Customer experience management in Food and Beverage outlet at Indian School of Business: Methodology and recommendations

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Abstract— **In a regular consumer product industry, stockouts are prevented by carrying safety stock to prevent underserving caused by changes in customer demand, incorrect forecast or variability in lead times. But, for a food outlet like the one at Indian School Business, option of carrying safety stock is not viable because of the need to provide freshly cooked meals to ISB residents. Besides, the food outlet being the sole provider has no incentives to reduce stockouts, as they have no fear of losing revenue, gross profit, customers and market share. Hence, innovative, easy to implement and practical ways of addressing the twin problem of long queues and poor customer experience needs to be investigated. Current work analyses the demand pattern of 11 different food items across a routine day. Based on this optimum resource allocation for all food items has been carried out by solving a linear programming problem with cost minimization as the objective. Concurrently, recommendations have been devised to address this demand and supply side problem keeping in mind their practicability. Currently, the recommendations are being discussed and implemented at ISB Hyderabad campus.**

Keywords: F&B industry, queuing analysis, demand management, resource allocation, Linear programming (LP).

I. Introduction

Customer experience management in restaurants is a real-life problem. Food and beverage (F&B) establishments experience lull periods in between meals and high demands during traditional meal times, sometimes to the point of restaurants having to turn diners away or making them wait in long queues when their maximum capacity in terms of human resources/ equipment/raw material are reached. This not only affects the eatery's profit-making potential but, also creates negative goodwill among customers, thereby, reducing the number of return customers. In fact, it has been reported that the current global dine-in market is worth about $2 trillion, but, it has the actual potential to make an estimated $590 billion in additional revenue if it incorporates better operations and management practices [1].

However, in institution-based settings where customers do not have any other choice, other than the designated restaurant. It becomes a multi-stakeholder problem adversely affecting the efficiency of those dependent on the restaurant beside creating challenges for leadership in such institutes. Hence, it becomes imperative to investigate ways to address this problem. One of the main cafeteria at Indian School of Business (ISB), Hyderabad campus has been facing a similar problem for quite some time. This motivated the author to explore ways to address this problem by applying lessons from operations management and leveraging the use of operations analytics.

Kimes et al. suggested that restaurants forecasting by the length of stay can be used to reduce the variation in it dining times by roughly determining how long people will stay at the table [2]. Queueing based optimization model with quasi birth-and-death process and state-dependent functions have been investigated by Hwang et al. to address the dynamic and nonlinearity related difficulties [3]. Hwang et al. also examined the impact of table assignment policies on waiting for time performance and the effects of key demand features for

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policy selection [4]. In fact, it has been reported that demand management has a huge business proposition [5]. Bertsimas et al. utilized various methods including integer programming, stochastic programming, and approximate dynamic programming methods to maximize revenue in a restaurant [6]. Hence, it becomes imperative to identify better operations management techniques and come out with better process design to improve the profitability of the F&B industry.

This work derives the optimal simultaneous capacity and production plan for a short life cycle, produce-to-sell good (F&B at ISB Hyderabad campus) under stochastic demand. Demand has been modelled using equations which capture the real-time demand data as a function of time. The real-time demand data has been collected over an interval of 2 weeks. We have studied multiple scenarios, which cover a normal working day, a weekend and an institutional holiday. Capacity can be reduced as well as added, at exogenously set unit prices, subject to certain constraints. Each of these scenarios have been modelled as a Multi variable linear pprogramming problem (LP). The resource variables have been converted into units of time. Such formulation overcomes the challenges involved in solving an integer programming problem, which solely utilizes the expected demand values as an indication of future customer orders. In each of these LPs, the constraints are the turn-around time per order, number of food preparation equipment, number of cooks and number of cooking assistants. All these resource variables have been converted to equivalent hours of service. The objective is to minimize the cost or maximize the weekly profit of the restaurant. In fact, an economist may question such selection of objective, as it targets maximising producer surplus. However, such an objective has been set keeping in the mind, the easy adoption of recommendations of the findings of this work by restaurant management. Besides, the constraint on turnaround time takes care of the customer experience. Hence, both producer and consumer surplus have been taken care in order to maximize total surplus. The LP has been solved using MATLAB in a standard PC with 8GB RAM and average solution times in the order of 5 hours have been recorded.

The present work identifies the reason behind the higher turnaround times and lack of order fulfilment. Next, these reasons have been traced to each activity and resource involved in the process. Bottleneck resources and resource utilization factor estimation provided us with several insights to improve customer experience. The findings of this study emphasize the importance of service capacity management in two broad areas namely: human resources and flexibility in capacity (refer Fig. 1). Elaborate recommendations have been provided for each of the scenario with skill-based training, leadership, cross training, and capacity alteration as the most suitable ones. The suitability of each of these recommendations has also been discussed with the restaurant management considering them as one of the critical stakeholders. This stakeholder engagement ensures that recommendations from this study are adopted swiftly and, in their entirety, to affect a real improvement in customer experience.

Currently, step by step implementation of the recommendations from this work is being done at ISB Hyderabad campus. Daily performance in terms of turnaround time for each order is being measured to measure the performance improvements post implementation of recommendations. We are discovering additional dependencies and constraints on a daily basis as we operationalize our recommendations. Next, we are planning to calibrate the suggested process improvements for arriving at a more practical yet optimal solution towards addressing this operational challenge of satisfying customer expectations from an F&B outlet under resource constraints through establishing lean and efficient process.

This work summarizes the latest research in the field of F&B operations management (in the Introduction section). Next, identifies the resources and constraints involved in the problem about customer experience at an F&B outlet in ISB. Then, models various scenarios using Linear Programming to find out the most optimal mix of resource utilization (in the Methodology section). Elaborate recommendations have been made in the conclusion section based on the findings from this work, and, their implications in real life scenario have also been investigated (in the Application section) to suggest the most effective solution to the problem of F&B outlet operation. Future scope for improving the F&B operations at ISB food outlet has been discussed in the concluding section.

II. METHODOLOGY

A. Data collection: Operations and resource allocation

First, data related to daily operations of the biggest food cafeteria at Indian School of Business, Hyderabad was collected over a week. This data provided us with demand pattern of various food items across the week. Demand data for 11 different food items (bulk selling items) across three different time segments viz. morning, afternoon and evening was identified and segregated. Next, the value chain for delivery of each food item was identified. This provided us with the resource requirement break-up for every food item. The expected time for each activity (t, t_c, t_d, t_e) has been calculated by observing the different activities involved in processing of each food item delivery based on following equations.

$$E(Time) = \frac{Best\ Case + 4 * Most\ Likely + Worst\ Case}{6}$$

$$Var(Time) = \frac{(Worst\ Case - Best\ Case)^2}{6}$$

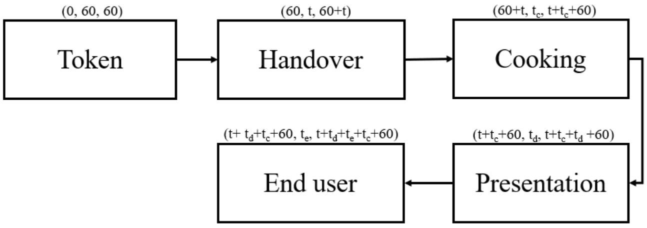

Fig. 1. Value chain of food delivery to customer

The value chain for delivery of food to customer has been broken down into 5 steps, as shown in Fig. 1. It starts with purchase of token by the customer, next the handover of token to the food counter happens. This is followed by processing of food at three different levels consisting of cooking and dressing (presentation of food) to the customer. Each of these steps involve manpower and equipment. The manpower and equipment vary from one food item to another. These two resources namely manpower and food processing equipment have been quantified in terms of the hours of availability and their respective costs. For example, ordering of dosa (a south Indian dish) by a customer involves processing by the cashier, 1 cook, 1 assistant and 2 food processing equipment. Once the resource requirement for all food items have been identified, separate variables have been defined for each of these. In particular, manpower and equipment requirement times have been mapped to token issue(B1), handover(B2), cooking(B3) and dressing(B4) steps in the activity flow.

B. Mathematical model: Resource estimation

The different resource requirements, in terms of time per food item per activity step has been quantified and captured by using variables m_{ij}, where "m_{ij}" is the resource requirement in time term, here, "i" stands for i^{th} resource and j^{th} food item. Next, constraint equations meeting each resource requirement have been written. The algorithm for modelling the constraints and objective function using MATLAB is outlined below:

For i=1: size(b1)

For j=1: size(b2)

For k=1: size(b3)

…

…..

$B_1(i,1)=B_1(i,1)+mm_{11}\times b_1(i,1)+mm_{21}\times b_2(j,1)+mm_{31}\times b_3(i,1) + mm_{41}\times b_4(j,1)..;$

$B_2(i,1)=B_2(i,1)+mm_{12}\times b_1(i,1)+mm_{22}\times b_2(j,1)+mm_{32}\times b_3(i,1) + mm_{42}\times b_4(j,1)…;$

$B_3(i,1)=B_3(i,1)+mm_{13}\times b_1(i,1)+mm_{21}\times b_2(j,1)+mm_{31}\times b_3(i,1) + mm_{41}\times b_4(j,1)…..;$

$B_4(i,1)=B_4(i,1)+mm_{21}\times b_1(i,1)+mm_{22}\times b_2(j,1)+mm_{32}\times b_3(i,1) + mm_{42}\times b_4(j,1)……..;$

…….

……….

End

End

End

Here, m_{ij} is the time taken for activity j by food item i

$b_1, b_2, b_3, b_4……, b_{11}$ are demand of different food items

Constraints:

$x_i \le B_i$ *here i=1,2,3,4*

Objective Function:

Minimize: $C_1*x_1+C_2*x_2+C_3*x_3+C_4*x_4$

$C_i=\{C_1, C_2, C_3, C_4\}$= Cost per unit resources 1,2,3,4 in rupees

$B_i=\{B_1, B_2, B_3, B_4\}$= Record of resources 1,2,3,4 in minutes for each demand scenario

For all possible demand scenarios, we find record of estimates of x_1,x_2,x_3,x_4 (in minutes) such that the total cost per demand scenario is minimized. Such calculations have been performed for each time segment during the day considering the food item mix order during that segment of the day. This provides the estimates of number of units of resources (n_i) required per demand scenario during that segment of the day. Here, 5 hours of working time per resource has been considered per service segment.

$$n_i = x_i / (60*8) \qquad \text{here } i=1,2,3,4$$

Next, 95% confidence intervals have been estimated for each of the resources 1,2,3,4 for each segment of day. This provides estimate for requirement of each resource (1,2,3,4).

C. Mathematical model: Queue analysis

A regular situation which the ISB's canteen has been facing is formation of long queues of customers waiting for food items to be served. Hence, further analysis has been carried out. However, theoretically parallels have been drawn between the actual observations and queuing theory.

1. If inter-arrival and processing times are constant, queues build up if and only if the arrival rate is greater than the processing rate.

2. If there is variability in inter-arrival and/or processing times, queues build up even if the average arrival rate is less than the average processing rate.

3. If variability in interarrival and processing times can be synchronized, queues and waiting times can be reduced.

$$W_q = \frac{1}{R} \times \frac{\rho^{\sqrt{2(c+1)}}}{1-\rho} \times \frac{CV_i^2 + CV_p^2}{2}$$

C= Number of servers

T_p = average processing time

$r = 1/T_p$ = Capacity of each server

R_p = Total service capacity

CV_p = coefficient of variation

$\rho = R_i/R_p$ = Utilization

R_i = Input flow rate (=R)

CV_i = Coefficient of variation of interarrival times

III. Results and Discussion

A. Analysis: Operations and resource allocation

A rigorous analysis of the operations of ISB's food canteen has been carried out based on the mathematical models elaborated in previous section. Based on which, estimates for each resource have been calculated for each segment of the day. In present case, three service segments have been identified 7AM-12PM, 12-5PM and 5-10PM. The resource requirement for the varying demand levels have been estimated for different service segments during the day and plotted below specifically for the afternoon segment, as shown in Fig. 2-4.

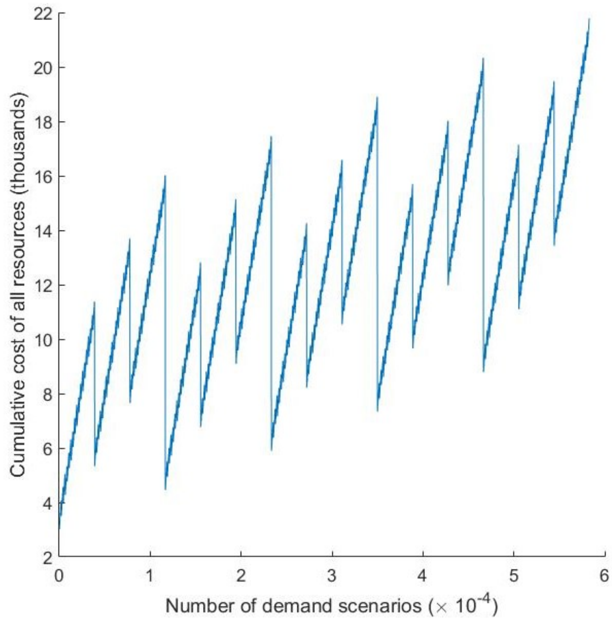

Fig. 2. Variation of cumulative cost across various resources for different demand scenarios

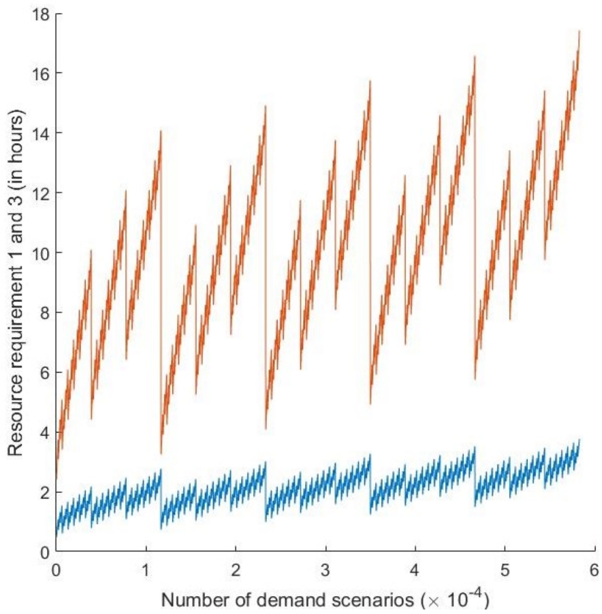

Fig. 3. Variation in requirement of resources 1 and 3 for different demand scenarios (Red: Resource 1, Blue: Resource 3)

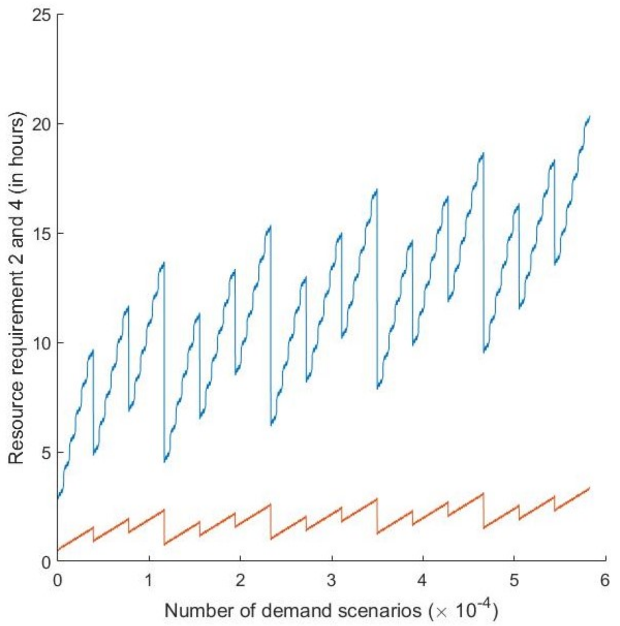

Fig. 4. Variation in requirement of resources 2 and 4 for different demand scenarios (Red: Resource 4 , Blue: Resource 2)

The 95% confidence interval around estimates of resource requirement in hours and costs have been estimated for each service segment and tabulated in Table 1 and Table 2.

There are few trends obvious from the plots that resource requirements change in line with change in demand across different demand scenarios. These estimates have been used to affect the planning of manpower and food processing equipment allocation at ISB's food canteen. Effectively, a workforce of assistants, cooks and various food processing equipment have been proposed. However, even after applying these estimations to allocate manpower and equipment, it was observed that queues were building up. Hence, it has been inferred that plausible reasons to explain it are: the arrival rate is greater than the processing rate OR variability in inter-arrival and/or processing times. Out of the above two considerations, it is clear that both scenarios provide us an opportunity to tune our internal capacities in such a way so that food processing rate exceeds average food demand requirement. However, despite allocating manpower and equipment as per this criterion, it is plausible that queues form. When the observations were compared with the ground realities, it was found that there are periods of on-time service without queues as well as periods of high demand where the queue size swelled up. Hence, the other possibility of variability in inter-arrival and/or processing times with little no-control has been explored further. In fact, we do not have to go very far to understand this, out of all the possible demand scenarios during any service segment of the day. There are multiple scenarios which support the fact that variability in inter-arrival and/or processing times is the bigger challenge which needs to be addressed.

B. *Analysis: Queuing and demand management*

Current analysis shows that maximum resource requirement during high demand period fluctuates between 1 to 20 hours during a 5-hour segment on any typical day. This translates to a manpower requirement of at least 4 for activities 3 and 4. If we apply additional factor of safety to account for inefficiencies due to breaks and communication gap among cooking staff. This will result in a maximum manpower requirement of 5 for some of the most demanding situations. Hence, cross working is essential to keep the processing time variability in control.

TABLE I. SUMMARY OF RESOURCE REQUIREMENT

Requirement (hrs)	Lower limit	Mean	Upper limit
Resource 1	0.36	0.8267	1.2933
Resource 2	0.98	2.38	3.78
Resource 3	0.2733	1.04	1.8067
Resource 4	0.36	0.8267	1.2933
Requirement (hrs)	Lower limit	Mean	Upper limit
Resource 1	1.215	2.1275	3.04
Resource 2	5.63	11.58	17.54
Resource 3	5.4	11.6	14.43
Resource 4	0.99	1.93	2.87
Requirement (hrs)	Lower limit	Mean	Upper limit
Resource 1	0.93	1.62	2.31
Resource 2	5.7	11.51	17.32
Resource 3	2.9	4.97	7.05
Resource 4	0.99	1.89	2.79

TABLE II. SUMMARY OF DEMAND SIDE VARIABILITY, COSTS AND UTILIZATION RATE

Demand (R_i)	Mean	Standard deviation	CV_i
Morning	50	14	0.28
Afternoon	81	17.75	0.21
Evening	75	15.65	0.208

Queue parameter	Capacity (R_p in hrs)	Cost (INR)	Utilization (R/R_p)
Morning	90	49600	0.45
Afternoon	120	81300	0.675
Evening	110	76000	0.68

C. Recommendations

In a regular consumer product industry, stockouts are prevented by carrying safety stock to prevent underserving. But, for a food outlet like the one at ISB, option of carrying safety stock is not viable because of the need to provide freshly cooked meals to ISB residents. Hence, innovative, easy to implement and practical ways of addressing the twin problem of long queues and poor customer experience have been devised, as follows:

1) Provide customer with real time data on food items which will take more processing time by recording and displaying information on expected processing time of various food items in real time. This not only empowers the customer, but, also reduces the coefficient of variation in interarrival times (CV_i).

2) For standardized refreshments like tea, coffee, cookies, snacks and milk shakes which have nearly constant demand pattern and can be prepared as well as stored in advance for serving later, issue tokens which can be purchased separately at any time from separate counters. This effectively does away the need to stand /wait in the queues (B1) and waiting for processing at food counters (B2). This will have positive spill over effects as it will reduce the in queue waiting time for diners who order freshly cooked items.

3) Cross training of cooks/cooking assistants to enable them to participate in cooking multiple food items during a day (reduce CV_p, B2 and B3).

4) Better training of cooks and their assistants to reduce processing time variability (reduce CV_p). Also, the complete cooking staff needs to be made conversant in either Hindi or English to swiftly understand the instructions/request from customer as well internal communication while serving and processing the meal respectively (reduce CV_p). Hence, reduce the time taken in activity B4.

IV. CONCLUSION

The current work investigates one of the most prevalent problems of F&B industry by analysing operations of a food outlet at Indian School of Business. The problems have been viewed from supply as well as demand side perspective by modelling various resources at supply side and modelling their utilization on a typical day using the real demand data collected over an observation period of 30 days. Most optimal resource allocation based on cost minimization with constraints on food processing time has been estimated to address the twin problem of incentivizing the service provider and meeting the expectations of end user. However, it was found that even with optimal resource allocation, customer waiting times have not come down significantly. Hence, queuing analysis has been carried out, which provided insight on demand and supply side processing variability as the main drivers of queue formation. In this perspective, recommendations have been devised keeping in mind their feasibility and some of these recommendations are being discussed and implemented at ISB Hyderabad campus.

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REFERENCES

[1] Can Yield Management Change the Future of Food & Beverage Industry, https://www.entrepreneur.com/article/297848

[2] Kimes, S. E. (2005). Restaurant revenue management: Could it work? [Electronic version]. Retrieved, from Cornell University, SHA School site: http://scholarship.sha.cornell.edu/articles/827

[3] J. Hwang, L. Gao, W. Jang,Joint demand and capacity management in a restaurant system, European Journal of Operational Research, Vol. 207, Issue 1, 2010, Pages 465-472, ISSN 0377-2217, https://doi.org/10.1016/j.ejor.2010.04.001.

[4] Johye Hwang (2008) Restaurant Table Management to Reduce Customer Waiting Times, Journal of Foodservice Business Research, 11:4, 334-351, DOI: 10.1080/15378020802519603

[5] Demand Management Provides a Business Model, https://www.inc.com/howard-greenstein/demand-management-provides-a-business-model.html, Howard Greenstein

[6] Dimitris Bertsimas and Romy Shioda. 2003. Restaurant Revenue Management. Oper. Res. 51, 3 (May 2003), 472-486. DOI=http://dx.doi.org/10.1287/opre.51.3.472.14956