A Model of Dynamic Scheduling of Restaurant Operations Considering the Order and Timing of Serving Dishes

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Abstract. Japanese and French restaurants provide dishes in an order specified by tradition; for example, from appetizers to desserts. On the other hand, customers in a Japanese-style bar or casual restaurant often order several dishes at one time. They may have implicit preferences as to the order and timing of serving the dishes according to the characteristics of the foods and their situations. For example, light meals that can be served quickly tend to be served first to cater to customer desires. This paper proposes a dynamic scheduling approach for restaurant service operations considering the order and timing of serving dishes. Customers specify their requests for the order of serving dishes to floor staff, and then a model configures cooking and serving schedules dynamically according to the customers' requests. In this paper, three models are proposed. In the first model, cooked dishes are stocked in a storage space until the customers' requirements for the order have been satisfied. The second model coordinates cooking schedules by considering the order sequence, cooking time, and lot assignment to adapt to customer requirements. The third model combines the first and second models.

Keywords: Dynamic scheduling · Service · Customer satisfaction
Operations management · Restaurant

1 Introduction

In the customer-facing service industry, this is not merely a pursuit of improved efficiency but is also required in order to improve or maintain customer satisfaction [1]. In research targeting the restaurant service industry, many studies have evaluated waiting time in terms of resource constraints such as numbers [2, 3]. They have considered the number of people that can be accommodated inside of a restaurant, the number of tables, and the number of staff. Hwang et al. modeled the restaurant service provision process and constructed a simulation model that evaluates the waiting time in different seat numbers and the number of floor staff and kitchen staff [4]. However, cooking time and meal time are constants in Fung's model, and the cooking schedule is not considered. In the model of Hwang et al., the order arrival rate and cooking rate are defined as variables, as in Fung et al., the cooking schedule is not considered. It demonstrated

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that cooking time is shortened by helping other cooking places but the cooking schedule was not taken into consideration.

Few studies have dealt with restaurants' cooking schedules, and few have focused on the order of cooking offerings and customer satisfaction. In restaurants, when a customer orders multiple dishes at the same time, it is conceivable that the order of the offerings and the time required to provide them as expected by customers are different, depending on the characteristics of the selections. In Japanese and French cuisine courses, the order of cooking is traditionally decided in advance. In restaurants, customers sometimes order multiple dishes one by one rather than courses for the purpose of eating accompanied by drinking and slowly tasting multiple dishes. In this scenario, customers may implicitly specify the order of supply and timing according to their requests. In improving customer satisfaction, the order of dishes is considered to be an important factor. Considering the operations at the realization site, it is possible to secure enough human resources at high-end and other restaurants and to adjust the cooking sequence and schedule according to the pace of each customer's meal.

On the other hand, efficiency is essential, especially in popular restaurants. It is necessary for cooking staff to devise a cooking order individually in response to incoming customer orders. In kitchens where a POS system is installed, customers' orders are divided into appropriately assigned cooking areas or facilities. By looking at an incoming group of customers' orders, the cooking staff devise an efficient order of cooking as in a batch set of compilation. One concern with the current approach is that acceptability or inadequacy of the device depends on the experience value or intuition of the individual. Basically, cooking staff cook the orders allocated to them in order from the chronological beginning of the order list Since this is a closed process within the staff, it is difficult for staff to consider the precedence relationship with the orders allocated to other cooking areas and equipment. Additionally, at restaurant service sites that have substantial subordinate work and heterogeneous services, there are many dynamic factors to be considered in the field and operating according to a complete schedule given from the outside is difficult. Therefore, this study proposes a model that schedules restaurants' cooking and serving tasks in consideration of the order and timing of dishes for food service. In this model, when a customer places a request for each dish at the time of ordering, the schedule of cooking and serving is dynamically constructed based on that order. This aims to improve customer satisfaction by considering the order and timing that customers expect when ordering.

2 Proposed Model

2.1 Modeling

This paper targets restaurants where customers order multiple single items at a time. The schedule of cooking and serving is decided based on four methods. In addition to the conventional provision method, the following three methods are proposed. Next, the three proposed methods are assessed by simulation.

- Floor scheduling considering the order of arrangement requested by customers (Proposed method (1))

- Cooking scheduling considering the ordering sequence (Proposed Method (2))
- Cooking considering the order of serving and floor scheduling (Proposed method (3)).

An example of a restaurant model is shown in Fig. 1. In this example, the restaurant is composed of three areas: the floor area, an area for stocking cooked goods, and a kitchen. The area of product placement is placed between the kitchen and the floor and cooked goods are kept there until they are served. The number of floor areas, the space for cooked goods, and the number of kitchens may be n to n; not one by one. The kitchen is divided into several zones for similar cooking work. For example, drinkers (make drinks), cooktops (to prepare ingredients), shops, fried grounds, and so on. Cooking facilities such as refrigerators and ovens are treated as one zone.

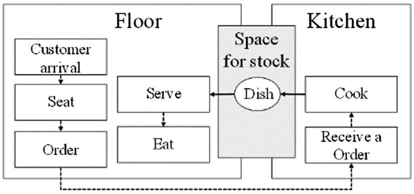

Fig. 1. Restaurant layout and service flow.

A number is allocated to the zone, and the dish ID and standard cooking time to be created there are set. The standard cooking time is set according to a given standard, and the actual cooking time fluctuates depending on the current condition of the kitchen. The store staff model is set for each role responsibility such as the floor charge and cooking. It is assumed that the customer model can be constructed in table units that may be ordered any number of times while visiting. At the time of ordering, the customer notifies the store staff of the desired arrangement order for serving the requested items.

The flow of ordering, cooking, and serving in these three areas is shown in Fig. 1. On the floor, the customer orders the selected items and the order is conveyed to the kitchen. The order is allocated to the cooking area or zone for each facility, and the cooking staff in charge of that zone cook the items based on the transmitted order. The items that have been cooked are placed in the storage area and the floor staff, who move around the floor, bring items from the storage area to the customer. The customer then eats the cooked items and issues new orders as desired.

In this study, we focus on the following two points that can manipulate the serving order requested by customers. The first is the timing of when customers' orders are conveyed to the kitchen. The timing of ordering and the contents of the orders are different for each customer. Under these inputs as originally issued, the restaurant side may not be able to operate; but the timing of supplying the order requests to the kitchen can be adjusted. In this way, kitchen staff can process the ordered items in turn. In this scenario, it is not necessary to consider the cooking schedule while cooking. Moreover, this makes it possible to exploit ingenuity in efficient cooking such as lot summary, which is being done at present without changing current operations. The second point of influence is when the floor staff delivers the cooked goods from the storage area. The timing of when to deliver the goods from the storage area is adjusted by the operations of the floor staff.

2.2 Algorithm

2.2.1 Conventional Provision Method

When a customer orders a dish, an order is placed in a difference queue for the zones where each dish is created. Cooking is done in a "first in, first out" (FIFO) order from a different queue when facilities in that zone are empty. However, when the same dish is ordered, simultaneous cooking can be performed by summarizing lots, and the cooking time is shortened. In this study, we set constraints on lot summarization when the same dish is entered one by one. Cooking completed cuisine is arranged by a staff member from the floor area.

2.2.2 Floor Arrangement Scheduling (Proposed Method 1)

In floor scheduling based on the order of supply requested by customers, the cooking order is the same as in the conventional method. The cooked goods are once placed in the storage area, and the floor staff adjusts the timing of serving according to the customer's requested order. The dishes placed in the store are served as in the customer's requested order. However, if it the resulting order is not the desired order, items are kept in the storage area until the dish intended to be served first is ready.

2.2.3 Cooking Scheduling (Proposed Method 2)

In cooking scheduling based on the order of supply requested by the customer, the cooking sequence is dynamically configured according to the order of provision desired by the customer. There are two types of precedence relationships in orders. The first is a precedence relation concerning the request order in the same order when the customer has ordered multiple dishes. The second is a prior relationship to orders from other customers in the zone. When customers order multiple dishes simultaneously, they are scheduled according to the constraints of the precedence relationship. Hence, cooking is completed simultaneously at or after the time at which the previous dish is cooked within the request provision order.

The flow of the cooking schedule from the order is shown in Fig. 2. First, when ordered by the customer, the order is stored in the order adjustment pool of the zones where each of the dishes is created. Then, according to the cooking scheduling algorithm, the chosen order is moved from an organized pool to a different queue. Which orders move to the differential queue depends on the cooking scheduling algorithm.

The conditions for moving from the order adjustment pool to a different queue are as follows. Considering the cooking time for the preceding dish and for the target dish, movement to the different queue is controlled so that cooking is not completed earlier than for the preceding dish. The following key points apply in this approach:

- The first order among those not cooked in the same order is processed

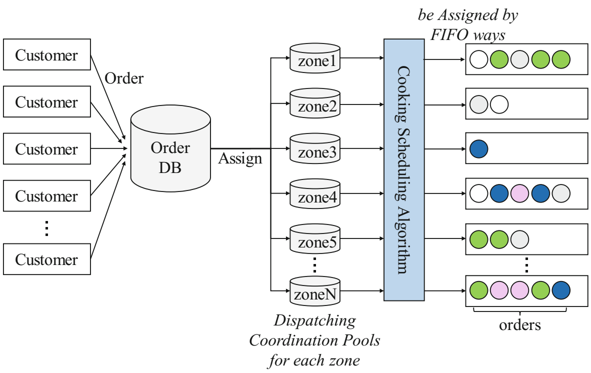

Fig. 2. A dispatching rule and cooking scheduling algorithm.

- Within the same order, it is later than the time when the cooking time of the order preceding the request provision order is finished cooking is subtracted from its own cooking time.

At the start and completion of the cooking of all the dishes, the presence or absence of dish allocation judgment is confirmed for all zones. After moving to a different queue, a dish is cooked in FIFO order when equipment in the zone is not busy, as in the conventional method. The procedure for lot summarization is the same. The cooked dishes are arranged as they are in the conventional method.

Figure 3 shows an example of a cooking schedule. The order from each customer is shown on the right of the figure, the time is shown on the horizontal axis of the Gantt chart, and the order to be cooked is shown on the vertical axis in terms of zones. When an order of A, B, C, D enters from Table 1, first all four orders are stored in the order adjustment pool for each zone. After that, the first order A moves to the different queue.

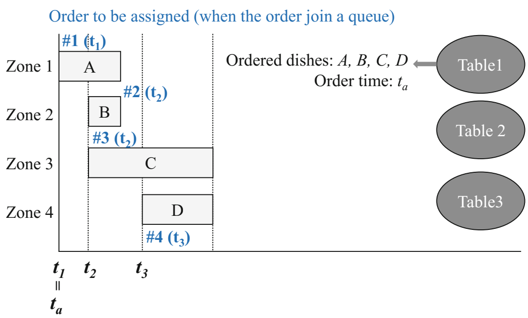

Fig. 3. Gantt chart for cooking scheduling in Proposed method (2).

When cooking of A is started at time t1, then order B, one after the request provision order, moves to the different queue at time t2. When the cooking of B is started at time t2, order C moves to the different queue. This is because this time is later than the time at which the cooking time of order C is subtracted from the cooking end time of order B. Next, order D moves to the different queue at time t3 when the difference between the cooking end time of the previous order C and its own cooking time are equal. In this example, at the time of movement for the four orders, equipment is empty in all zones. Because of this, cooking is started at the same time as it moves to the different queue.

2.2.4 Cooking and Floor Scheduling (Proposed Method 3)

With the cooking scheduling of Proposed method (2) alone, cooking cannot always be completed in the order of the customer's request, necessarily depending on fluctuations in cooking time from the standard cooking time and the setting situation for different tasks. Therefore, in this method, the serving order is adjusted by combining Proposed methods (1) and (2). Order differences for each zone of the kitchen are controlled by the cooking scheduling algorithm in the same way as Proposed method (2). Thus, the cooked commodity is served as it is when satisfying the order of provisions requested at the completion of cooking, as in the case of Proposed method (1); otherwise, it is stored in the storage area. The timing of serving is adjusted by the operation of the floor staff.

3 Conclusions

This study proposed a model constructed by algorithms that dynamically configure scheduling and cooking in restaurants and catering scheduling considering the order and timing of cooking for food service. A future task is to further refine the customer model to include such elements as differences in the ordering frequency and the timing of drinks and meals, verification by computer experiment.

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