scheduled works on overhaul and upgrading (Dela Cruz 2019). In previous years, the administration rehabilitated the MRT-3. One of its upgrades includes increasing the number of trains leading to reduced waiting time between trains (Parrocha 2022).

While improving travel time and train operations reliability can help satisfy passengers' needs, it is not enough to create happy customers or to improve the quality of their travel experience. It is equally important to know the expectations of passengers as customers and to define and provide these qualities to improve their overall travel experience (Hagen and Oort 2019). Hagen and Oort (2019) suggest that the dimensions of passenger quality expectations can be ranked in the form of a pyramid, wherein the primary expectation is safety and reliability, followed by speed, and then by ease. These first three dimensions form the prerequisite needs and expectations of passengers, that when not provided will cause their dissatisfaction. On the other hand, passengers also expect a certain degree of

physical comfort at the station, and a pleasant experience that must be fulfilled by the facilities of the rail through its architecture, design, cleanliness, interior, and finishing materials. These two influence the satisfaction of passengers.

1.1 Objectives

The overall purpose of the study is to improve the experience of rail passengers by improving the facilities of its station through principles of Facilities Planning and Design. Specifically, the study aims to:

- Assess a rail station facility and determine the gaps and opportunities in its facility design with regard to the factors affecting passenger experience; and
- Develop recommendation/s on how to address the gaps and improve the facility's design to improve the passenger experience.

2. Literature Review

Globally, there are various ways that companies are innovating in terms of their services to improve the travel experience of their customers; and in these innovations, they are prioritizing the needs and expectations of their passengers by having a customer-focused approach in their rail services. The rail industry is now embracing the philosophy of putting customers first in terms of their service (Fowler 2021).

One company in the United Kingdom, Chapman Taylor, is using design management strategies to create better passenger experience in railway stations. In their designs they try to create stations that are passenger-focused by combining standards of operational efficiency and safety with an empathetic approach to the varying needs of passengers using the facility and a future-proofed social and commercial environment that are fully integrated with the surrounding community. The primary strategies they employ consider the operations of the station which take into account its horizon (or future-proofing of the station's design in relation to its future expansion), mobility (physical needs of the different demographics of passengers that should be accommodated by the station), entrances (to facilitate the access and natural flow of passengers in the different facilities of the station), level changes (vertical circulation of passengers in the different levels of the station), and inclusion (factor the complex, multicultural, multi-religious, multi-gender society of different ages and abilities of the passengers to be more inclusive). Moreover, Wayfinding, Commercial Planning, and Media are also integral factors that are taken into consideration by Chapman Taylor in creating strategies to design rail stations (Farmer 2020).

There is no industry-wide standard that is followed in designing rail stations since the design of station facilities are site-specific. Therefore, rail operators are free to tailor their station facilities based on their operational and passenger needs. Fourie (2014) created a general guideline for facility planning and layout design for railway stations based on pedestrian movement and volume, and to facilitate efficient passenger flow. The guideline by Fourie defined the Functional Station Design Principles which include, Functioning Arrangement of Space, Passenger Sequence of Movement, Direct, Continuous Movement, Conflict Between Different Flows, Passenger Density, and Identification of Entry and Exit Points. Furthermore, Pedestrian Speed Distribution and Pedestrian Spatial Requirements (for walkways/overpass, stairway design, queuing and waiting areas, and platforms) are proposed in the guidelines as relevant factors that need to be considered in designing stations (Fourie 2014).

Another aspect that needs to be considered in the station facility is the needs of the passengers in relation to the different functions and services of the station. A behavior mapping approach can be done to understand passenger behavior and its influence on the design of the facility. A study conducted in a commuter line station in Jakarta found that passenger pathways, preferred waiting areas, crowded areas during peak time, platform capacity, railway crossing capacity, and the availability and lack of primary, secondary, and tertiary facilities can be determined by mapping passenger behavior (Zubair et al. 2019). These in turn can be used to redesign station facilities to better conform to passenger behaviors; thus, will help in providing a better facility experience.

The relationship between the environment in the station and the passenger waiting experience. It is found that passengers who are waiting are receptive to environmental stimuli so they can be distracted by the time or delays. Adding the appropriate environmental stimuli can help passengers have a more pleasant waiting experience given different situations (peak hours, off-peak hours, train delays, etc.); hence, to provide optimal experience to passengers, environmental stimuli should be dynamic and not static. These stimuli include Color and Light Program, Music Program, and Infotainment Program, which can steer the waiting experience in a positive direction, and must be

applied depending on different situations given passenger volume, passenger movement, and function of the area (Hagen 2011).

Several literatures already studied the factors affecting passenger experience. Wang, et al. (2018) did an extensive review of the various studies conducted to determine the different factors that influence the satisfaction of passengers. These factors include service quality (Eboli and Mazzulla 2014); behavior of employees (Agarwal 2008); customer loyalty and reduction of complaints (Cao and Chen 2011); service attributes (Stuart et al. 2000); car cleanliness, employees' neat appearance, employee service attitude, air-conditioning comfort, and punctuality (Chou et al. 2014); service quality and corporate image (Yilmaz and Ari 2017); as factors studied and found to affect passenger satisfaction (Wang et al. 2018). Other factors that influence passenger satisfaction include environmental and thermal factors (Peng et al. 2022, Wang et al. 2015) and operational factors (Monsuur 2021). However, none of these factors tackled or included in their scope the different layers of passenger expectations from the quality dimensions, which would have been a more passenger-focused approach in providing insights how to improve rail transportation to provide better passenger experience.

3. Methods

The methodology that was used for the study is summarized in the flow of activities presented in Figure 1.

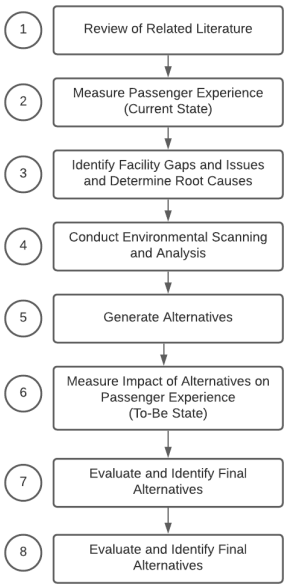

Figure 1. Methodology Activities

1. Conduct a review of related literature to identify factors and facility dimensions that impact rail passenger experience.
2. Assess the current experience of the passengers in terms of the train station's facility design dimensions through a survey. For the study, passengers who are using the chosen station were asked to answer and provide their overall assessment of the facility's quality dimension online.
3. Based on the reviewed literature, the identified facility design elements and requirements per each dimension were investigated and observed by the researcher in the station. Current conditions, design gaps, and issues related to facilities were identified through a series of observations for separate three days in the Taft Station. The Stream Diagnostic Chart was used to identify the root causes of the identified issues and gaps. These root causes were then used as the focal point in terms of the facility elements that need to be improved.
4. Alternatives targeted to improve the root causes were generated based on the insights and standards from the literature reviewed and with consideration of the facility design limitations and opportunities.

4. Data Collection

4.1 Systems Framework

The MRT-3 Taft Avenue Station is one of the 13 stations of the Metro Manila Transit Line 3 (MRT-3), one of the busiest line transits in the Philippines. This station is the chosen subject for this study as it is the most active station of MRT-3 (Pushpins n.d.). This is because it serves as the transfer point for commuters riding to Manila Light Rail Transit Line 1 (LRT-1), which has the greatest number of train passengers in 2021 (Department of Transportation, 2022). Figure 2 shows the MRT-3 line in blue, the LRT-1 line in yellow, and another train station, LRT-2, in violet. This figure shows that a passenger who comes to the MRT-3 Taft Station will either ride to go to the other stations of the MRT-3 line, transfer to LRT-1 EDSA Station, or go to other points accessible through the station like the Metro Point Mall, and EDSA Northbound and Southbound sides.

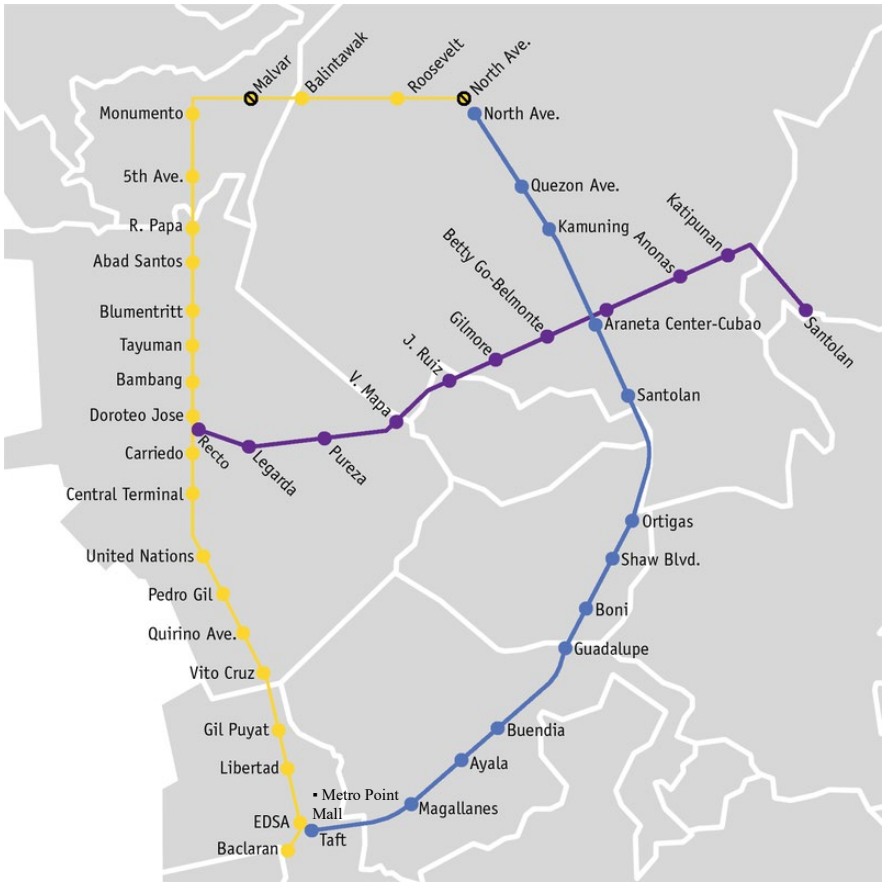

Figure 2. Map of the Metro Lines in Metro Manila, from (Mapa-metro 2010)

To better understand how the facility should be assessed based on passenger experience, the flow of activities that a typical passenger does in the Taft Station is mapped. The flowchart in Figure 3 shows the basic flow of activities that a passenger does in the Taft Station divided into his/her touchpoints in the different areas of the facility.

Based on the flowchart shown, a passenger who will come to the station has three possible courses of action:

- Go to the station to ride MRT-3 line
- Go to the station to transfer to LRT-1 EDSA Station
- Go to the station to go to other points accessible through the station (Metro Point Mall, Northbound and Southbound sides of EDSA, Pasay Rotonda Walkway)

From these activities, the areas where they had facility interaction or touchpoint will be determined and will be used

as reference in assessing the elements and parts of the facility which should be improved and given focus on to improve their overall passenger experience, since these will be the ones that will directly impact them.

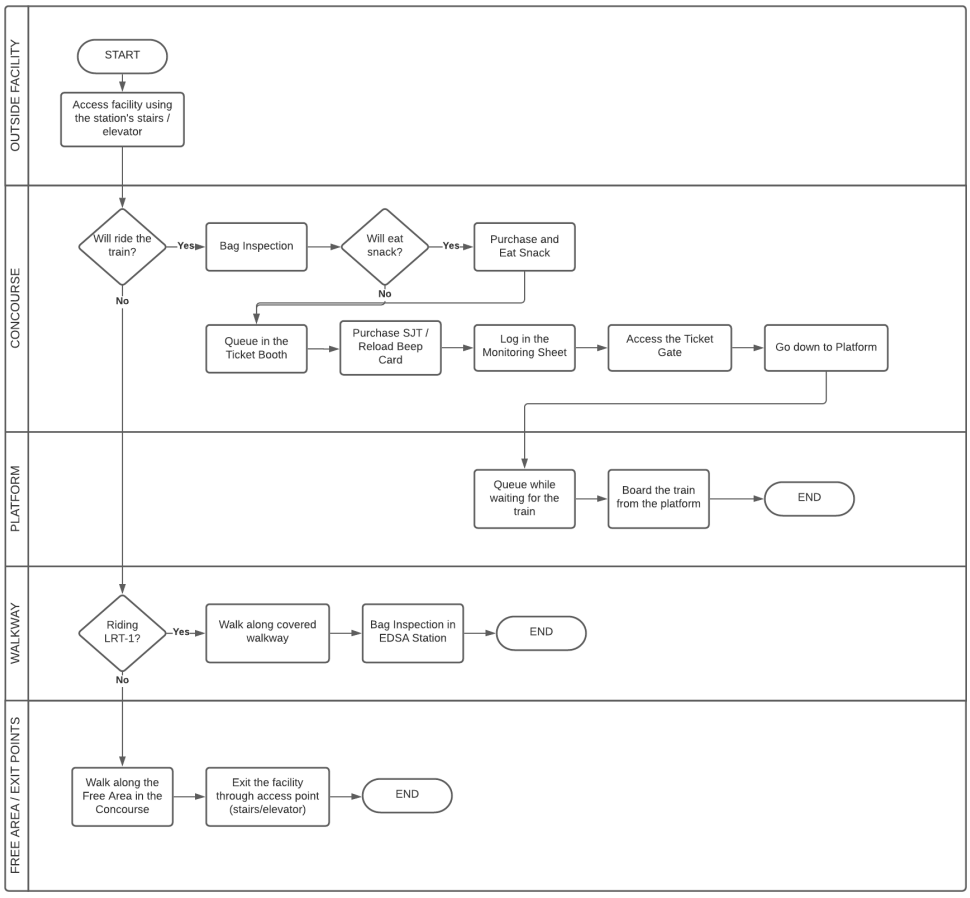

Figure 3. Passenger Activity Flow

4.2 Identification of factors and facility dimensions affecting rail passenger experience

Through the literature review conducted, it was observed that there are several factors that influence passenger experience. Hagen and Oort (2019) suggested the comfort and experience (through convenience) in the station is one of the expectations of passengers. Fourie (2014) defined through his functional design principles different ways on how to improve a station to provide good experience through the principles relating to accessibility. Lastly, Zubair et al. (2019) suggested correlation between passengers' behavior in navigating the station and passenger experience. These three factors or dimensions: (1) Accessibility; (2) Navigation; and (3) Comfort and Convenience will be used in the study as the factors that will be considered in improving the facility to improve passenger experience. It can also be construed that improvement in these dimensions will directly translate to improvement in passenger experience.

4.3 Assessment of Taft Station's facility design's dimensions

A passenger experience assessment was conducted to measure the current perception of Taft Station passengers with regard to their personal opinion of the facility's accessibility, navigation, and comfort & convenience. A questionnaire was used to ask them to rate the three dimensions from 1 to 5 (1 being "Not Accessible", "Hard to Navigate", and "Not Comfortable" and 5 being "Very Accessible", "Very Easy to Navigate", and "Very Comfortable", respectively). The questions include:

1. In terms of accessibility, how accessible (e.g., is it easy to get into and out of the facility, is it easy to locate different areas, etc.) is the MRT-3 Taft Station?

2. In terms of navigation and passenger flow, how easy is it to navigate the Taft Station (e.g., is it easy to get from one point to another, is it easy to locate areas and recognize signages, is it easy to queue?)
3. In terms of general comfort, how comfortable do you feel when you are in the station when using its facilities (e.g., elevator, stairs, pathways, ticket booths, benches, CR, etc.)?

Then, the average rating per each dimension was computed. There were 37 passengers who responded to the assessment online.

4.4 Facility Observation & Inspection

Three ocular visits were done to observe the facility and to experience firsthand as a passenger the different functions of the MRT-3 station. Personal experiences and observations in the past are also used as bases in identifying the problems and areas of improvement of MRT-3 station in relation to its effect and impact on the passenger experience.

5. Results and Discussion

5.1 Numerical Results on the Facility Design Assessment

The computed average assessment scores for the three dimensions are summarized in Table 1. Based on this result, none of these dimensions of the facility's current design can provide a good or acceptable passenger experience. The average scores of 2.784, 2.297, and 2.649 fall within the range of 2 - 3 which suggests that, in general, surveyed passengers perceive their experience as *Somehow Accessible, Somehow Comfortable,* and *Can be Navigated but with Difficulty.* This presents a problem for the current facility, as the goal is to make the facility accessible, navigable, and comfortable & convenient to provide a good passenger experience.

Table 1. Result of Passenger Experience Assessment

Facility Dimension	Average Passenger Experience Assessment Score
Accessibility	2.784
Navigation and Passenger Flow	2.297
Comfort and Convenience	2.649

5.2 Results from Facility Observation & Inspection

To identify the specific issues and gaps of the facility related to the three dimensions of Accessibility; Navigation and Passenger Flow; and Comfort and Convenience, ocular visits in the Taft Station were conducted. The ocular visit done is based on the current pandemic setup. From observations and personal experiences, the issues are categorized based on the following aspects: (i) People, (ii) Process and Management, (iii) Layout & Infrastructure, and (iv) Equipment & Fixtures.

A. People (P) - this refers to the factors that are done by people (employees, passengers, vendors, station users) in the station which impact the overall experience of station users. The following are issues identified under People:
   P1: Passengers not queuing properly causing congestion
   P2: Passengers and Station Users mixing together causing mixed flow
   P3: Merchants are blocking stairs and other access points
   P4: Passengers are not following correctly the supposed flow of the queue
B. Management & Process (M) - this refers to issues from the management of the facility and how processes are done as implemented by MRTC which cause negative experiences or aspects that currently have gaps. The following are issues identified under Management and Process:
   M1: No strict enforcement of limited access for vendors
   M2: No available information on train arrival and departure in the station
   M3: Bottleneck in queues due to bag inspection and contact tracing filling out.
   M4: Food stalls for beverages and snacks are closed
C. Layout & Infrastructure (L)
   L1: Facility areas with different functions are not properly set apart from each other

L2: Entrances of some access points are not wide enough
L3: No railings in the platform level that serves as barricade between the platform and railtracks
L4: Lack of facility features that aid PWDs and elderlies (proper handrails, slopes, guided access). See Figure 4 for an example.
L5: Inconsistent color of floor tiles making floor markings in the concourse level unnoticeable
L6: Accesses are obstructed by vendors and their merchandise. See Figure 4 for an example.
L7: Concourse level for free and paid areas have open walls which expose passengers queueing during heavy rain
L8: Some areas look dim and gritty

D. Equipment & Fixtures (E)
E1: Signages and directional markings are inconsistent and not fully visible. The left picture in Figure 5 shows an example of the entrance not visible from the street level. The right picture shows that the elevator is not located easily due to lack of signage.
E2: Informational boards are not fully utilized
E3: Placement of important announcements and posters are in areas that are not in line of sightand can be covered by people passing by
E4: Lack of Directional Instructions for passengers to follow given that there are a lot of areas that were restricted and cordoned off.
E5: Analog Clocks, Fans, LCD TVs are not working or are not being used
E6: Ticket vending machines are not easy to locate since they get hidden behind people queuing to buy tickets
E7: Lack of resting benches/area where passengers can momentarily rest

Figure 4. (From left to right) Lack of facility features that aid PWDs and elderlies. Accesses are obstructed by vendors and their merchandise

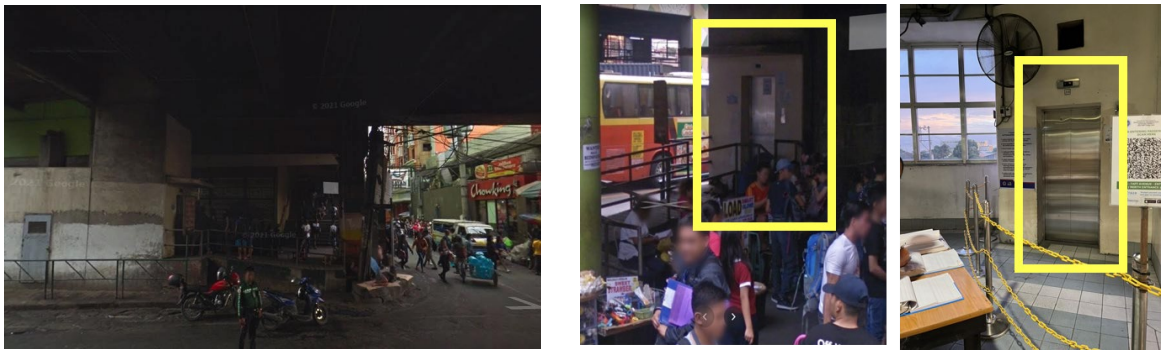

Figure 5. Signages and directional markings are inconsistent and not fully visible at the entrance of the station and elevator location.

The problem areas were further reviewed and using Stream Diagnostic Chart, the dependency of each item was identified, thereby determining the root causes among them. See Figure 6 below:

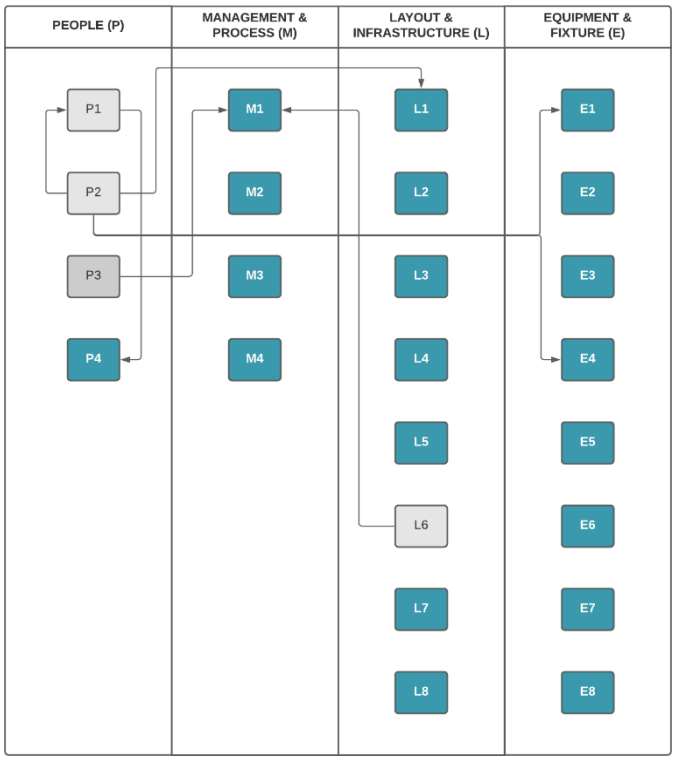

Figure 6. Stream Diagnostic Chart for Taft Station Facility

Through the figure above, the identification of root causes is shown. The problem areas are represented by their codes (P1, M1, L1, etc.) for simpler representation. The result of this analysis shows that the root causes identified (those highlighted in blue) can be further summarized into three, namely:

- Unorganized & Mixing Passenger Flow due to issues in the lack of directional signages, lack of area partitions, improper placement of functional fixtures, blocking merchants, etc. (P4, M1, M3, L1, L2, L5, E1, E3)
- Repair and Proper Maintenance of facility's standard equipment & fixtures: fans, clocks, boards, floors, facility walls, etc. (L8, E4, E5, E6)
- Lack of facility features to support the need and convenience of passengers and station users: virtual & real time information boards, safety railings, PWD- support facility guides, protection from weather elements, food stalls, etc.(M2, M4, L3, L4, L7, E7)

5.3 Proposed Improvements

The general problems that were identified as root causes of the problem in terms of the Taft Station's facility design were individually reviewed and recommendations on how to address the gaps and resolve the issues were generated based on industry standards. The recommendations should be aligned with the dimensions of the facility that impacts passenger experience such as Accessibility, Navigation, and Comfort. In a separate feasibility study conducted, there were 12 alternatives generated. Here are some of the recommendations that address the station's issues with accessibility, navigation, comfort & convenience.

1. **Create curb ramp/s in the station's entrance.** Based on the Facility Accessibility Design Standards (2007), curb ramps are essential infrastructure to enable the accessibility of rail stations. Hence, curb ramps in the station's street-level access should be constructed following the requirements: the ramp shall have a minimum width of 1.5m (see Figure 7, left picture). The curb ramp should have a rough texture or ground pattern to make it detectable and slip-resistant. The color of its surface should be distinct and must contrast with the surrounding surfaces to guide pedestrians with limited vision (Figure 7, right picture).

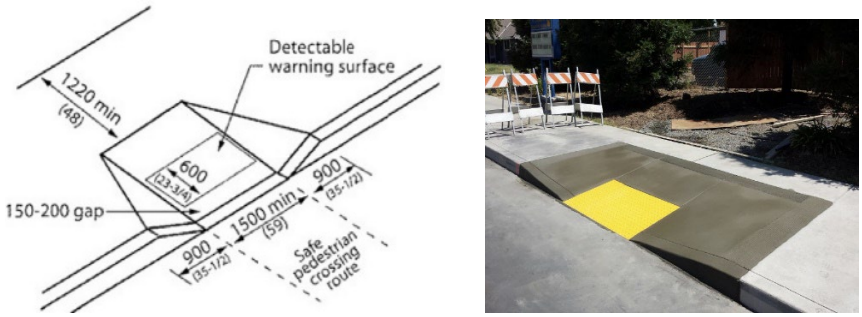

Figure 7. (From left to right) Facility Accessibility Design Standards on curb ramps; Example of curb ramp

2. **Install floor lines, markings, signages, and guides.** One improvement that can be done which is also practiced by other rail stations is the use of floor line markings, floor directional arrows, and tactile guides. Directional signage mounted on a pole can also be installed on street intersections (The State of Queensland 2021). Main signages can also show the entrance name based on their location (see Figure 8).

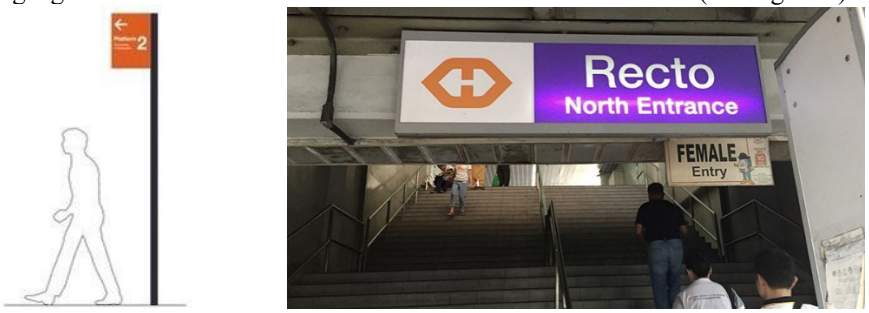

Figure 8. (From left to right) Directional signage mounted on a pole; Example of main signage with entrance name based on location

3. **Use standard information display boards (LED Displays and Bulletin Boards).** The State of Queensland (2021) recommends the use of Information Boards and Information Stands in disseminating information in the facility for passengers' information and reference. These can be located on the concourse level, in the platform level, at the entrance, and in the ticket vending area.
4. **Deployment of benches and leaning bars.** Based on Facility Accessibility Design Standards (2007), the benches' height must be .45-.5m with provision for backrest and armrest. Leaning Bars on the other hand must have a height of at least 30-38 inches to provide passengers rest while waiting.
5. **Relocate ticket booths and ticket-vending machines.** The ticket machines should be relocated to one of the free spaces in the ticket office (see Figure 9) so that all queues for ticket purchases will have the same flow reducing possible mix ups – similar to orientation of ticket booths and ticket machines in picture (see Figure 9) where machines and booths are placed alongside each other.

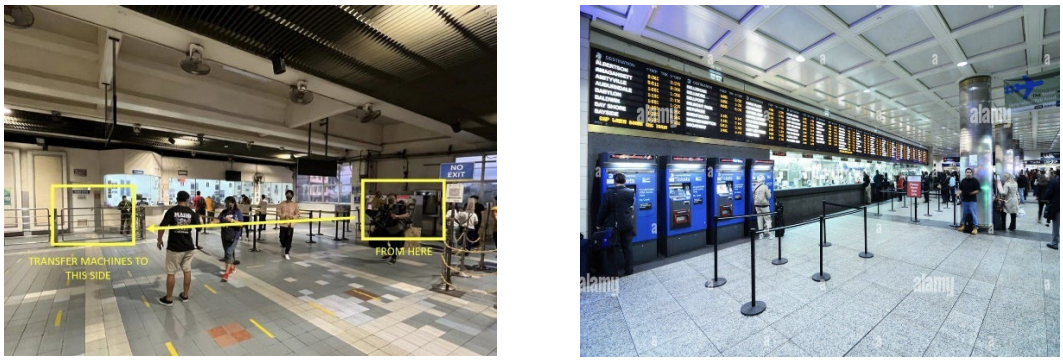

Figure 9. (From left to right) Suggested location of the ticket machines; Example of the orientation of ticket booths and machine

5.4 Validation

Based on the proposed improvements in the current design/state of the Taft Station facility through the 12 alternatives determined, 37 MRT-3 Passengers who have been to Taft Station were asked to provide their assessment of the generated alternatives. They were asked to provide their personal assessment of how much each proposed alternative will impact and likely improve the overall passenger experience once implemented. Each alternative is given a rating from 1 to 5 with the following assessment equivalent:

1 - Will Not Improve Passenger Experience
2 - Will Have Low Contribution in Passenger Experience
3 - Will Improve Passenger Experience
4 - Will Contribute High Improvement in Passenger Experience
5 - Will Contribute Very High Improvement in Passenger Experience

Some of the questions are the following, together with the sample pictures of the recommendation:

1. How much do you think will the recommendation of putting up curb ramps (for wheelchairs) improve the experience of getting into the station from its entrance?
2. How much do you think will the recommendation of putting floor markings such as directional arrows and line markers (to direct passengers to key areas in the facility and to manage the flow of people, especially those who are queuing) improve the experience of passengers?
3. How much do you think will the recommendation of using (1) fixed bulletin boards (for posting of announcements and key instructions), (2) designated information stand in entrances to display policies, and (3) electronic information displays for train operation information improve the experience of passengers in navigating the station?
4. How much do you think will the recommendation of deploying benches and making resting areas available on the concourse level improve the experience of passengers in using the station?
5. How much do you think will the recommendation of (1) relocating the ticket-vending machine to a more visible location, (2) having PWD-dedicated ticket booths, and (3) putting barriers to segregate queues per booth improve the experience of passengers in using the station?

The average rating for each alternative was used as a basis by the study in gauging the improvement that it will bring in terms of passenger experience. A minimum average score of 3.0 which indicates that an alternative will improve passenger experience will be used as the threshold. Alternatives that will have an average score of below 3.0 will not be considered in further evaluation. The result of the Passenger Experience Perceived Improvement Assessment is shown on Table 2.

The average rating for all the alternatives is more than 3.0 with Alternative no. 4 with the highest perceived impact followed by Alternative no. 5. All the alternatives will then be considered for evaluation in selecting the final recommendation/s for implementation. These will be evaluated in a feasibility study based on the following criteria: (1) Impact on Company Goals, (2) Improvement of Passenger Experience, and (3) Ease of Implementation.

Table 2. Assessment Result of the Impact of Alternatives on Passenger Experience

GENERATED ALTERNATIVES	Impact on Passenger Experience Improvement
1. Create Curb Ramp/s in Station's Entrance	4.28
2. Install Floor Lines, Markings, Signages, and Guides	4.22
3. Have Designated Platforms for Information Dissemination	4.31
4. Deployment of Benches and Leaning Bars in Resting Areas	4.36
5. Improvement on Ticket Booths and Ticket-Vending Machines	4.33

6. Conclusion

One factor that affects the experience of passengers in their railway commute is their experience in and with the rail station facility. Hence, if passenger experience is aimed to be improved, a vital component of the improvements that should be done is with the facility.

The Design Qualities of a railway station are factors that can be considered in improving the passenger experience. It includes accessibility, comfort, convenience, and ease of use among others. These are qualities that a rail station's facility must have to provide a positive customer experience.

However, in the case of MRT-3 Taft Station, there are gaps and issues in terms of congestion, lack of facility features, and poor facility arrangement/maintenance which could negatively affect the experience of passengers. To address these, solution alternatives were developed. These alternatives aim to Improve Station's accessibility, navigation, and passenger flow, and provide comfort and convenience to passengers – that if all implemented well, will help contribute to the improvement of passenger experience and help with the achievement of the company's goals.

For the areas of future study, other researchers may consider the impact of passenger volume in the station in determining the appropriate quality dimension features of the facility that will be improved. This should cover the study of the appropriate spatial and capacity requirements (ex: number of ticket booths, dedicated lanes for queueing, size of the platform, etc.) given the current and future passenger demand – which was not covered in this study. A similar assessment method can also be used for other train stations as well.

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