INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATION & MANAGEMENT

IJRCM

A Monthly Double-Blind Peer Reviewed Refereed Open Access International e-Journal - Included in the International Serial Directories

Indexed & Listed at:

Ulrich's Periodicals Directory ©, ProQuest, U.S.A., EBSCO Publishing, U.S.A., Index Copernicus Publishers Panel, Poland,

Open J-Gage, India [link of the same is duly available at Inflibnet of University Grants Commission (U.G.C.)]

as well as in Cabell's Directories of Publishing Opportunities, U.S.A.

Circulated all over the world & Google has verified that scholars of more than Hundred & Twenty One countries/territories are visiting our journal on regular basis.

Ground Floor, Building No. 1041-C-1, Devi Bhawan Bazar, JAGADHRI – 135 003, Yamunanagar, Haryana, INDIA

www.ijrcm.org.in

CONTENTS

CALL FOR MANUSCRIPTS

We invite unpublished novel, original, empirical and high quality research work pertaining to recent developments & practices in the area of Computer, Business, Finance, Marketing, Human Resource Management, General Management, Banking, Insurance, Corporate Governance and emerging paradigms in allied subjects like Accounting Education; Accounting Information Systems; Accounting Theory & Practice; Auditing; Behavioral Accounting; Behavioral Economics; Corporate Finance; Cost Accounting; Econometrics; Economic Development; Economic History; Financial Institutions & Markets; Financial Services; Fiscal Policy; Government & Non Profit Accounting; Industrial Organization; International Economics & Trade; International Finance; Macro Economics; Micro Economics; Monetary Policy; Portfolio & Security Analysis; Public Policy Economics; Real Estate; Regional Economics; Tax Accounting; Advertising & Promotion Management; Business Education; Management Information Systems (MIS); Business Law, Public Responsibility & Ethics; Communication; Direct Marketing; E-Commerce; Global Business; Health Care Administration; Labor Relations & Human Resource Management; Marketing Research; Marketing Theory & Applications; Non-Profit Organizations; Office Administration/Management; Operations Research/Statistics; Organizational Behavior & Theory; Organizational Development; Production/Operations; Public Administration; Purchasing/Materials Management; Retailing; Sales/Selling; Services; Small Business Entrepreneurship; Strategic Management Policy; Technology/Innovation; Tourism, Hospitality & Leisure; Transportation/Physical Distribution; Algorithms; Artificial Intelligence; Compilers & Translation; Computer Aided Design (CAD); Computer Aided Manufacturing; Computer Graphics; Computer Organization & Architecture; Database Structures & Systems; Digital Logic; Discrete Structures; Internet; Management Information Systems; Modeling & Simulation; Multimedia; Neural Systems/Neural Networks; Numerical Analysis/Scientific Computing; Object Oriented Programming; Operating Systems; Programming Languages; Robotics; Symbolic & Formal Logic and Web Design. The above mentioned tracks are only indicative, and not exhaustive.

Anybody can submit the soft copy of his/her manuscript **anytime** in M.S. Word format after preparing the same as per our submission guidelines duly available on our website under the heading guidelines for submission, at the email addresses: infoijrcm@gmail.com or info@ijrcm.org.in.

GUIDELINES FOR SUBMISSION OF MANUSCRIPT

1. **COVERING LETTER FOR SUBMISSION:**

DATED: _____

THE EDITOR
IJRCM

Subject: **SUBMISSION OF MANUSCRIPT IN THE AREA OF** _____.

(e.g. Finance/Marketing/HRM/General Management/Economics/Psychology/Law/Computer/IT/Engineering/Mathematics/other, please specify)

DEAR SIR/MADAM

Please find my submission of manuscript entitled '_____' for possible publication in your journals.

I hereby affirm that the contents of this manuscript are original. Furthermore, it has neither been published elsewhere in any language fully or partly, nor is it under review for publication elsewhere.

I affirm that all the author (s) have seen and agreed to the submitted version of the manuscript and their inclusion of name (s) as co-author (s).

Also, if my/our manuscript is accepted, I/We agree to comply with the formalities as given on the website of the journal & you are free to publish our contribution in any of your journals.

NAME OF CORRESPONDING AUTHOR:
Designation:
Affiliation with full address, contact numbers & Pin Code:
Residential address with Pin Code:
Mobile Number (s):
Landline Number (s):
E-mail Address:
Alternate E-mail Address:

NOTES:

a) The whole manuscript is required to be in ***ONE MS WORD FILE*** only (pdf. version is liable to be rejected without any consideration), which will start from the covering letter, inside the manuscript.
b) The sender is required to mention the following in the **SUBJECT COLUMN** of the mail:
New Manuscript for Review in the area of (Finance/Marketing/HRM/General Management/Economics/Psychology/Law/Computer/IT/ Engineering/Mathematics/other, please specify)
c) There is no need to give any text in the body of mail, except the cases where the author wishes to give any specific message w.r.t. to the manuscript.
d) The total size of the file containing the manuscript is required to be below **500 KB**.
e) Abstract alone will not be considered for review, and the author is required to submit the complete manuscript in the first instance.
f) The journal gives acknowledgement w.r.t. the receipt of every email and in case of non-receipt of acknowledgment from the journal, w.r.t. the submission of manuscript, within two days of submission, the corresponding author is required to demand for the same by sending separate mail to the journal.

2. **MANUSCRIPT TITLE:** The title of the paper should be in a 12 point Calibri Font. It should be bold typed, centered and fully capitalised.

3. **AUTHOR NAME (S) & AFFILIATIONS:** The author (s) **full name**, **designation**, **affiliation** (s), **address**, **mobile/landline numbers**, and **email/alternate email address** should be in italic & 11-point Calibri Font. It must be centered underneath the title.

4. **ABSTRACT:** Abstract should be in fully italicized text, not exceeding 250 words. The abstract must be informative and explain the background, aims, methods, results & conclusion in a single para. Abbreviations must be mentioned in full.

5. **KEYWORDS:** Abstract must be followed by a list of keywords, subject to the maximum of five. These should be arranged in alphabetic order separated by commas and full stops at the end.

6. **MANUSCRIPT:** Manuscript must be in ***BRITISH ENGLISH*** prepared on a standard A4 size ***PORTRAIT SETTING PAPER***. It must be prepared on a single space and single column with 1" margin set for top, bottom, left and right. It should be typed in 8 point Calibri Font with page numbers at the bottom and centre of every page. It should be free from grammatical, spelling and punctuation errors and must be thoroughly edited.

7. **HEADINGS:** All the headings should be in a 10 point Calibri Font. These must be bold-faced, aligned left and fully capitalised. Leave a blank line before each heading.

8. **SUB-HEADINGS:** All the sub-headings should be in a 8 point Calibri Font. These must be bold-faced, aligned left and fully capitalised.

9. **MAIN TEXT:** The main text should follow the following sequence:

INTRODUCTION

REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESES

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

SCOPE FOR FURTHER RESEARCH

ACKNOWLEDGMENTS

REFERENCES

APPENDIX/ANNEXURE

It should be in a 8 point Calibri Font, single spaced and justified. The manuscript should preferably not exceed ***5000 WORDS***.

10. **FIGURES &TABLES:** These should be simple, centered, separately numbered & self explained, and **titles must be above the table/figure**. **Sources of data should be mentioned below the table/figure**. It should be ensured that the tables/figures are referred to from the main text.

11. **EQUATIONS:** These should be consecutively numbered in parentheses, horizontally centered with equation number placed at the right.

12. **REFERENCES:** The list of all references should be alphabetically arranged. The author (s) should mention only the actually utilised references in the preparation of manuscript and they are supposed to follow **Harvard Style of Referencing**. The author (s) are supposed to follow the references as per the following:

- All works cited in the text (including sources for tables and figures) should be listed alphabetically.
- Use (**ed.**) for one editor, and (**ed.s)** for multiple editors.
- When listing two or more works by one author, use --- (20xx), such as after Kohl (1997), use --- (2001), etc, in chronologically ascending order.
- Indicate (opening and closing) page numbers for articles in journals and for chapters in books.
- The title of books and journals should be in italics. Double quotation marks are used for titles of journal articles, book chapters, dissertations, reports, working papers, unpublished material, etc.
- For titles in a language other than English, provide an English translation in parentheses.
- The location of endnotes within the text should be indicated by superscript numbers.

PLEASE USE THE FOLLOWING FOR STYLE AND PUNCTUATION IN REFERENCES:

BOOKS

- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio" Ohio State University, Nigeria.

CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

JOURNAL AND OTHER ARTICLES

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

UNPUBLISHED DISSERTATIONS AND THESES

- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

ONLINE RESOURCES

- Always indicate the date that the source was accessed, as online resources are frequently updated or removed.

WEBSITE

- Garg, Bhavet (2011): Towards a New Natural Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

PERFORMANCE ANALYSIS OF THE LIGHT RAIL TRANSIT'S (LRT's) TICKET-BASED SYSTEM IN STATION X USING SIMULATION SOFTWARE

MA. TEODORA E. GUTIERREZ
ASST. PROFESSOR
INDUSTRIAL ENGINEERING DEPARTMENT
TECHNOLOGICAL INSTITUTE OF THE PHILIPPINES
PHILIPPINES

ABSTRACT

The study evaluated the present performance of the light rail transit's (LRT's) fare collection ticket-based system at Station X. The goal is to measure the performance of the current system in terms of the average time that passengers spent in operation that is, procuring the ticket from vending machines and time spent in waiting lines. Total number of passengers in waiting lines was also identified as well as the number of passengers already exited from the system given the thirty (30) minutes observed time. Application of Queue theory in the field of transportation was used as model framework and Promodel simulation software was applied to calculate the present and proposed system.

KEYWORDS

Rail transit, Simulation, Queue Theory.

INTRODUCTION

The presence of rail transit in the developing countries is imperative because it reduces the travel time from one destination to another that helps both individual commuters and businesses alike. The Light Rail Transit Authority (LRTA) is a wholly owned government corporation which is recognized to provide reliable, efficient, and environment-friendly mass rail services to all residents in Metro Manila. In that case, evaluating their systems performance is critical.

The objective of the study is to conduct performance analysis of the fare collection ticket-based systems of LRTA in station X. Moreover, the intention of the study is to improve the systems performance in terms of identifying the optimum number of ticketing machines.

LITERATURE REVIEW

Queuing theory is used to mathematically measure the waiting time of an entity. An entity could be a products, customers, materials and machines. Also, this theory permits to calculate other performance indicators of a system like average time spent, average number of customers in a system, etc. On the other hand, simulation is one of a tool to understand queuing models because of its capability to measure a system performance.

Researches in the field of Queuing theory were applied mostly in transportation industry. For instance, Soh, et al (2009), uses simulation to propose a new traffic model for multilane multiple intersection based on queuing theory. Moreover, Toledo, et al (2010) presented a transit simulation model in order to support evaluation of operations, planning and control where travel time is the basis of performance.

METHODOLOGY

The Light Rail Transit Authority's fare collection system is a ticket based system, which uses two types of tickets: a single journey (one way ticket) whose cost is dependent on the destination and a stored value (multiple –use) which cost one hundred pesos (P100). The study focused on a single journey ticket which can be procured from vending machines.

The evaluation of the current performance was observed between 1:00pm to 1:30 pm at station X. Since that the station is considered as the central place and connecting place to the other rail transit, the period of time that the observation takes place is considered as peak hour. The data collected was stated in table 1. ProModel simulation software was used to measure its performance.

TABLE 1 – ARRIVAL FREQUENCY AND SERVICE TIME OF ALL PASSENGERS

PEAK HOUR 1:OO PM – 1:30 PM					
	Machine 1	Machine 2	Machine 3	**TOTAL**	**Average per Machine**
A. Number of passengers arrive	111	79	139	329	109.67
B. Number of Minutes observed	30 minutes	30 minutes	30 minutes		
C. Total service time of all passengers arrive in 30 minutes	63.70	47.33	58.90	169.93	56.64
A.1 Arrival Rate					
A.1.1 Passengers per Minute ($\frac{A}{B}$)	3.70	2.63	4.63	10.97	3.66
A.1.2 Minute per passenger ($\frac{B}{A}$)	0.27	0.38	0.22	.091	0.29
B.1 Service rate					
B.1.1. Passenger per minute ($\frac{A}{C}$)	1.74	1.67	.87	4.29	1.43
B.1.2 Minute per passenger($\frac{C}{A}$)	0..57	0.60	1.14	2.32	0.77

In the above table, three machines are working during actual observation, although there are seven machines available, the other four machines are under repair. The frequency of passengers' arrival per ticketing machine within the 30 minutes observation ranges from 79 passengers to 139 passengers, which forms an average of approximately 110 passengers. On the other hand, the service time for all passengers which arrived in one ticketing machine within the 30 minutes observation ranges from 47.30 minutes to 63.70 minutes, which constitute an average service time of 56.64 minutes.

The actual observation of passenger's arrival rate was done from 1:00 pm to 1:30 pm, but the total time consumed in directly observing the system of LRTA station X is 4.5 hours, because all passengers arrived from 1:00 pm to 1:30pm were monitored up to the time they exit the system. The system defined here is where passengers procured their ticket through vending machines.

Given the observed data, in order to measure the performance of the Light Rail Transit's (LRT) ticketing machine, the study will use Promodel Simulation software. First step in promodel simulation is to build Location, where it involves identifying the fixed locations of the waiting lines and the ticketing machines in which passengers are routed for processing their transactions. The structure of the system is that each machine has its own waiting line (See figure 1).

Second step in Promodel simulation is to identify Entity, it refers to the items being processed in the system (Benson, 1997). In this case, the entity is the passenger.

Third step is to build Arrival rate. The total number of passengers arrived within the thirty (30) minutes observation is 329 passengers. Hence, arrival rate is 10.97 passengers per minute or 0.091 minute per passenger. The arrival rate is assumed to have exponential distribution in which it characterizes the independencies of arrival. Therefore, the arrival rate encoded in the Promodel has a syntax of E (0.91) MIN.

The last step is to build Processing. The highlight of this step is to identify the service rate. In this study, the service rate is assumed to have uniform distribution with an average of 1.4 passengers per minute per machine or equivalent to 0.77 minute per passenger per machine. It is interesting to note that the service rate becomes longer when the arrival rate increases as implied in the above table where machine 3 has the longest service rate. The service rate ranges from 0.57 minute per passenger to 1.14 minute per passenger. Therefore the service rate encoded in the Promodel has syntax of U (0.77, 0.37) MIN, which means that the service rate has an average of 0.77 minute per passenger per machine and variance of 0.37 minute per passenger per machine.

RESULTS

Below are the results of the simulation after the abovementioned procedures.

FIG. 1 – PROMODEL SIMULATION ON THE TICKETING SYSTEM OF LRTA STATION X

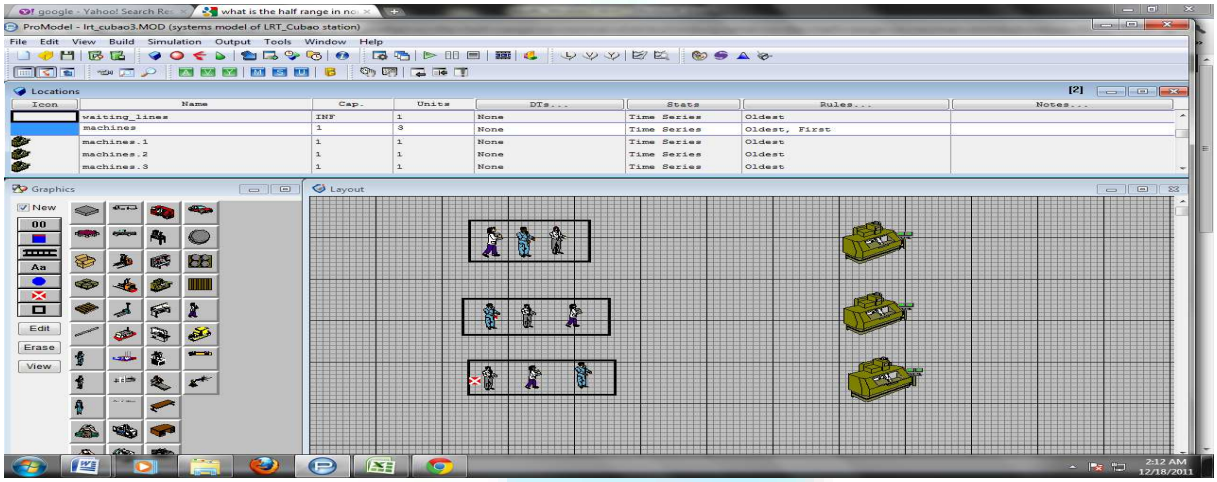
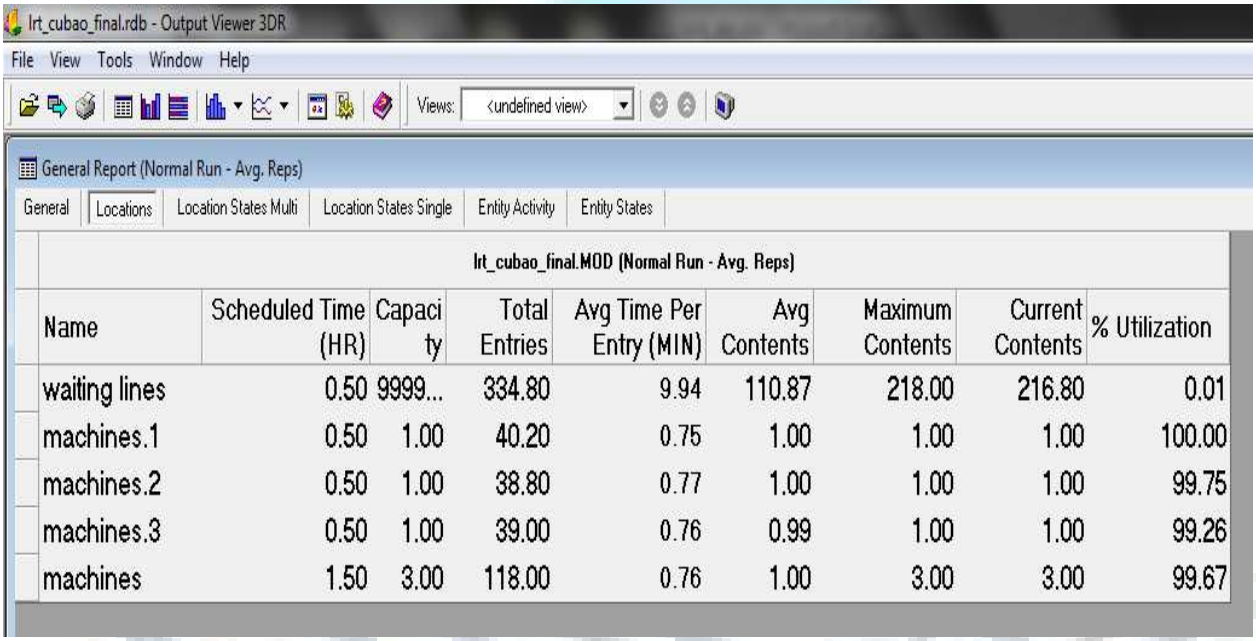


FIG. 2 – PROMODEL OUTPUT REPORTS ON LOCATIONS WITH THREE MACHINES



lrt_cubao_final.rdb - Output Viewer 3DR

File View Tools Window Help

Views: <undefined view>

General Report (Normal Run - Avg. Reps)

General | Locations | Location States Multi | Location States Single | Entity Activity | Entity States

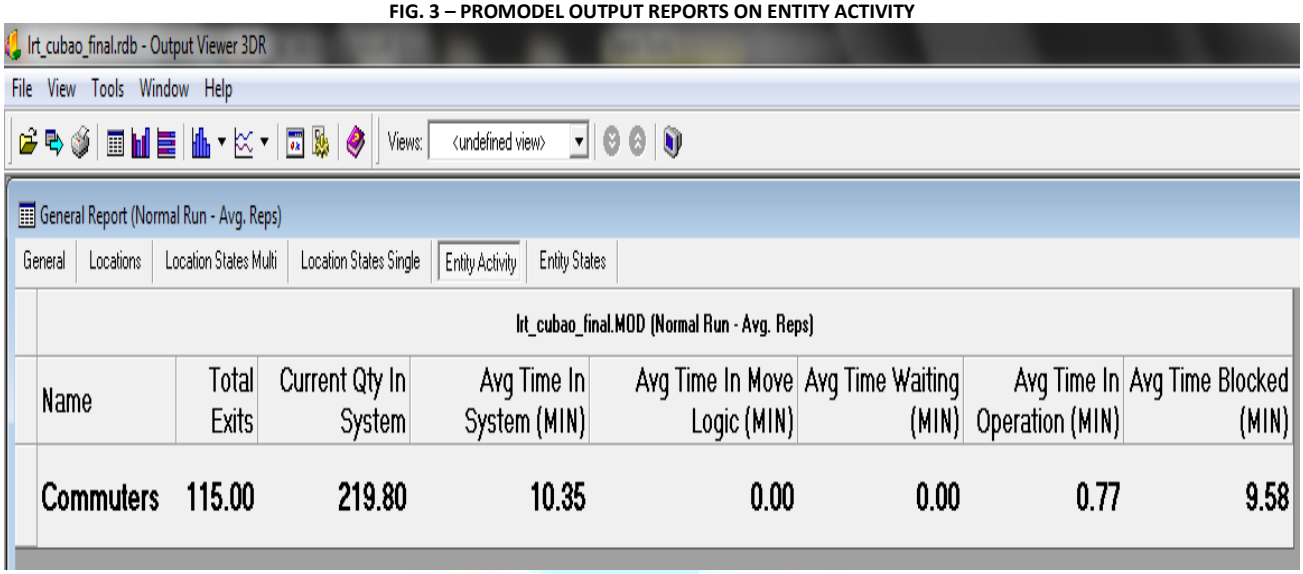
lrt_cubao_final.MOD (Normal Run - Avg. Reps)

Name	Scheduled Time (HR)	Capacity	Total Entries	Avg Time Per Entry (MIN)	Avg Contents	Maximum Contents	Current Contents	% Utilization
waiting lines	0.50	9999...	334.80	9.94	110.87	218.00	216.80	0.01
machines.1	0.50	1.00	40.20	0.75	1.00	1.00	1.00	100.00
machines.2	0.50	1.00	38.80	0.77	1.00	1.00	1.00	99.75
machines.3	0.50	1.00	39.00	0.76	0.99	1.00	1.00	99.26
machines	1.50	3.00	118.00	0.76	1.00	3.00	3.00	99.67

To validate the built model in relation to the actual data collected, the simulation run hours is set to thirty (30) minutes. Actual observation reflected that a total of 329 passengers arrived in the system within the time period of thirty (30 minutes), and in the simulation output report total entries is 334.80 passengers. Moreover, in figure 3 , simulation output revealed that the average time the passengers is in operation or procuring the ticket is 0.77 minutes. Hence, there's a little discrepancy if not none in terms of the data collected and the simulation output report, thus, the simulation model validates the actual fare collection's ticket based system of LRTA station X.

The current performance of the ticketing system of LRTA's station X after thirty (30) minutes of observation time during peak hours an average number of 110.87 passengers that are still waiting in lines .Each machine had already served an average of 40 passengers.

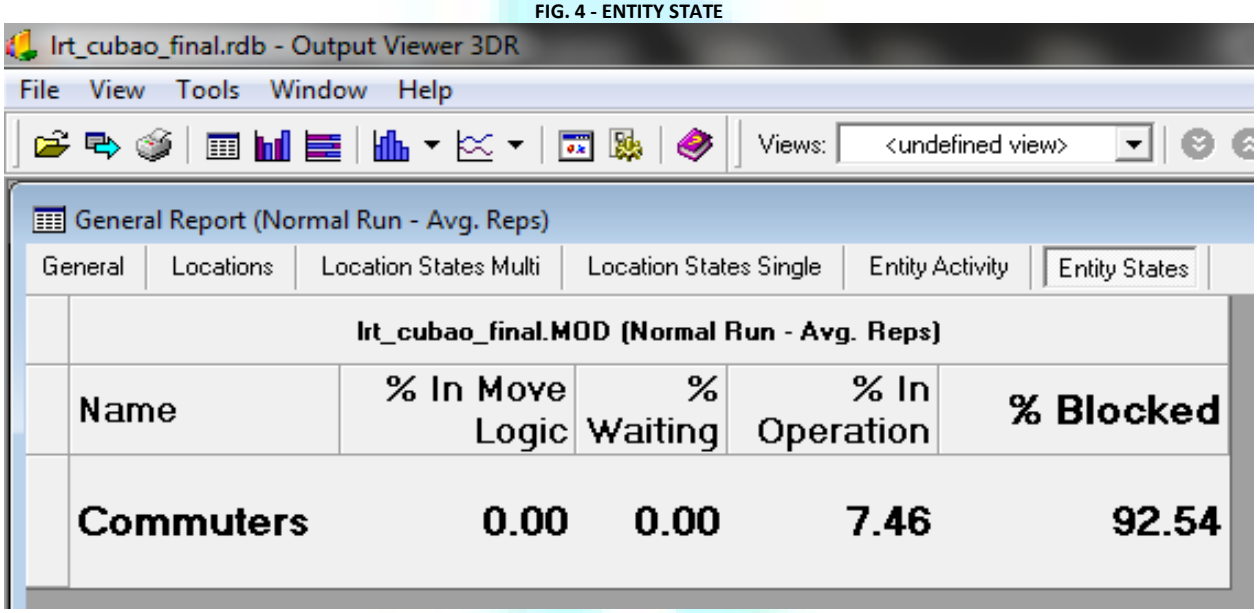
FIG. 3 – PROMODEL OUTPUT REPORTS ON ENTITY ACTIVITY



Name	Total Exits	Current Qty In System	Avg Time In System (MIN)	Avg Time In Move Logic (MIN)	Avg Time Waiting (MIN)	Avg Time In Operation (MIN)	Avg Time Blocked (MIN)
Commuters	115.00	219.80	10.35	0.00	0.00	0.77	9.58

Each passenger spent 10.35 minutes in procuring a ticket. Comprises of 0.77 minutes spent in procuring the ticket, and 9.58 minutes were spent in the waiting lines. Moreover, 115 passengers have already been served or exited in the system and 219.80 passengers are still waiting in line.

FIG. 4 - ENTITY STATE



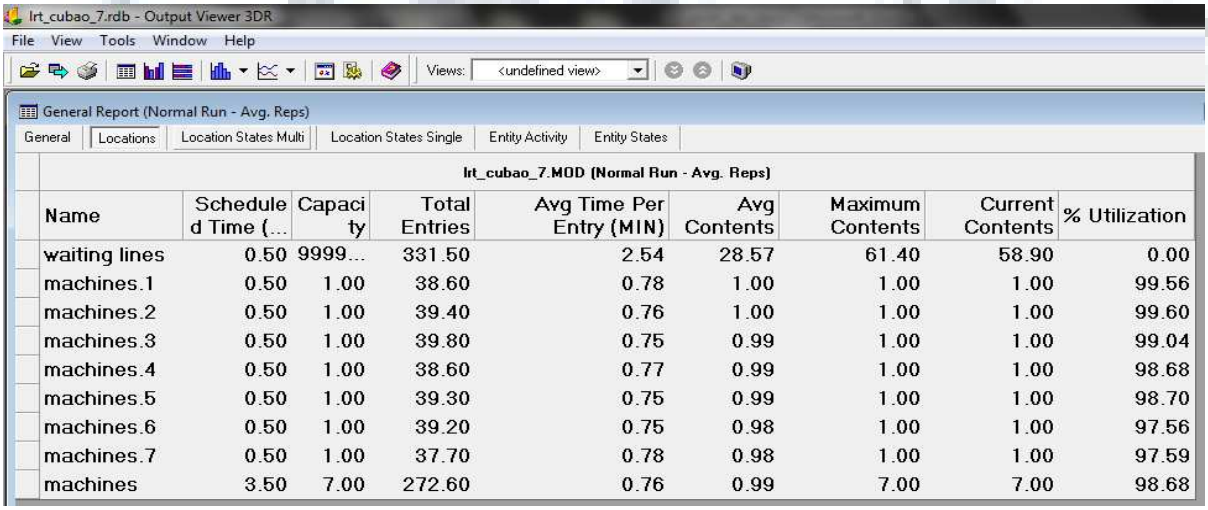
Name	% In Move Logic	% Waiting	% In Operation	% Blocked
Commuters	0.00	0.00	7.46	92.54

The passenger's state in the present system with only three (3) *available* vending machines revealed that each passenger spent 92.54% of the total time waiting in line and only 7.46% of the time spent in procuring a ticket.

The present performance of the system revealed poor customer service because it depicts the purpose of the passengers to arrive at their destination with lesser time for reason of them spending almost ten (10) minutes in queue or waiting lines.

Hence, another scenario could be evaluated by having more available ticketing machines. During the actual observation, four ticketing machines are under repair. Measuring the systems performance when all ticket vending machines were used, reveals the following output:

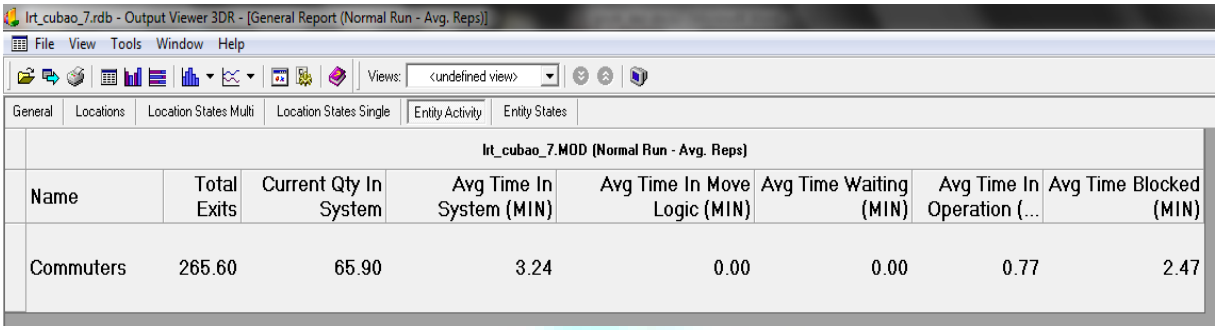
FIG. 5 – PROMODEL OUTPUT REPORTS ON LOCATIONS WITH SEVEN MACHINE



Name	Scheduled Time (...	Capacity	Total Entries	Avg Time Per Entry (MIN)	Avg Contents	Maximum Contents	Current Contents	% Utilization
waiting lines	0.50	9999...	331.50	2.54	28.57	61.40	58.90	0.00
machines.1	0.50	1.00	38.60	0.78	1.00	1.00	1.00	99.56
machines.2	0.50	1.00	39.40	0.76	1.00	1.00	1.00	99.60
machines.3	0.50	1.00	39.80	0.75	0.99	1.00	1.00	99.04
machines.4	0.50	1.00	38.60	0.77	0.99	1.00	1.00	98.68
machines.5	0.50	1.00	39.30	0.75	0.99	1.00	1.00	98.70
machines.6	0.50	1.00	39.20	0.75	0.98	1.00	1.00	97.56
machines.7	0.50	1.00	37.70	0.78	0.98	1.00	1.00	97.59
machines	3.50	7.00	272.60	0.76	0.99	7.00	7.00	98.68

If seven (7) vending machines were used, the average number of passengers waiting in line is 28.57, which resulted to a possible reduction of approximately 200 passengers as compared to the previously observed scenario. Moreover, there is a huge reduction in terms of number of passengers in queue evident by only one passenger left waiting in line in each machine.

FIG. 6 – PROMODEL OUTPUT REPORTS ON ENTITY ACTIVITY WITH SEVEN MACHINES



Name	Total Exits	Current Qty In System	Avg Time In System (MIN)	Avg Time In Move Logic (MIN)	Avg Time Waiting (MIN)	Avg Time In Operation (...	Avg Time Blocked (MIN)
Commuters	265.60	65.90	3.24	0.00	0.00	0.77	2.47

If there are seven machines working, the passenger will spend 3.24 minutes in the system which *comprises* of both operation time and waiting time. The waiting time is 2.47 minutes as compared to the previous scenario of 9.58 Minutes. Moreover, the total passengers exited in the system after thirty (30) minutes is already 265.60 as compared to the previous scenario which is 115 passengers.

CONCLUSION

The performance of the actual observed system which was also termed as present system with three (3) vending machines reflects poor customer service since the time spent by each passenger is 10.3 minutes, which contradicts the purpose of Light Rail Transit (LRT), known to provide efficient and fast service.

On the other hand, the proposed scenario, that is the usage of all seven (7) ticket vending machines, resulted to 3.24 minutes passenger's time spent in the system. This is much lower when compared to the present scenario or the observed system which resulted to a reduction of 69% of the total time spent in the system. Also, the total number of remaining passengers after thirty (30) minutes is 65.90 passengers, a difference of 153.90 passengers or a 70% reduction of passengers. Nonetheless, further study in the analysis of increasing the number of vending machines and its effect to the system performance measure is recommended.

REFERENCES

BOOKS

Banks, J., Carson, J, S. II, Nelson, B., Nicol, D.(2010) " Discrete event system simulation " 5th Edition .Pearson

Hillier, F., Lieberman, G. (2010). "Introduction to Operations Research" Mc Graw Hill

JOURNALS

Soh, A., Khalid,M., Marhaban.M., Yusof ,R. (2009) "Modeling of a multilane-multiple intersection based on queue theory and standard approach techniques" Simulation Modeling Practice and Theory 17 (2009) 1081–1105

Toledo, T., Cats, O., Burghout, W, Koutsopoulos,H. (2010). "Mesoscopic simulation for transit operations". Transportation Research pp. 896–908

Benson, D. (1997) "Simulation Modeling and Optimization using Promodel". Proceedings of the 1997 Winter Simulation Conference

WEBSITE

Bose, S. (2011) "An Introduction to Queuing Systems "viewed on December 18, 2011 http://home.iitk.ac.in/~skb/ee679/ee679.html

REQUEST FOR FEEDBACK

Dear Readers

At the very outset, International Journal of Research in Computer Application and Management (IJRCM) acknowledges & appreciates your efforts in showing interest in our present issue under your kind perusal.

I would like to request you to supply your critical comments and suggestions about the material published in this issue as well as on the journal as a whole, on our E-mails i.e. **infoijrcm@gmail.com** or **info@ijrcm.org.in** for further improvements in the interest of research.

If you have any queries please feel free to contact us on our E-mail **infoijrcm@gmail.com**.

I am sure that your feedback and deliberations would make future issues better – a result of our joint effort.

Looking forward an appropriate consideration.

With sincere regards

Thanking you profoundly

Academically yours

Sd/-

Co-ordinator

ABOUT THE JOURNAL

In this age of Commerce, Economics, Computer, I.T. & Management and cut throat competition, a group of intellectuals felt the need to have some platform, where young and budding managers and academicians could express their views and discuss the problems among their peers. This journal was conceived with this noble intention in view. This journal has been introduced to give an opportunity for expressing refined and innovative ideas in this field. It is our humble endeavour to provide a springboard to the upcoming specialists and give a chance to know about the latest in the sphere of research and knowledge. We have taken a small step and we hope that with the active co-operation of like-minded scholars, we shall be able to serve the society with our humble efforts.

Our Other Journals