Scheduling Methodology to Minimize Random Customer Arrival

K. D. H. A. Kothalawala
Department of Transport and Logistics Management
Faculty of Engineering, University of Moratuwa
Moratuwa, Sri Lanka
heshanko777@gmail.com

N. A. Samarasekera
Department of Transport and Logistics Management
Faculty of Engineering, University of Moratuwa
Moratuwa, Sri Lanka
nsmrskr@yahoo.com

***Abstract* - The main problem addressed by the research is random arrival of customers to pick goods at a product distribution center. Using a Case Study approach, a methodology is developed for scheduling of customer arrivals as a solution. Initially the problem is studied in detail. A survey was carried out to study the current customer behavior of the selected product distribution center. Using the findings of the survey and the literature review, different scheduling solutions are generated. Three most viable solutions are selected and then those three solutions are evaluated in financial, operational and change management aspects to find the best solution. A simulation is also done for customer arrivals to quantify the impact of implementing the scheduling system. The findings of the research clearly indicate the feasibility and the customer service improvements derived by customer scheduling. The customer waiting times and the idling of the distribution point assets can be significantly reduced by the developed scheduling system. Customers' perception of the waiting time can be reduced by providing waiting information of customers prior to their arrival.**

Keywords - random customer arrival; scheduling; customer service improvement, process mapping; distribution; logistics

I. INTRODUCTION

Unplanned, random arrival of customers causes inherent queues in the distribution points, which is unfavorable for both customers and the organization. The amount of waiting time is uncertain and has a high variability. Loading cycle time[1] increases due to uncertain customer arrival patterns, and results in idling of vehicles and drivers/helpers. This unplanned arrival of customers create demand peaks and low demand periods. During this low demand time periods, the distribution points are underutilized (both machines and laborers). Uncertain arrival of customers' increase the lead time and thereby reduce the customer perceived value.

Objective of this research is to develop a solution to address the problem of unplanned, random arrival of customers. The research covers both internal and external considerations and qualitative and quantitative aspects of customer scheduling.

This research has a case study approach to the identified problem. The selected company has a distribution point[2] which has a single queue of customers and 2 loading points. The existing practice is for customers to arrive at the distribution point without prior notice, randomly.

II. METHODOLOGY

A. *Research on the identified problem*

Initial step of the research is to study the problem of random customer arrival. The key problem addressed by the research is random customer arrival to a distribution point in a supply chain.

The following information sources were used for this research:

- Literature review
- Customer survey (primary data)
- Historical data (secondary information) on customer arrival
- Interviews and meetings with relevant staff members of the selected company

B. *Generating solutions*

Different solutions are developed for customer scheduling. The information gathered by the literature review interviews with relevant staff members of the selected company survey are used for developing these solutions.

C. *Selecting three suitable solutions*

Generated solutions are shortlisted based on their applicability. Social, demographic and behavioral factors of customers are considered for short listing.

D. *Selecting the best solution*

The shortlisted solutions are further analyzed, in following criteria to find the best solution.

[1] The time spent by a customer from the moment of entering the distribution point until leaving the distribution point.

[2] A warehouse or other specialized building, which is stocked with goods to be redistributed to retailers, to wholesalers, or directly to consumers.

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- Operational feasibility
- Financial feasibility
- Change management

E. *Predicting the performance of the proposed system*

Subsequently a computer program is developed to simulate the effect of the proposed scheduling system.

III. METHODOLOGY (DETAILED DESCRIPTION)

A. *Research on the identified problem*

1) Literature review

Random customer arrival in a distribution point of any supply chain many issues such as uneven load cycle times, vehicle idling, underutilization of the distribution point etc. A company's goal is to minimize this waiting times and thereby increasing the customer service. There are 2 approaches for managing waiting lines of customers in [1]. Perception management and operations management are those approaches. Perception management focuses on reducing perceived waiting time and is based on cognitive psychology and marketing theories. Operations management focuses on reducing actual waiting time and is based on management science and operations research theories. Cognitive psychological theories such as dissonance theory, resource allocation model and uncertainty reduction model suggest that giving waiting time information prior to waiting reduces customer dissatisfaction [1].

Health care is an industry in which customer scheduling is widely used. In order to ensure operational efficiency in customer scheduling, the following three changes should be made in the human resources. Training on proper knowledge about the scheduling system, recruiting or developing a multi-skilled work force (beneficial in handling peak situations) and giving priority to accurate and fast communication technologies (e.g. walkie-talkies[3], PDA[4], computer dash boards, etc.) [2].

Managing delays and no shows is major operational aspect in customer scheduling system. It is identified that text messaging and calling to mobile phones as productive method to remind appointments to scheduled customers [3].

Automated shopping order system can replace physical queue of customers by an electronic queue [4]. Queuing theory can be used for studying the customer arrivals [5].

2) Customer survey

A survey was carried, with the intention of further studying the random arrival. The objectives were, understanding the scheduling feasibility, quantifying on time arrivals[5], understanding delays etc. Respondents of the survey were customers. Sampling method was convenient sampling and the sample size was 44. Data collection was carried out for a week. Customers' acceptance of the scheduling system was proved by this survey. 75% of the respondents approved the scheduling system.

Delays in customer arrival are identified as a major operational challenge in a customer scheduling system. In this survey the delays were studied. According to the survey results 'on time arrivals' will be 76.41% of total arrivals.

Vehicle breakdowns (especially tire damages), traffic congestions, road repairs and constructions, interruptions by traffic police are identified as factors that cause these customer delays.

Updating the ETA[6] of the customer, at halfway of the journey, is proposed as a measure to ensure the on time arrival. According to survey results 86% customers approved this measure. Respondents stated that this will reduce the time stress on the trip. Because in an unexpected delay, customer can inform the company so the scheduled time slot can be shifted.

B. *Generating solutions*

Five different solutions are developed for scheduling, using information gathered from literature review, meetings and the survey.

- Third party call centre with FCFS[7] slot[8] allocation: - Outsourced call centre is used for operations (order communication, slot allocation). Slot allocation is done on first-come, first-served basis through a computer system. This solution has significant cost savings. But there are security problem regarding sharing information with the third party.
- In house call centre with customized slot allocation: - This solution gives highly customized service. This requires an extensive database and knowledge on customers and their behavior the system tries to fulfill customer orders by mapping time slots and customer requirements.
- Slot allocation by sales representatives: - considering monthly dispatch targets, demand conditions and customer profitability sales representative allocate time slots for customers on an online IT platform. Since sales representative have good knowledge on each customer this system can be implemented. This IT platform is visible to all internal logistics related stakeholders

[3] Hand-held, portable, two-way radio transceiver
[4] Personal digital assistant
[5] Customers who arrive to the distribution point on the scheduled time without any delays.
[6] Estimated time of arrival
[7] First-come, first-served - A service policy whereby the requests of customers or clients are attended to in the order that they arrived, without other biases or preferences.
[8] Measurable time periods of the distribution centre

- Advanced tracking, using GPS: - This is similar to 1st option. The difference is GPS is used for tracking the incoming customer trucks. By GPS the accuracy of tracking can be increased.
- Third party call centre solution with centralized order reception system: - In this system the 3rd party call centre is used for communications and the transactions are done prior to the arrival as described in the Centralized order reception system. This solution consists with a new transaction system is invented and practiced by the selected company .Specialty of the system is that the order placing and transactions are done prior to the arrival to dispatch point. So the time spent for the transactions at the dispatch point is eliminated. In this system the customer can place orders before travelling to the dispatch point.

C. *Short-listing three (3) suitable solutions*

Five generated solutions are shortlisted to 3, based on their applicability. Solutions are ranked using following social, demographic and behavioral factors.

- Compatibility with customers' culture (Age group, educational level, attitude etc)
- Sense of reliability and equality for the customers (sense of unbiased and fair nature)
- Compatibility with transportation, Redistribution practices (Night time preference, frequency etc)
- Financial feasibility for the customer.
- Compatibility with transaction practice

The following three solutions are selected in this step.

i. Third party call centre
ii. In-house call centre
iii. Third party call centre solution with centralized order reception system

D. *Selecting the best solution*

Those three shortlisted solutions are further analyzed on financial feasibility, operational feasibility and change management aspects.

1) Financial feasibility

Fixed and variable costs for each solution are calculated considering all cost components at average industry values.

TABLE I. SUMMARY COST ANALYSIS OF THE THREE SOLUTIONS

Solution	Fixed cost (LKR)	Monthly variable cost (LKR)	Total cost
i.Third party call centre	No fixed cost	451,500.00	451,500.00
ii.In-house call centre	1,650,000.00	3,982,500.00	5,632,500.00
iii.Third party call centre - centralized order reception	3,500,000.00	801,500.00	4,301,500.00

2) Operational feasibility

The processes of the all three solutions are analyzed in order to identify potential operational issues. Following table demonstrate identified issues in this analysis.

TABLE II. SUMMARY COST ANALYSIS OF OPERATIONAL FEASIBILITY

Solution	Operational issues
i.Third party call centre	No major operational issues detected
ii.In-house call centre	Potential issue in slot allocation
iii.Third party call centre - centralized order reception system	No major operational issues detected

3) Change management

Similarly change management aspects of the three solutions are analyzed in order to identify potential issues in change management. Following table demonstrate identified issues in this analysis.

TABLE III. SUMMARY COST ANALYSIS OF CHANGE MANAGEMENT

Solution	Summery
i.Third party call centre	Minor change management required
ii.In-house call centre	Potential change management issues detected
iii.Third party call centre - centralized order reception system	Minor change management required

Each solution is ranked using results of the results of financial, operational and change management analysis.

TABLE IV. SUMMARY ANALYSIS OF THE THREE SOLUTIONS

Criteria	Ranking of each solution		
	3rd party call centre	In-house call centre	3rd party call centre (centralized order taking)
Financial feasibility	1	2	3
Operational feasibility	1	2	3
Change management	1	2	3

All three criteria favor 3rd party call centre (FCFS slot allocation) as the best solution. So that solution is identified as the most suitable for minimize the problem of random customer arrival for the given scenario. As the next step the

performance of the developed solution is quantified by a computer simulation.

E. *Predicting the performance of the proposed system – by a computer simulation.*

The developed model is tested for the performance using a simulation. This simulation would quantify the customer service improvements and possible bottlenecks & required improvements. Simulation is coded as a VBA[9] macro using VBA programming language.

Initially the loading rate of the selected distribution point is calculated using past data derived from the ERP system of the company. One minute and six seconds per Metric Ton (MT) is the loading rate of the selected distribution point.

20% Tolerance level is added for loading time considering operational delays, but this number is a variable in the simulation. With additional 20% loading time, the loading rate is one minute and nineteen seconds per MT.

- Arrival information of customers are taken from a selected past date. By those past data a scheduled behavior is simulated.
- The simulated scheduled behavior is compared with actual behavior. Then the quantitative effect of the scheduling system is measured. The customer service attributes such as load cycle times[10], delays, etc are compared.

1) Assumptions

- The proposed scheduling system takes customers request for scheduling and allocates time slot for each customer. But such information is not currently available for this simulation. The closest available information that resembles these criteria is 'gate in[11]' information. So the 'gate in' information is used for the simulation.
- In other words this simulation schedules customers at the time of arrival at the gate. But the system actually schedules prior to the arrival at the trip origin (starting location of the trip). So if customers are scheduled at the trip origin the results will improve further.
- It is assumed that all customer orders can be served by at least one of the loading points. So there will be no customers that cannot be served.

2) Description of the Algorithm used for the simulation (Figure 1)

Step1: Selects the first customer order for scheduling on FCFS basis.
Step 2: checks whether the customer should be exclusively catered by loading point 1
Step 2. A: Allocates the customer to loading point 1 (If ***Step 2*** is true this step is executed)
Step 3: checks whether the customer should be exclusively catered by loading point 2
Step 3. A: Allocates the customer to loading point 2 (If ***Step 3*** is true this step is executed)
When the ***Step 4*** is arrived, ***Step 2*** and ***Step 3*** have been passed. In other words the customer can be served by any of the two loading points.
Step 4: Finds the loading point which will available earlier.
Step 5: Allocates the customer to the loading point found in ***Step 4***.
Step 6: Checks whether time slots are allocated to all customers.
Step 6. A: the program is terminated (If ***Step 6***: is true)
Step 7: Next customer is selected (and the loops the process from continues ***Step 2***.)

3) Algorithm design

There might be loading limitations for loading points depending on its design. Example: loading point XYZ has a smaller maneuvering area for the truck, therefore bigger trucks cannot be loaded by that specific loading point.

When these loading limitations are considered, four different sets of customers can be identified (similarly there are '2^n' number of possible sets, for 'n' number of loading points, according to the theory of combinations)

- Customers that can be served, exclusively by the loading point 1.
- Customers that can be served, exclusively by the loading point 2.
- Customers that can be served, by any of the two loading point
- Customers that cannot be served by, any of the two loading point

When it is assumed that each of the customers can be served by at least one loading point, the 4th set can be deleted. Now there are only 3 sets (similarly, for 'n' number of customers the figure will be '2^n -1')

- Customers that can be served exclusively by the loading point 1.
- Customers that can be served exclusively by the loading point 2.
- Customers that can be served by any of the two loading point

The algorithm selects one customer at a time and checks for the above 3 sets and allocates the customer.

[9] Visual Basic for Applications (VBA)
[10] The time spent by a customer from the moment of entering the distribution point until leaving the distribution point.
[11] The instance where ,a customer enters the distribution point promises through the entrance.

First two sets are checked in steps **2** and **3**. Since rests of the customer belong to the 3rd set they are allocated to the 3rd set in step **4** and **5**.

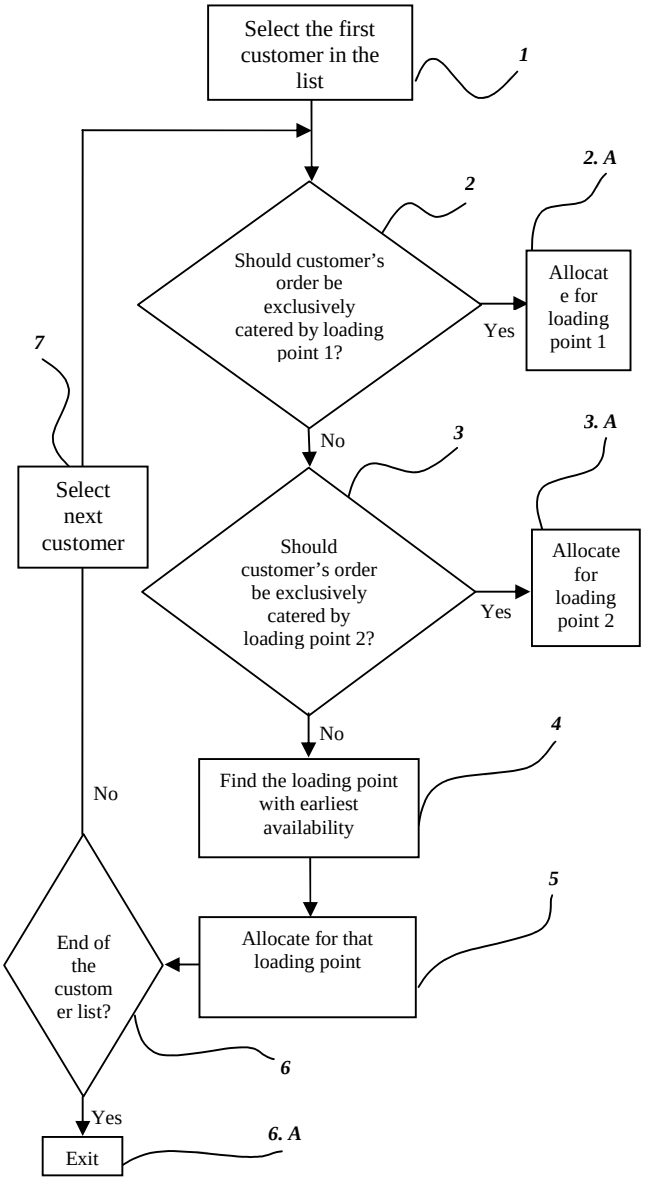

Figure 1. Algorithm used for the simulation

TABLE V. SIMULATION RESULTS SUMMARY

Scenario	Criteria	Maximum LCT (HH:MM)	Average LCT (HH:MM)	Number of customer exceeding LCT KPI (02:30)
Demand peak scenario	Actual	19:04	05:39	88
	Simulated	11:53	03:40	56
	Reduction	38%	35%	36%
Average demand scenario	Actual	15:48	08:08	89
	Simulated	07:39	03:21	43
	Reduction	51%	59%	52%
Low supply scenario	Actual	09:29	03:46	59
	Simulated	07:32	03:19	43
	Reduction	20%	12%	27%

Using the algorithm shown in the Figure1 the VBA program simulates customer scheduling. Cycle times of the customers (usual arrival vs. (simulated) scheduled arrival) are compared.

Results of the simulation demonstrate that the proposed system has significant customer service improvements. Three scenarios are considered in the simulation average demand scenario, low supply scenario, demand peak. 2.5 hours is the KPI[12] maintained for the customer LCT in the selected company.

IV. CONCLUSIONS AND RECOMMENDATIONS

Random customer arrival to distributions points of the supply chain is a phenomenon which causes many negative impacts to customer and the company. Scheduling customers is a feasible option to minimize the negative impacts of this random customer arrival.

The customer dissatisfaction caused by inconsistent and high waiting time can be reduced by providing customer with information about waiting time. The perception of the delay can be reduced by prior provision of waiting time information.

Simulation results prove that there is considerable time savings and thereby customer service improvements, by scheduling customers arrivals. All scenarios considered in the simulation prove the time savings of customer scheduling.

[12] Key performance indicator

Customer scheduling using a 3rd party (outsourced) call centre is the most suitable solutions in all aspects (financial, operational, change management). When using a 3rd party (outsourced) call centre there will be significant cost savings. But there will be disadvantages in data security and quality control. These threats can be minimized, by well planned IT security systems and call centre quality control (monitoring) system and supervision.

Transportation delays are a main operational challenge to customer arrival scheduling. The status updates over the phone can reduce the operational issues created by transportation delays. Mobile phone is identified as the feasible mode for communication considering this scenario. But technology such as, GPS is highly viable for this status updating process. It has significant benefits such as accuracy etc. But GPS technology is not proposed in this scenario due to high fixed costs.

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