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Staff motion reduction at a Japanese restaurant by kitchen layout redesign after kitchen simulation

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Abstract

This study was conducted to decrease the moving distance of kitchen staff at a Japanese cuisine restaurant store by remodeling the kitchen layout according to simulation results. Restaurants must reduce moving distance because it deeply affects employee fatigue. Furthermore, moving distance reduction is important for customers because it reduces cooking times and therefore waiting times. Conventionally, kitchen architects conduct kitchen layout design mainly to maximize cooking capacity, minimize investment, and optimize cooking capacity and customer orders, not to minimize staff burdens. Reducing kitchen staff burdens is discussed by experienced chefs, but they cannot assess motion in a redesigned kitchen. A kitchen simulator is applied to simulate moving distances of individual kitchen staff members in an existing kitchen of a Japanese cuisine restaurant. Based on simulation results, a kitchen layout is remodeled by a kitchen architect, a chef of the restaurant, and a supervisor to reduce motion for tasks. To confirm the efficacy of the remodeled kitchen, actual moving distances of kitchen staff members were measured using a pedometer before remodeling, immediately after remodeling, and 2 months after remodeling. Results show that actual moving distances were reduced to the level of the simulation at 2 months after remodeling. However, moving distances lengthened immediately after the redesign because kitchen staff members were unaccustomed to the new kitchen layout. They required some time to become accustomed with new kitchen layout. Moreover, kitchen staff members continually change the placement of kitchen utensils and ingredients because they seek better placement of cooking utensils and ingredients for the new kitchen layout. To resolve the difficulties, site remediation such as quality control activities are necessary to promote moving distance reduction.

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Keywords: Service engineering, restaurant, simulation, moving distance

1. Introduction

In the 1970s, the Japanese restaurant industry introduced the chain store system to improve cooking operations of restaurants [1] [2]. The system introduced a central kitchen to cook dishes together and reduced the total number of kitchen staff workers at restaurants. Moreover, the system simplified menu assortments to reduce cooking operations and cooking machines at restaurants. Menu simplification can reduce dependence on experienced chefs and increase the usage of part time staff at restaurants. Consequently, Japanese restaurant companies have rapidly increased the total number of restaurants and sales revenues. The industry has become a key industry, hiring over 4 million staff members. The industry market size reached 3 trillion yen in the 1990s [3].

In the 1990s, the industry strove to improve cooking operations at restaurant kitchen. For instance, production capacities and numbers of cooking machines were assessed and optimized to satisfy customer demands [4]. Moreover, new cooking devices were adopted to reduce the number of kitchen staff members and to increase production capacity. Particularly, sushi cooking machines and sushi serving systems increased sushi production capacity and reduced floor service workers at sushi restaurants [5].

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In the 2000s, the restaurant industry introduced a Process Management System (PMS) based on a POS system. The POS indicates order information by an order sheet individually: dish-by-dish. Therefore, kitchen staff members can count the dishes when they cook them simultaneously. PMS calculates the total dishes the staff should cook. Therefore, staff members need not calculate them [6]. Kitchen staff can improve cooking speed and capacity using PMS.

Although the restaurant industry introduced these systems and machines, some difficulties persist. First, conventional studies do not consider specific service characteristics. Service is intangible. Therefore, it cannot be stocked. Consequently, services must be produced simultaneously to meet a customer's request. Moreover, customer demand changes day-by-day. Customer demand fluctuation should be considered if a service provider intends to raise labor productivity [7].

The authors developed a kitchen simulator to design a restaurant kitchen layout to optimize labor input and to meet fluctuating customer demand using POS data. Based on simulation results, a restaurant kitchen was remodeled to improve cooking speeds because waiting time is an important factor underpinning customer satisfaction [8] [9] [10]. Another restaurant kitchen was remodeled to reduce cooking staff work hours and to improve labor productivity [11].

However, neither conventional studies nor studies of kitchen remodeling using simulation examined the workloads of staff members although worker fatigue degrades their performance. The restaurant industry should improve cooking operations not only for labor productivity but also for reduction of the workloads of staff and ES [12].

To resolve these difficulties, the restaurant kitchen was remodeled to reduce the necessary walking distance of cooking staff. The moving distance of the cooking staff was simulated to reduce the number of paces they must take, because walking deeply affects staff fatigue. Based on simulation results, the kitchen layout and cooking machines were remodeled to reduce the moving distance of kitchen staff members. The total number of steps before remodeling, immediately after remodeling, and 2 months after remodeling were recorded to assess the efficacy of the simulation-based improvement of the layout.

2. Restaurant kitchen remodeling using simulation results

This study was conducted at a Japanese restaurant (Osaka, Japan). First, the moving distance in the existing kitchen layout was simulated using a kitchen simulator. Figure 1 portrays the existing kitchen layout of the restaurant. Order data, and work hour data of the restaurant were recorded for a week to simulate the moving distance. A POS system recorded order data (POS record order-received time, kind of dish, and cooking position). An attendant management system recorded work hours: the working position, time going to work, and time leaving work. The cooking machine placement was measured at the kitchen. A placement database was produced to include size, front, position, and cooking capacity data.

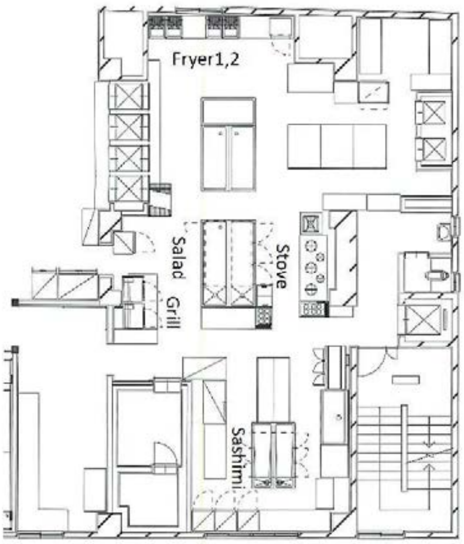

Fig. 1. Layout of the existing restaurant kitchen.

Based on the simulation results, the kitchen designer, store manager, chef, and supervisor discussed the kitchen layout difficulty, number of cooking machines, and cooking position placement. The kitchen designer redesigned the kitchen layout according to the number of cooking machines, the results of

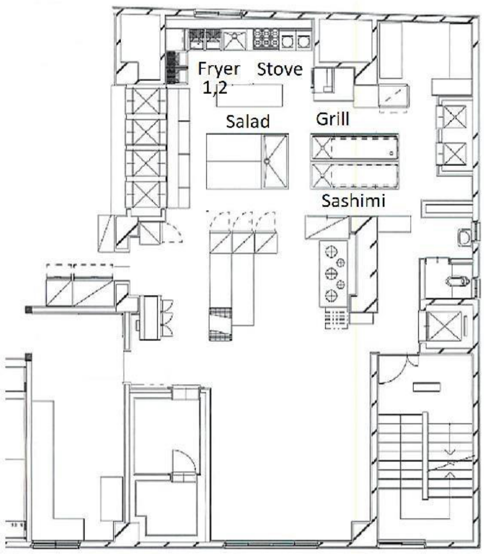

Fig. 2. Layout of the remodeled restaurant kitchen.

the discussion and the simulation. Figure 2 shows the remodeled restaurant kitchen layout. Moving distance of the remodeled kitchen is simulated again to confirm the efficacy of remodeling. The same data used in the first simulation were used for the second simulation.

The steps of each cooking worker were counted using a pedometer to confirm the efficacy of remodeling based on the simulation results. Measurements were conducted three times: for the existing kitchen layout, immediately after remodeling of the kitchen, and two months after remodeling. Each measurement was done for one week. When a kitchen employee starts working, the worker wears a pedometer. After work, the number of steps and the working position are written on a summary sheet. The average distance per step is measured to infer the moving distance based on footstep data.

3. Results

Results of measurement show 0.6 m as the average footstep. The moving distance (m) was calculated by multiplying the number of steps of kitchen staff members by the average footstep length (0.6 m). Table 1 shows the moving distance of each kitchen staff member calculated using simulation results. The total number of steps for the existing kitchen layout is 56,131 (staff of stove=9,252, grill=10,132, sashimi=7,625, salad=9,076, fryer 1=9,922, and fryer 2=10,124 steps). The total of number of steps for the remodeled kitchen layout is 50,630 steps (staff of stove=7,927, grill=7,763, sashimi=6,950, salad=8,745, fryer 1=9,586, and fryer 2=9,659 steps).

Table 1. Simulation results (m)

	Before remodel	After remodel
Stove	5,551	4,756
Grill	6,079	4,658
Sashimi	4,575	4,170
Salad	5,446	5,247
Fryer 1	5,953	5,752
Fryer 2	6,074	5,795

Table 2. Actual steps (m)

after Remodel	before remodel	Immediately after remodel	Two months
Stove	3,757	7,093	3,047
Grill	1,406	6,326	1,112
Sashimi	1,834	5,838	1,647
Salad	1,895	5,382	1,761
Fryer 1	2,566	3,627	2,222
Flyer 2	1,497	4,169	1,960
Total	12,954	32,435	11,749

Table 2 shows the actual moving distance of each kitchen staff member measured using the pedometer. The total number of steps under the existing kitchen layout is 21,950 steps (staff of stove=6,261, grill=2,343, sashimi=3,057, salad=3,158, fryer 1=4,276, and fryer 2=2,495 steps). The total number of steps immediately after remodeling the kitchen is 54,058 steps (staff of stove=11,821, grill=10,543, sashimi=9,729, salad=8,971, fryer 1=6,045, and fryer 2=6,949 steps). The total number of steps of 2 months after kitchen remodeling is 19,582 steps (staff of stove=5,079, grill=1,853, sashimi=2,745, salad=2,936, fryer 1=3,073, and fryer 2=3,266 steps).

4. Discussion

First, the relation between the number of steps shown in the simulation and remodeling of the kitchen layout is discussed. As Table 1 shows, the remodeled kitchen layout reduces both the total of number of steps and that of individual cooking positions. As Figure 1 shows, cooking machines are stubbed in the kitchen at existing kitchen. When a kitchen worker finishes cooking, the worker should move from the cooking position to a food lift to send it to a service staff member. The cooking positions of the stove, grill, and sashimi are placed far from the food lift. Therefore, cooking staff at those positions must pace long distances back and forth, compared to the fryer and salad staff members.

As Figure 2 shows, the stove, griller, and sashimi are gathered near food lifts to shorten the moving distance from these positions to the food lift. Naturally, the necessary steps of these cooking positions are fewer than those of the existing kitchen layout, requiring less moving distance than the existing kitchen (stove=85.7%, grill=76.6%, sashimi=91.1%).

By contrast, fryer and salad cooking positions are near the food lift in the existing kitchen. Consequently, the moving distance from the positions is less than that for the stove, grill, and sashimi staff members. Figure 2 shows that the salad and fryer 2 are relocated from existing positions to locations near the food lift. The necessary motion for these positions is reduced; it is less than that of the stove, griller, or sashimi areas (salad=96.4%, fryer 1=96.6%, fryer 2=95.4%)

Secondly, the relation between kitchen remodeling and the actual number of steps is discussed. Table 2 shows that the numbers of steps of all cooking positions worsens immediately after remodeling, compared to the existing kitchen (stove=188.8%, grill=450.0%, sashimi=318.2%, salad=284.1%, fryer 1=141.4%, fryer 2=278.5%).

Why did the number of steps increase despite the improved kitchen layout? The first reason is habituation of cooking staff members. The restaurant has been operated for more than 30 years without kitchen remodeling. Cooking staff members are accustomed to the existing kitchen layout. Therefore, cooking operations worsen after kitchen layout remodeling. A second reason is the replacement of cooking utensil and ingredients. When the kitchen is remodeled, shelves and refrigerators are also replaced at the time of cooking position placement. Staff members must replace cooking utensils from existing shelves to new shelves, and must replace ingredients from the existing refrigerator location to the new refrigerator location. Furthermore, although cooking staff members who replace cooking utensils and ingredients know the new layout, other staff members might not know the new location. If another worker wants to use a tool or ingredient, then the worker must seek it, or ask a staff member. A third reason is improvement activities for cooking utensil and ingredient placement. The new position might not be ideal for a worker under the new kitchen layout. Therefore, cooking staff members continually replace cooking utensils and ingredients to find a better place. As a result, the placement changes day-by-day. Staff members should seek them while improvement activities continue.

By contrast, at two months after remodeling, the number of steps of the new kitchen layout improved, except at fryer 2 (stove=81.1%, grill=79.1%, sashimi=89.8%, salad=93.0%, fryer 1=86.6%). Generally, both results of simulation and the actual number of steps indicate moving distance reduction, but the rates of decrease differ. The differences in the rates of decrease between the simulated number of steps (existing layout/ after remodeling) and the actual number of steps (existing layout/ two months after remodeling) of stove, grill, sashimi, and salad are less than 5% (stove=4.5%, grill=2.5% sashimi=1.4%, salad=3.4%), but those of the fryers is greater than 10% (fryer 1=10.0%, fryer 2=35.5%).

The difference comes from cooking methods of Japanese cuisine. At the stove, grill, sashimi, and salad positions, orders are cooked dish-by-dish, and are served to customers individually. For instance, when a nimono dish (Japanese simmered food) is cooked, cooking staff use a pot because seasoning differs dish-by-dish. Furthermore, cooking staff workers must continually put sauces on the ingredients to improve the taste. Nimono production yields dishes one by one. As a result, both the simulation and actual cooking staff cook orders dish-by-dish. Therefore, moving distance results of the simulation and the actual kitchen do not differ much.

In contrast, different kinds of fried foods can be prepared simultaneously. For instance, when a worker cooks tempura of different kinds, the worker can prepare ingredients, sprinkle tempura flour, put them into tempura batter, and fry them. The process does not differ dish-by-dish. Therefore, fried foods are amenable to batch production. The cooking capacity of batch production depends strongly on the staff ability. A chef who can cook fried foods can cook many foods simultaneously, but an unskilled worker can only cook them one by one. Results show that the rate of decrease for fryer 1 was 86.6% (skilled staff); that of fryer 2 was 130.9% (unskilled staff).

Kitchen redesign based on simulation presents some unresolved difficulties. First, large gaps separate simulation results and actual moving distances. As this study shows, simulation results show a rough trend (improve/not improve), but results do not show a specific trend. Staff members work individually in the simulation, but work together in an actual kitchen. The simulation accuracy should be improved. Second, the actual moving distance worsens immediately after remodeling. Results show that the staff member workload increases (bad factor for ES) cooking speed also worsens (bad factor for CS). Improvement activities such as training or preparation should be introduced to prevent that phenomenon.

5. Conclusions

This study was conducted to decrease the moving distance of cooking staff at a restaurant serving Japanese cuisine. A cooking simulator was applied to infer the moving distance of staff members. First, the moving distance under the existing kitchen layout was simulated. Then layout difficulties were discussed. Second, the remodeled kitchen layout was designed based on the simulation and discussion results. They were simulated again for confirmation. Then actual remodeling was done. The actual moving distance of staff members was measured three times using pedometers: before remodeling, immediately after remodeling, and two months after remodeling. Results demonstrate the possibility of reducing motion based on simulator results, but the moving distance worsens immediately after remodeling. Simulation results and actual moving distance do not differ greatly for the stove, grill, sashimi, and salad, but differ at the fryer because of cooking differences (singular vs. batch production).

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