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Shift Scheduling Model Designed to Level Workloads of Employees

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Abstract : *This paper focuses on the staff shift scheduling problem on luxury hotel restaurant. Effective staff scheduling has always been a concern for restaurant managers. This paper addresses this issue by investigating the nature of restaurant jobs, ultimately proposing a Shift Scheduling Model designed to level workloads of employees in restaurant service at these establishments. This model creates shift schedules that minimize labor costs while measuring improvements in employee satisfaction as a result of equally distributed workloads among individual workers. Further, it does not rely on subjective personal experience or other unspoken rules that have traditionally guided the shift scheduling process. Specifically, the author conducted logistic research analysis based on data, such as sales results and day of the week, to create a model that estimates workload. Next, mathematical programming methods are used to create shift schedules designed to level the workload and minimize labor costs. The authors then make use of the insights gained through this process to verify the effectiveness of this Shift Scheduling Model, and obtain the desired results.*
Keywords *- shift scheduling, workloads, personnel costs, mathematical programming*

I. Introduction

Personnel costs make up a high percentage of the total operating costs at hotels and Japanese-style inns, so keeping those costs down is a critical management issue for these establishments. Within these businesses, restaurants in particular depend heavily not only on their menu selections and ingredients, but also on the level of staff service for customer satisfaction. Putting together a shift schedule designed to provide peak customer service requires a considerable number of staff members and therefore higher personnel costs. On the other hand, trying to improve service without increasing the number of personnel causes the bulk of the work duties to fall on specific employees. This results in overwork among the mid-career and younger employees who handle most of the frontline service tasks at these establishments, which gives rise to the ongoing problem of considerable turnover rates among these staff members.

This paper addresses this issue by investigating the nature of restaurant jobs at highly classical luxury hotel restaurants, ultimately proposing a shift scheduling model. This model creates shift schedules that minimize labor costs while ensuring improvements in employee satisfaction as a result of equally distributed workloads among individual workers. Further, it does not rely on subjective personal experience or other unspoken rules that have traditionally guided the shift scheduling process. Specifically, the author conducted logistic research analysis based on data, such as sales results and day of the week, to create a model that estimates workload. Next, mathematical programming methods are used to create shift schedules designed to level the workload and minimize labor costs.

II. Shift Schedules: Current Status And Issues

2.1 The importance of shift scheduling in the hotel industry

Generally speaking, establishments in the hotel industry such as hotels and Japanese-style inns incur significant costs such as investment in facilities as well as personnel costs for the staff required to provide service. This means that ordinary profit tends to be low in comparison to other industries. Personnel costs make up a high percentage of the total operating costs and a reduction of even one percent can enable a substantial cost saving that ultimately makes a difference to the revenue, making this a critical management issue for these establishments. Therefore, the trade-off between improving customer service and reducing operation costs presents a challenge for the people running the hotel facilities and those who create shift schedules (managers).

The authors conducted interviews at 15 locations in order to assess the current status of shift schedule creation in the hotel industry and to identify key issues. The three issues identified are listed below.

a) Providing the required number of employees takes priority and therefore shift schedule creation does not take into account the need to reduce personnel costs.
b) Shift schedulers often create schedules on an ad hoc basis rather than based on the capabilities of employees and effectiveness of employee combinations.

c) The number of hours worked (including the overtime hours) and how busy employees are differ depending on the individual, resulting in dissatisfaction among employees due to the unfair distribution of work.

Based on these findings, the authors infer that the current implicit methods of schedule creation are failing to address the problems of "reducing personnel costs" and "reducing turnover rates by resolving employee dissatisfaction", which are critical management issues for hotel operations. Therefore, it is necessary to establish a new method to enable more rational shift schedule creation within the hotel industry.

2.2 The Need for Research

Thus, the authors searched the literature for research on creating work shift schedules in the restaurant business both in Japan and overseas. Although much research was found on creating shift schedules for nurses, very little research was being conducted on shift scheduling in the restaurant business. Furthermore, it was found that restaurant shift scheduling differs from nurse scheduling in the following ways.

(a) It is necessary to take into account varying employee combinations from shift to shift.
(b) Work varies depending on the time of day, day of the week, and period.
(c) Extra servers (temporary workers) are brought in as the required number of employees changes.

The characteristics of shift scheduling in the restaurant business are compared in more detail below.

a) In nurse scheduling, shifts are arranged in two or three shift patterns (Day, Evening, Night), which means that employee combinations do not vary from shift to shift. In the restaurant business, however, there are multiple shifts in operation during meal times (Breakfast, Lunch, Dinner), making it necessary for shift schedules to take into account the resulting variation in employee combinations.
b) In the hotel restaurant business, employees' work duties vary considerably on busy days and slack days, and at meal times. Therefore, rather than just leveling out the number of work days and hours, it is necessary to determine the actual work load based on the employees' work duties.
c) In the hotel restaurant business, the required number of employees varies considerably due to events such as wedding celebrations and dinner parties. This means that there are times when the company cannot completely cover employee requirements solely with the existing employee base. In the restaurant business, the problem is addressed by bringing in extra servers (temporary employees). The extra servers can temporarily cover the gap, but these workers cost more than the regular workforce and often result in poorer service quality.

Based on the above characteristics, the authors determined that it was necessary to establish a new shift scheduling method that takes into account the workload based on the restaurant duties.

III. Shift Scheduling Model Designed To Level Workloads

In an effort to address the issues outlined above, the authors proposed a shift scheduling model. This model creates shift schedules that minimize labor costs while measuring improvements in employee satisfaction as a result of equally distributed workloads among individual workers. Further, it does not rely on subjective personal experience or other unspoken rules that have traditionally guided the shift scheduling process. The model was then put into action and further developed. Specifically, the author conducted logistic research analysis based on data, such as sales results and day of the week, to create a model that estimates workload (step#1). Next, mathematical programming methods are used to create shift schedules designed to level the workload and minimize labor costs (step#2).

3.1 Calculating employee workload (step #1)

First, the employee workload is defined based on data such as past business results and operational trends for each day of the week. Next, a model is created to predict workloads using logistic regression analysis. The authors suggest that calculating the workload in this way will provide the following three benefits.

a) Leveling employee workloads both quantitatively (Work hours) and qualitatively (work content) enables employee dissatisfaction to be resolved and turnover rates to be reduced.
b) In the restaurant business, the services provided differ depending on the customer. Predicting the workload beforehand helps to prevent overburden and inconsistencies, enabling the level of customer service to be maintained and improved.
c) Employees tend to work more overtime hours on days when there is a higher workload. Leveling the number of high workload days worked helps to level employees' overtime hours, enabling labor costs to be reduced.

3.1.1 Defining workload

The authors conducted additional interviews with employees to determine the following two pieces of information regarding workload.

a) Frontline employee workload is affected by the type of meal course that the customer selects (workload is higher for fancier courses)
b) Serving customers on the weekends is more complicated than serving customers on weekdays (each customer must be visited more times, they tend to order more items, and the per-item cost is higher), when employees are busier, have a higher workload, and tend to work many overtime hours

Table 1. Customers order course and the number of services

index	Normal course	Middle course	Expensive course
Course price	10,000	14,000	18,000
Number of items	5 items	7 items	9 items
Number of services	12 times+α	18 times+α	23 times+α

In (a) above, as table 1 indicates, the number of items increases (Normal: 5 items, Middle: 7 items, Expensive: 9 items) as customers order more expensive courses (regular, mid-level, or high-level). Additionally, as the number of items increases, servers are required to visit customers more times.

Regarding (b), The authors analyzed the above information in terms of per-customer cost on the weekdays (Monday through Thursday) and weekends (Friday through Sunday) by looking at the difference between F-test (equal variance test) and t-test (mean difference test) results. It was confirmed that per-customer spending was higher on weekends than it was on weekdays (5% significance). This indicates that there is a correlation between employee workload and per-customer cost. (F-test $*F(31,41)=1.864, p<.01***$, t-test $*t(72)=-5.389, p<.05**$)

3.1.2 Calculating Workload

Next, fluctuations in workload were defined as the objective variable, while day of the week and how busy the hotel or restaurant was were defined as explanatory variables (see Table 2). A logistic regression analysis was then conducted in order to come up with a mathematical model (Formula 1) that could predict (estimate) days with high workload.

Table 2. Explanatory variables description (logistic regression analysis)

index	Variable	Variable description
Objective variable	p:	High workload day? (Y/N) (1/0)
Explanatory variables	x_1- x_7:	Day of the week (Monday through Saturday, holiday) (1/0)
	x_8:	Extended holiday? (Y/N) (1/0)
	x_9:	Peak period? (Y/N) (1/0)
	x_{10}:	Restaurant full? (Y/N) (1/0)
	x_{11}:	Hotel full? (Y/N) (1/0)

$$\log\left(\frac{p}{1-p}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k \quad \text{....(1)}$$

α: Constant
β_k: The partial regression coefficient in the variable x_k

3.2 Calculating the Employee Shift Schedule (step #2)

Using the results of the preliminary surveys in section 3.1.1 and the findings from section 3.1.2, shift schedules are created that minimize labor costs while measuring improvements in employee satisfaction as a result of equally distributed workloads among individual workers. This method of creating shift schedules involves formulating a model (formula) based on the purpose and constraints set out below to enable appropriate shift schedules to be calculated using mathematical programming.

Symbol description

Staff = {staff 1, staff 2, …, staff e} : Set of staffs
Day = {day 1, day 2, …, day d} : Set of days
Shift = {shift 1, shift2, …, shift s} : Set of shifts
WorkShift = { shift 1, shift2, …, shift s-1} : Set of work shifts (Except holiday shift)
Meal = {breakfast, lunch, dinner, night} : Set of mealtime
Group = {group 1, group 2,…, group 3} : Set of employees work groups
Constraint = {constraint 1, constraint 2, …, constraint n} : Set of constraints
Restaurant = {restaurant 1, restaurant 2, …, restaurant r} : Set of restaurants
$x_{i,j,k} \in \{0,1\}$, $i \in$ Staff, $j \in$ Day, $k \in$ Shift :Binary variable(1:staff i work shift k on day j, 0:not)

$p_{j,m} \in \{0,\text{Integer}\}$, $j \in$ Day, $m \in$ Meal :The number of temporary workers
$A_{g,j,k}$, $g \in$ Group, $j \in$ Day, $k \in$ Shift
:Low limit of the number of people assigned to shift k from Group g on day j
$B_{g,j,k}$, $g \in$ Group, $j \in$ Day, $k \in$ Shift
:High limit of the number of people assigned to shift k from Group g on day j
$D_{g,k}$, $g \in$ Group, $k \in$ Shift :Low limit of the number times assigned shift k from Group g
$E_{g,k}$, $g \in$ Group, $k \in$ Shift :High limit of the number times assigned shift k from Group g
F_i , $i \in$ Staff : Low limit of the total working hours of staff i
G_i , $i \in$ Staff : High limit of the total working hours of staff i
T_k , $k \in$ Shift : Standard working hours of the shift k
W_n , $n \in$ Constraint : If constraint violation, set of weights
$N_{r,j,m}$, $r \in$ Restaurant, $j \in$ Day, $m \in$ Meal
:The necessary number of people to meal m in restaurant r on day j
$(i,j,k) \in Q_1$, $i \in$ Staff, $j \in$ Day, $k \in$ Shift : Fix staff i to shift k on day j
$(i,j,k) \in Q_0$, $i \in$ Staff, $j \in$ Day, $k \in$ Shift : Avoid staff i to shift k on day j

Minimize

$$\sum_{j \in Day} \sum_{m \in Meal} p_{j,m} + \sum_{n \in W} w_n \qquad \text{….(2)}$$

Subject to (Mandatory Constraints)

$$\sum_{k \in Shift} x_{i,j,k} = 1 \qquad i \in Staff\,,\ j \in Day \qquad \text{….(3)}$$

$$\sum_{i \in Staff} \sum_{k \in Shift_m} x_{i,j,k} + p_{j,m} \geq \sum_{r \in Restaurant} N_{r,j,m} \qquad j \in Day, m \in Meal \qquad \text{….(4)}$$

$$A_{g,j,k} \leq \sum_{i \in Staff_g} x_{i,j,k} \leq B_{g,j,k} \qquad g \in Group, j \in Day, k \in Shift \qquad \text{….(5)}$$

$$D_{g,k} \leq \sum_{i \in Staff_g} \sum_{j \in Day} x_{i,j,k} \leq E_{g,k} \qquad g \in Group, k \in Shift \qquad \text{….(6)}$$

$$F_i \leq \sum_{j \in Day} \sum_{k \in Shift} (x_{i,j,k} \times T_k) \leq G_i \qquad i \in Staff \qquad \text{….(7)}$$

$$\sum_{\alpha=1}^{h} x_{i,j+\alpha-1,k} \leq R \qquad i \in Staff\,,\ j = \{1,2,...,n-1+h\}, k \in WorkShift, (k,R) \in P_h \qquad \text{….(8)}$$

$$x_{i,j,k} = 1 \qquad (i,j,k) \in Q_1 \qquad \text{….(9)}$$

$$x_{i,j,k} = 0 \qquad (i,j,k) \in Q_0 \qquad \text{….(10)}$$

Subject to (Discretionary Constraints)

$$\sum_{j \in Day} \sum_{k \in DShift} (x_{i,j,k} \times WL_j \times e) = \sum_{i \in Staff} \sum_{j \in Day} \sum_{k \in shift} (x_{i,j,k} \times WL_j) \quad i \in Staff\,,\ j \in Day, k \in Shift \qquad \text{….(11)}$$

$$x_{i,j,k} = 1 \qquad i \in staff_k\,,\ j \in Day, k \in Shift \qquad \text{….(12)}$$

$$x_{i,j,k} = 0 \qquad i \in staf_k\,f\,,\ j \in Day, k \in Shift \qquad \text{….(13)}$$

Purpose :
Minimize the sum of (1) number of extra servers (temporary workers) used and (2) weight of constraint violation (Wn). ….(Formula 2)

Mandatory Constraints：

1) Have employees select one work shift ….(Formula 3)
2) Provide the number of workers needed during the entire period ….(Formula 4)
3) Define the number of each group of team needed ….(Formula 5)
4) Set upper and lower limits on the number of shifts assigned ….(Formula 6)
5) Limit the number of total hours worked per month ….(Formula 7)
6) Do not allow employees to work more than seven days in a row ….(Formula 8)
7) Set specific shifts for specific employees ….(Formula 9)
8) Do not allow specific shifts for specific employees ….(Formula 10)

Discretionary Constraints：

9) Level the number of days that each employee works on high workload days ...(Formula 11)
10) Fix/avoid specific shifts for specific employees ….(Formula 12/13)

The purpose of this shift schedule calculation method is to minimize the total number of extra servers (temporary workers) used during the period covered by the created shift schedule. The reasons for this are as follows.

(a)At hotel restaurants where there is a high percentage of permanent employees (80% or higher), a large proportion of the personnel costs are fixed, leaving little scope for cost reduction.

(b)It is possible to reduce payments to external organizations (costs for extra servers) without having to reduce costs for existing employees, thereby minimizing dissatisfaction among existing employees.

Mandatory constraints are constraints that should always be applied when creating shift schedules. These constraints include constraint conditions required for creating a mathematical programming model (constraint 1, constraint 4, constraint 6) and constraints on continuous working hours stipulated by working regulations (constraint 5). The weight of constraint conditions (wn) for these constraints is substantial. Discretionary constraints are generally used to solve scheduling problems that are considered “NP-hard” by applying minor weighting to the constraints in order to allow violations, thereby avoiding infeasibilities.

These constraints include constraint 8 and constraint 9. The workload tends to be higher on days when many employees are required and, if all employees adhere to constraints that level the workload, infeasibilities can occur due to the relationship with other constraints that are important to restaurant operation (Mandatory constraints etc...). Thus, discretionary constraints are used which allow different weighting to be applied to constraint conditions based on an employee’s position and the type of work duties they perform, enabling the workload to be leveled without obstructing normal restaurant operations.

IV. Adaptation Example

In an effort to address the issues outlined above, the authors came up with a two-step approach that they organized into this Shift Scheduling Model. The model was then put into action and further developed.

4.1 Calculating employee workload (step #1)

The authors use of factors that affect the working load are shown in Table 2, Section 3.1.2, to calculate the employee workload.

Specifically, x1 - x7 indicate the influence due to day of the week (Monday through Saturday, holiday). x10: “Peak period? (Y/N)” indicates the influence due to the hotel’s peak periods (Holidays such as Golden Week, Obon, and the Year End and New Year). x11: “Restaurant full? (Y/N)” indicates that the number of restaurant customers is expected to occupy 95% or more of its seating capacity. x12: “Hotel full? (Y/N)” indicates that the hotel is operating at an occupancy rate of approximately 100%.

The results of that logistic regression analysis (table 3), and the mathematical model used to calculate the workload (formula 14) are shown below.

Table 3. Explanatory variables description (logistic regression analysis)

index	coefficients	index	coefficients	index	coefficients
β_1	-2.653*	β_5	0.219	β_9	3.719***
β_2	-3.321**	β_6	0.395	β_{10}	3.387**
β_3	0.134	β_7	21.915**	β_{11}	2.077***
β_4	-7.000**	β_8	22.912*	constant	-1.202*

1%significance:*** 5%significance:** 10%significance:*

$$\log\left(\frac{p}{1-p}\right) = -2.65x_1 - 3.32x_2 - 7.00x_4 + 21.92x_7 + 22.91x_8 + 3.72x_9 + 3.39x_{10} + 2.08x_{11} - 1.20 \text{ ....(14)}$$

As Table 3 indicates, if partial regression coefficients are positive, their workload is increasing. On the other hand, if partial regression coefficients are negative, their workload is decreasing.

4.2 Calculating the Employee Shift Schedule (step #2)

The authors took the workload level identified in step #1 and entered them as conditions in order to create a shift schedule that could be used to manage work at highly classical luxury hotel restaurants. The shift schedule in table 4 was created in order to make sure that employees provided a sufficient workforce to cover restaurant operations. In situations where the company could not provide a sufficient number of workers using only its existing employee base (57 employees), it could bring in extra servers (temporary workers) to cover the gap—but these workers cost more than the regular workforce and often result in poorer service quality.

In addition, the required tasks differ depending on the workplace, and so different skill sets and work experience are needed. The authors classified employees into teams according to years of experience and special skills (e.g. sommeliers, bartenders).

Table 4. Outline of Calculating the Employee Shift Schedule

Index	Outline
Employees	Existing employee (57 employees) Extra servers (temporary workers)
Restaurants	Restaurant (French, Western, Café, Bar) Banquet room (Main, Sub) Total 6 restaurants
Shift	6 Pattern (Rest, BLD, BL, BD, LD, Bar)
Day	1 month (30day)
Team	Skills (Chief, Cashier, Sommelier, Bartender) Career (Intern, Younger, Mid-career, Expert,)

V. Comparison With The Work Shift

This section compares the shift pattern that was identified during the preliminary survey in section 2.1 "(1) Previous shift pattern: Shift created using previous scheduling method relying on manager's experience" with two other shift patterns, namely, "(2) New shift pattern 1: Shift created applying only Step #2 (shift calculation) of the proposed shift scheduling method" and "(3) New shift pattern 2: Shift created applying Step #1 and Step #2 of the proposed shift scheduling method".

These shifts are compared below in terms of the following:

(a) The number of temporary workers per 1 month (30 days)
(b) The total personnel costs per 1 month (30 days) :The authors estimated from the employee cost
(c) The variation of the total work hours per 1 month (30 days)
(d) The variation of the high workload days per 1 month (30 days)

For this comparison, the weight of constraint conditions (W_n) applied were as follows: mandatory constraints (W_1～W_7=10000) and discretionary constraints (W_8=5,W_9=1).

(a)Using the previous shift scheduling method, which relies heavily on the experience-based implicit knowledge of shift schedulers (Manager), it is not possible to effectively combine shifts to provide the number of workers required for meal times (Breakfast, Lunch, Dinner). Therefore, the restaurant cannot provide enough workers using the existing employee base and must bring in extra servers, the costs for which make up a large proportion of the overall labor cost. However, using mathematical programming to create the shift schedules makes it unnecessary to deploy more than the required number of workers. "(2) New shift pattern 1" enabled a reduction of 98 employees (27% of the total). Additionally, although introducing new constraints with respect to the workload resulted in an increase in the number of extra servers used, the number only increased by as few as 4 servers (1% of the total). This means that the effect of introducing workload constraints will be only slight.

Table 5. Comparison with three work shift

index	(1) Previous shift pattern	(2) New shift pattern 1: Step #2	(3) New shift pattern 2: Step #1 and Step #2
(a)Temporary workers	369 person	271 person	275 person
(b)Personnel costs	About 1,490	About 1,340	About 1,343
(c) variation of the total work hours	28.5 hours (Existing employee/ Temporary workers)	12.5 hours (Existing employee/ Temporary workers)	6.3 hours (Existing employee/ Temporary workers)
(d)variation of the high workload days	5.1 day (Existing employee/ Temporary workers)	3.7 day (Existing employee/ Temporary workers)	1.4day (Existing employee/ Temporary workers)

(b) As stated above, the issues caused by combining shifts using the previous shift scheduling method can result in extra labor costs. However, using mathematical programming to create "(2) New shift pattern 1" enabled a cost reduction of approximately 10%. Additionally, although after introducing workload constraints the cost increased due to the increase in the number of extra servers used, the cost only increased by as little as approximately 0.2%. This means that the effect of introducing workload constraints will be only slight.

(c) In terms of working hours, with "(1) Previous shift pattern" the working hours vary considerably even among permanent employees, as some workers work mainly at the weekend (Weekdays is holiday) and some workers work mainly on weekdays (Weekend is holiday). As a result, there are considerable inconsistencies in terms of the number of overtime hours and the amounts paid for overtime. However, with "(2) New shift pattern 1", introducing constraints on the total working hours enabled the inconsistency in working hours to be reduced by 16 hours (56% of the total). Additionally, with "(3) New shift pattern 2", leveling the workload and leveling the overtime hours on high workload days enabled the inconsistency in working hours to be reduced by a further 6.2 hours (22 % of the total). This means that the effect of using this method will be substantial.

(d) As with working hours, the number of high workload days worked is a factor that could not adequately be taken into account using the previous shift scheduling method. However, it was found that by applying Step #1 and Step #2 of the proposed shift scheduling method it was possible to reduce the number of high workload days worked by 3.7 days (76% of the total).

VI. Conclusion

For the purpose of resolving problems in the hotel industry with creating employee work schedules, the authors propose a shift scheduling model that helps to level the workload. More specifically, the model is applied to create a shift schedule for an actual highly classical luxury hotel restaurant, making it possible to quickly level the employees' workload. As a result, the model's calculations helped to level the employees' workload while also reducing labor costs. The model proposed in this paper was thus demonstrated to be effective in this example.

In the future, the authors propose that the model should be used to create shift schedules that take into account compatibility between employees and customers based on an examination of customer attributes (not covered by this paper) in order to enable improvements to be made to customer service, as well as to create shift schedules that take into account conditions related to specific employee combinations and individual workloads resulting from individual work responsibilities.

References

[1] Ikegami, A. and Niwa, A, A subproblem-centric model and approach to the nurse scheduling problem, Math. Program, 97 (3),2003, 517-541.
[2] Ernst, A.T., Jiang, H., Krishnamoorhty, M. and Sier, D, Staff scheduling and rostering: A review of application, methods and models, European Journal of Operational Research1, 53,2004, 3-27.
[3] Christina, G. and Dogan, G, Employee satisfaction, customer satisfaction, and financial performance, An empirical examination", International Journal of Hospitality Management, 28, 2009, 245–253.
[4] Brucker, P., Burke, E., Curtois, T. and Berghe, G, A shift sequence based approach for nurse scheduling and a new benchmark dataset, Journal of Heuristics, 16, 2010, 559-573.
[5] Ikegami, A, Scheduling doctors for night duty, Proc. 29th meeting of the EURO Working Group on Operational Research Applied to Health Services, 2004, 135-145.
[6] Okihara, D., Nakamura, M. and Amasaka, K, Establishment of a Staff Allocation Method Reflecting Customer Information, International Organization of Scientific Research Journal of Business and Management, 16 (11), 2014, 21-28.
[7] Kathryn, A, d, Nurse scheduling with tabu search and strategic oscillation, European Journal of Operational Research, 106, 1998, 393 – 407.
[8] Ernst, A.T., Jiang, H., Krishnamoorhty, M. and Sier, D, Staff scheduling and rostering : A review of application, methods and models, European Journal of Operational Research, 53, 2004, 3 - 27.
[9] Christina, G. and Dogan, G, Employee satisfaction, customer satisfaction, and financial performance, An empirical examination", International Journal of Hospitality Management, 28, 2009, 245–253.
[10] Brucker, P., Burke, E., Curtois, T. and Berghe, G. (2010), A shift sequence based approach for nurse scheduling and a new benchmark dataset, Journal of Heuristics16, 559–573.

[11] Fujita, K. and Amasaka, K, Creation of Total Shift Scheduling Model in Restaurant Service, Proc. the 15th Asia Pacific Industrial Engneering and Management System Conference, 2014, 2070-2076.
[12] Kyuwan, C., Johye H, and Myoungju, P, Scheduling restaurant workers to minimize labor cost and meet service standards, Journal Cornell Hospitality Quarterly, 50 (2), 2009, 155-167.
[13] Jichul,J., R. Thomas,G, Understanding the influence of polychronicity on job satisfaction and turnover intention: A study of non-supervisory hotel employees, International Journal of Hospitality Management, 31 (5), 2012, 588-595.