Facility Management System Improvement of the Philippine National Railways

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Abstract

The purpose of this study is to improve the current Facility Management System of the Philippine National Railways, wherein, a combination of different knowledge with regards to the field of specialization of the researchers had taken place to resolve certain issues. The issues that were identified by the researchers are free loading passengers, passenger management, long queues and safety issues. The researchers first acquire all the possible data that will be needed to assess the facility management and the totality of the system of PNR. After taking the different sets of data, statistical tools and other related literatures are used to get specific factors that will be considered to have a precise output. Finally, Industrial Engineering tools like quality function deployment (QFD), queuing theory, systematic layout planning (SLP) and systems and procedures were used for the design of the improved facility management system of the stations. These tools are intended for a specific issue. The common ground for the improvement of the three stations are the systems and procedures, that is why the researchers made a standard operating procedure/rule book for the employees that is in the perimeter of the station (i.e. security personnel, ticket booth personnel, mechanic and ticket inspectors). When in terms to the comparison of the present and improved facility management system of the Philippine National Railway, the researchers used Failure Mode and Effect Analysis (FMEA) to check whether the improved system will have a better effect for commuters when compared to the present system.

Keywords
Facility management system, PNR, QFD, FMEA, Rule book

1. Introduction

Public transportation nowadays is a big help not only for their daily lives but also for our environment. Some benefits of public transportations may include saving money, improving health, cleaning the environment and reducing traffic congestions (U.S. Environmental Protection Agency, 2011).

Catching public vehicles can help them to save money than driving yourself for work, school or home. According to a research of the Royal Automobile Club of Queensland (RACQ), public transportations can be four times cheaper than private transport. Thus, it can save you from the cost of buying, maintaining and running additional vehicles. Public Vehicles will also allow people to have an exercise in their daily activities in the form of walking. Lastly, using public vehicle is good for the environment, it will reduce the number of the cars that will travel on a daily basis because public vehicles could accommodate more people than in a private vehicle (U.S. Environmental Protection Agency, 2011).

Public land transportations found in the Philippines are buses, jeepneys, metered taxis, van, motorized tricycles, multicabs, trains, pedicabs, kalesa and other more. The famous and unique public land transportation in the Philippines is the "Jeepneys". This mode of transportation started at the age of world war two and the concept in building this vehicle, is the jeeps of the American people, these vehicles is one of the cheapest in the means of transportation (Chadhaury, 2012). Tricycles are motorcycles that have a sidecar attached to it. These tricycles are known only for short trips for they only go around in a town. In NCR alone, Jeepneys consists of 34,522 units, Uvs has 6,000 units and, Tricycle and pedicabs has 200,000 units (Dabu, 2015).

In Metro Manila, trains are considered as the best vehicle for mass transportation especially when you are relying on the speed, because trains has only rails that they will follow and has no traffic to experience. As observed by the researchers, many commuters tend to ride in rail transits in order to reach their destinations in time and for them to avoid the traffic congestions. There are 3 Rail transit in Metro Manila: LRT, MRT and PNR.

PNR or the Philippine National Railways has begun their operations in the year 1892 and used to travel for about 1,100 km from La Union to Bicol but now, due to the continuous neglecting of passengers, the route for PNR is only from Tutuban, Manila to Calamba in Laguna that consist of 26 Stations. Many commuters are now choosing to ride the Philippine National Railways. There is no need to spend much money for a taxi if you could ride the PNR train since it has access to almost all of the important landmarks in Metro Manila. PNR train is much better to use to preserve the environment than to use a car. Using PNR Trains is safer than other alternative transportations specially for the women and children, because they allot 2 coaches for them; to avoid unnecessary actions of other people and also allotted 2 marshals for each coach.

Even if there are increasing number of commuters for the Philippine National Railways, there are many problems that needs to be focused on in their Facility Management System because of some issues that the researchers presented in chapters 1 and 2. Furthermore, from the researcher statements, they said, when comparing the 3 rails system of the Philippines, the PNR will be the least in option because of their outdated facilities.

2. Methodology

The researchers first determined the top three stations that has the most ridership from their historical data shown in figure 1.

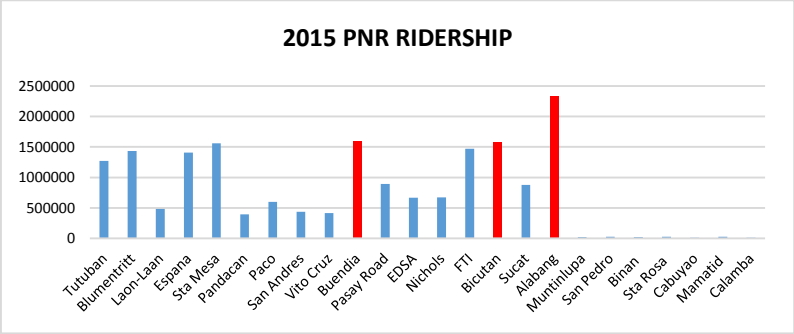

Figure 1. Graph of 2015 Ridership

The top three stations that were identified are Alabang Station, Bicutan Station and Buendia Station. With the use of Slovin's formula, the researchers were able to identify the sample size for each of the three stations which is 100 and a total of 300 respondents for the three stations. The researchers then disseminated a survey that contains basic information of the passenger (name, age, occupation and gender) and factors that will be evaluated based on what they observe in their respective station of location. Factors from the survey were based from related researches/studies.

Facility Performance Evaluation (FPE) was also conducted by the researchers. FPE consists of surveys, focused groups, interview and observation/walkthrough. Through this evaluation, the researchers were able to determine issues that need to be addressed in the study. Upon the results of the surveys and other related literature, the researchers had classified this information to create a sub-factor for the factors found in the ServQual results for a better output.

Furthermore, time study was conducted for one week covering all days of the week for each station and from opening time to closing time in order to determine the arrival rate and service time of each server in a ticket booth. Arrival rate was measured by counting all passengers that enters into the system per minute. On the other hand, service time was measured by also counting all passengers that were serviced per minute per booth.

In addition, the researchers need to measure the current physical ergonomic measurements of the three stations. By using particular equipment to measure noise, lighting and temperature the researchers obtained the current physical ergonomic measurements for each of the three stations.

2.1. Statistical Analyses

From the preliminary survey that was disseminated, the researchers were able to gather sufficient results in order to further analyze is using statistics. The researchers used ANOVA through Minitab to determine the significant factors to be considered in the design of a new facility management system of the Philippine National Railways.

3. Results

For the first phase of the research, the researchers evaluated the current facility management system of the stations of the Philippine National Railways. The researchers conducted a survey to know the passenger's observation with regards to the facility of the station of their location. Shown in Table 1 is the current physical ergonomic assessment for each of the three stations.

Table 1. Current Physical Ergonomic Assessment

	ALABANG	BUENDIA	BICUTAN
LIGHT	9.5 Fc	8.2 Fc	7.3 Fc
NOISE	109.4 dbA	104.3 dbA	106.6 dbA
TEMPERATURE	33 °C	32.8 °C	33.5 °C

These physical ergonomic measurements were obtained through the use of ergonomic equipment for a particular aspect. Like for temperature, the instrument that was used is thermometer. For noise, the researchers used noise dosimeter and for lighting is lux meter. It is observed that each of the physical ergonomic property does not meet OSH standards. For lighting, all the three stations have a measured lighting of 9.5, 8.2, and 7.3 fc but its recommended value is at a range of 10-20 fc. Furthermore, the recommended value for noise is 57 dB only but each of the stations have a measure noise of 109.4, 104.3 and 106.6 dB. The main contributor of this high level of noise is the loudness of the honk of the train.

Through Facility Performance Evaluation (FPE), surveys and interviews, the researchers were able to determine all factors associated with the study. Factors that were determined are security, platform capacity, platform properties, circulation area and system. Through the use of ServQual the researchers classified the factors that were identified through related literatures and use these classifications to determine the factors that will be considered for the next phase of the research.

Table 2. ServQual Result for Alabang Station

DIMENSIONS	RATING
Reliability	-2.324
Assurance	0.145
Tangibles	0.005
Empathy	0.112
Responsiveness	-2.355

These factors were classified into reliability, assurance, tangibles, empathy and responsiveness and then solved using the concept of ServQual by subtracting Perception to Expectation. Marked with red are the significant factors that are needed to be considered in the study. From the Results shown in Table 2, the researchers first focused on the tangibles as this factor will be used for the physical design of the station.

Table 3. Survey Questions Classified into Sub-Factors

TANGIBLES

Excellent transportation service provider will have modern looking equipment	Security Equipment
	Seats in the waiting area
	Station is rain and heat proof
The physical facilities at excellent transportation service provider will be visually appealing.	Length of the train fit the platform
	Adequate space for entrance and exit
	Platform can accommodate passengers Peak Hours
	Number of Ticket Booths Regular Hours
	Number of Ticket Booths Peak Hours
	Flow of issuing Tickets
	Flow of Passengers (Entering and Leaving the Station)
Materials associated with the service will be visually appealing at an excellent transportation service provider.	Noise
	Temperature
	Lighting
	Markings in the platform that the train will stop there
	Signs and Warnings

From there, the researchers were able to classify questions from the survey according to the conditions under tangibles which is shown in Table 3. After this, the researchers used ANOVA in order to determine the significant factor that to be considered in the physical design of the stations. Results are shown in Table 4.

Table 4. Significant Factors

SIGNIFICANT FACTORS		
ALABANG STATION	BICUTAN STATION	BUENDIA STATION
Security equipment	Seats in the waiting area	Security equipment
Seats in the waiting area	Station is ran and heat proof	Seats in the waiting area
Station is rain and heat proof	Length of the train fit the platform	Length of the train fit the platform
Flow of passengers (entering and leaving)	Adequate space for entrance and exit	Platform can accommodate passengers peak hours
Lighting	Platform can accommodate passengers peak hours	Adequate space for entrance and exit
Markings in the platform	Number of ticket booths peak hours	Flow of passengers (entering and leaving)
	Number of ticket booths regular hours	Markings in the platform that the train will stop there
	Markings in the platform	

As observed in Alabang Station, the significant factors were security equipment, seats in the waiting area, station is rain and heat proof, flow of passengers (entering and leaving), lighting and markings in the platform. The significant factors clearly justify the weakness of this station. Alabang Station has the longest platform that fits the longest train. But despite of this, the station lacks security equipment specifically CCTV and seats. Supposedly, the station's priority is to allocate the seats to elders and disabled persons. But due to insufficient number of seats, not all elders and disabled persons seat on it. Furthermore, Alabang station have roof but it isn't enough because approximately only half of it is covered. For lighting, based from the measured value lights in the station is not enough. Lastly, there are no markings present in the platform. In addition, for Bicutan Station, significant factors that were obtained are seats in the waiting area, station is rain and heat proof, length of the train fit the platform, adequate space for entrance and exit, platform can accommodate passengers during peak hours, number of ticket booths during peak hours and regular hours and markings in the platform. For this station, its length is very short and actually it only fits for almost 5 coaches of the train only. In addition, there is only 1 ticket booth for both southbound and northbound passengers. Same scenario with the previous station, Bicutan only has limited number of seats in its waiting area. There are no markings present in the platform. The fact that the platform is short in length, during peak hours the platform is very crowded. Next for Buendia Station, significant factors that were determined are security equipment, seats in the waiting area, length of the train fir the platform, platform can accommodate passengers during peak hours, adequate space for entrance and exit, flow of passengers (entering and leaving) and markings in the platform. The Platform for Buendia Station is also not the long to fit the length of the train. Furthermore, there are insufficient number of seats that the passenger seat on the side of the platform. Also, like the other 2 stations this station doesn't have markings present on the platform.

Shown in Table 4 are the results of ANOVA that will be used for House of Quality in the next phase of the study. For the House of Quality, the researchers will need the importance ranking of the significant factors. Importance ranking are shown in Table 5.

Table 5. Ranking of Significant Factors per Station

SURVEY QUESTIONS	Alabang	Bicutan	Buendia
More security personnel	2	5	3
More inspectors for the outgoing passengers	6	6	4
Bigger space of the entrance and exit	4	14	14
Bigger space of the platform	3	12	9
More lightings (for Night)	10	2	2
Security equipment (CCTVs, Railings signs and etc.)	13	7	11
Longer platform	1	10	15
Environmental friendly platform	12	11	1
Proper signage where the door train stops	11	9	10
More ticket booths during regular hours	5	15	8
More ticket booths during peak hours	9	13	7
More seats in waiting area	14	8	12
Warning signs in the platform	7	3	6
Systematic flow for the entering and leaving passengers	15	1	13
Systematic flow in issuing tickets	8	4	5

Table 5 shows the results of the survey that was carried out by the researchers to determine the importance ranking of the significant factors per station. Based form the commuters in Alabang, the systematic flow for the entering and leaving passengers should be our top priority, more ticket booths in Bicutan and longer platform in Buendia station.

Table 6. Hourly Ridership

HOURLY RIDERSHIP																					
TIME	MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			SUNDAY		
	AA	BIC	DIA	AA	BIC	DIA	AA	BIC	DIA	AA	BIC	DIA	AA	BIC	DIA	AA	BIC	DIA	AA	BIC	DIA
5-6 AM	757	538	669	610	551	667	604	512	658	547	519	586	613	535	605	571	432	528	421	546	442
6-7 AM	675	545	660	608	550	664	543	446	668	519	453	607	627	505	625	470	427	560	310	450	438
7-8 AM	679	556	658	638	547	655	546	477	654	534	518	590	504	480	584	392	357	537	275	365	416
8-9 AM	606	537	643	621	539	637	558	463	582	576	487	534	580	480	570	452	471	561	425	400	398
9-10 AM	576	375	605	283	381	609	555	420	556	459	409	572	607	411	626	414	402	489	423	404	366
10-11 AM	361	337	503	424	343	468	422	427	456	342	389	521	279	342	496	417	353	429	321	368	393
11-12 AM	386	310	358	445	331	347	426	315	354	426	298	353	369	299	368	405	352	330	323	296	306
12-1 PM	392	318	320	395	283	325	391	321	300	387	284	313	420	319	387	411	333	329	344	310	324
1-2 PM	415	319	344	425	244	294	391	316	314	423	298	317	396	337	325	414	314	334	339	245	334
2-3 PM	381	309	300	346	245	360	419	283	379	402	338	346	414	276	335	342	319	384	361	274	307
3-4 PM	407	294	486	453	225	362	446	236	452	405	333	491	441	290	475	429	313	477	350	263	257
4-5 PM	447	303	503	381	235	392	407	279	458	438	284	455	360	289	519	432	281	416	427	265	281
5-6 PM	412	307	491	425	248	481	431	288	425	483	240	493	468	261	495	483	310	388	327	253	276
6-7 PM	445	274	307	486	221	337	390	260	286	450	218	297	351	222	289	492	230	299	398	199	270
7-8 PM	384	274	294	396	205	278	351	167	277	364	202	256	291	201	285	284	206	291	257	159	299
TOTAL	7323	5596	7141	6936	5148	6876	6880	5210	6819	6755	5270	6731	6720	5247	6984	6408	5100	6352	5301	4797	5107
	20060			18960			18909			18756			18951			17860			15205		

Table 6 shows the result of the time study that was conducted by the researchers. It is seen from the results that the days that have the most passengers riding are Monday and Friday. In addition, researchers used Systematic Layout Planning (SLP) to determine the most optimal layout strategy that will be applied for the stations. Shown in the figure are the relationship diagram for the stations.

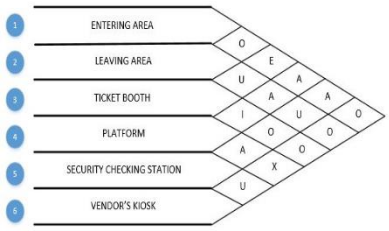

Figure 2. Relationship Diagram

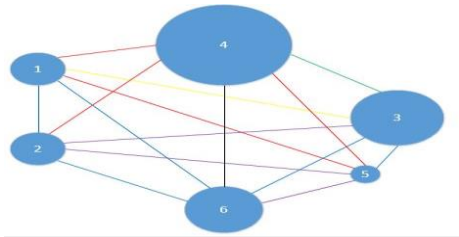

Figure 3. Space Relationship Diagram

Figure 2 shows the basis for the layout strategy that will be done by the researchers. A toilet facility was placed in the layout of the platform as it is a basic need for both employees and passengers. It could be placed anywhere but also considering that it will not affect the operations of the railway.

In addition, a Standard Operating Procedure (SOP) manual was developed by the researchers for each employee because it will be of great help for the welfare and improvement of the system of PNR. The SOP was based on the ServQual results and from the survey questions that were classified.

Table 7. ServQual Table for SOP

RESPONSIVENESS	
Employees of excellent transportation service provider will give prompt service to customers.	• Passengers requiring assistance • Specifics instructions (SOP intended on specific personnel) Order and codes
Employees of excellent transportation service provider will always be willing to help customers.	• Passengers requiring assistance • Order and codes • Prioritizing Senior Citizen
Employees of excellent transportation service provider will never be too busy to respond to customer requests.	• Passengers requiring assistance • Order and codes
RELIABILITY	
When a customer has a problem, excellent transportation service provider will show interest solving it.	• Passengers requiring assistance • Restricted things • Rules and regulations of PNR
Excellent transportation service provider will perform the service right the first time.	• Familiarization of rules, regulations, Procedures, orders, instruction, notices and advisories • Qualifications of Employee (Training) • Order and codes
Excellent transportation service provider will insist on error free records.	• Specifics instructions (SOP intended on specific personnel) • Gears and equipment • Order and codes • Rules and regulations of PNR
TANGIBLES	
Employees at excellent transportation service provider will be neat appearing.	• Uniforms

Table 7 shows the basis for the SOP manual that was made by the researchers. The factors in the right side of the table came from related literatures and studies.

3.1. Discussion

For the first phase of the study, the researchers will have to evaluate the current facility management system of the Philippine National Railways. The result of the physical ergonomic assessment is shown in Table 8 compared to the recommended value that is based on Occupational Safety and Health (OSH) standards.

Table 8. Physical Ergonomic Assessment compared to Standard

	ALABANG	BUENDIA	BICUTAN	STANDARD
LIGHT	9.5 Fc	8.2 Fc	7.3 Fc	10-20 Fc
NOISE	109.4 dbA	104.3 dbA	106.6 dbA	57 dB
TEMPERATURE	33 °C	32.8 °C	33.5 °C	-

It is observed that each of the physical ergonomic property does not meet OSH standards. For lighting, all the three stations have a measured lighting of 9.5, 8.2, and 7.3 fc but its recommended value is at a range of 10-20 fc. Furthermore, the recommended value for noise is 57 dB only but each of the stations have a measure noise of 109.4, 104.3 and 106.6 db. The main contributor of this high level of noise is the loudness of the honk of the train. In addition to the current physical ergonomic assessment, the Researchers also found out other factors from related literatures and studies that can be considered for this research. Factors such as security, platform properties, platform capacity, system and circulation areas.

For the next phase of the research, the researchers were able to determine the significant factors that were determined per station which is shown in Table 4. As observed in Alabang Station, the significant factors were security equipment, seats in the waiting area, station is rain and heat proof, flow of passengers (entering and leaving), lighting and markings in the platform. The significant factors clearly justify the weakness of this station. Alabang Station has the longest platform that fits the longest train. But despite of this, the station lacks security equipment specifically CCTV and

seats. Supposedly, the station's priority is to allocate the seats to elders and disabled persons. But due to insufficient number of seats, not all elders and disabled persons seat on it. Furthermore, Alabang station have roof but it isn't enough because approximately only half of it is covered. For lighting, based from the measured value lights in the station is not enough. Lastly, there are no markings present in the platform. In addition, for Bicutan Station, significant factors that were obtained are seats in the waiting area, station is rain and heat proof, length of the train fit the platform, adequate space for entrance and exit, platform can accommodate passengers during peak hours, number of ticket booths during peak hours and regular hours and markings in the platform. For this station, its length is very short and actually it only fits for almost 5 coaches of the train only. In addition, there is only 1 ticket booth for both southbound and northbound passengers. Same scenario with the previous station, Bicutan only has limited number of seats in its waiting area. There are no markings present in the platform. The fact that the platform is short in length, during peak hours the platform is very crowded. Next for Buendia Station, significant factors that were determined are security equipment, seats in the waiting area, length of the train fir the platform, platform can accommodate passengers during peak hours, adequate space for entrance and exit, flow of passengers (entering and leaving) and markings in the platform. The Platform for Buendia Station is also not the long to fit the length of the train. Furthermore, there are insufficient number of seats that the passenger seat on the side of the platform. Also, like the other 2 stations this station doesn't have markings present on the platform.

In the House of Quality for Alabang Station, it is observed that the systematic flow of the passengers entering and leaving the station got the highest rank. This is because many passengers in Alabang had difficulty in entering and leaving the train. Passengers tend to rush to go inside of the train without letting the other passengers to go out first. The lowest rank is the need for longer platform because Alabang Station can accommodate even the longest train. On the other hand, for Bicutan Station, there is a need for additional ticket booth during peak hours. It is actually based from the time study that was conducted by the researchers. The least important for this station is the systematic flow for passengers entering and leaving. For the last station, which is Buendia Station, there is a need for longer platform because not all trains fit its platform and there is a tendency that passengers enter the train outside the vicinity of the station.

For the Queuing Theory, the researchers computed for the required number of servers for each station using the arrival rate and service time that was conducted. Based from the results, only Bicutan station has a need to add one more ticket booth in its station. Because as observed by the researchers, there is only one ticket booth that services all northbound and southbound passengers. Unlike in Buendia Station, there is one ticket booth each northbound and southbound platforms.

In the last phase of the research, the researchers have to recommend courses of action to the possible failure risks of the proposed design. But before that, the researchers constructed and initial FMEA Table for the current design and based from the results from the previous phases physical improvements were done to propose the ideal design for the stations.

4. Conclusion

From the objectives of this study, the researchers have thoroughly examined and discussed all inputs and outputs for this research. For Phase 1 objective which is to evaluate the current facility management system of the top 3 stations of the Philippine National Railways. The top 3 stations that were evaluated are: Alabang Station, Bicutan Station and Buendia Station.

The researchers have found out that by inspecting and observing the 3 stations, these 3 stations in way have differences. All of these has been examined by the researchers and will be given course of action according to its needs. Thus, the output for this phase are the factors that are essential to the passengers. Factors that were determined by the researchers are: security, platform capacity, platform properties, circulation area and its system.

In addition, for the second objective wherein the Researchers will evaluate these factors using statistical tools to determine the significant factors that will be considered in the design and improvement of the facility management system of PNR. Through the use of ANOVA the researchers have determined that each station has varying significant factors depending on its need.

For the third and last objective, the researchers used SLP to effectively arrange the areas depending on its relationship with the other areas. After that, the researchers used QFD to design a station depending on the customer wants.

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