Cornell Hospitality Quarterly

http://cqx.sagepub.com

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Cornell Hospitality Quarterly 2009; 50; 155
DOI: 10.1177/1938965509333557

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Volume 50, Issue 2 155-167

Scheduling Restaurant Workers to Minimize Labor Cost and Meet Service Standards

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In labor scheduling, restaurant managers face dual challenges: overstaffing that means excessive labor costs and understaffing that invites the opportunity cost of service errors and lost business. Most operators seek to rely on their personal experience and judgment to determine schedules that are meant to maintain service quality and limit labor costs, but an analysis of one Korean restaurant finds that this goal is elusive. The labor scheduling model based on integer programming (IP) is presented to address the staffing and scheduling issues and service standards by maintaining an appropriate ratio of part-time to full-time employees. Using appropriate constraints, the model was used to generate a schedule for a table service restaurant in Seoul, South Korea, that is affiliated with a global chain. When compared to the existing schedule, the IP-generated schedule helped the restaurant reduce overall labor costs while ensuring appropriate service levels.

Keywords: restaurant scheduling; cost minimization; full-time and part-time employee ratios; labor scheduling; overstaffing; service quality; understaffing; Korea; chain restaurants

Effective labor scheduling has always been a concern for restaurant managers. This article focuses on the labor-capacity management problems confronted by a single unit of a multiunit global chain restaurant located in downtown Seoul, South Korea. The labor-scheduling model proposed in this article seeks to minimize labor costs while ensuring that customer demand is satisfactorily met. Restaurant managers are only too aware of the problems inherent in scheduling, with its twin dangers of underscheduling and overscheduling.

Scheduling issues complicate the competitive challenges of the Korean market. The profitability of casual dining restaurants in global chains has diminished greatly since 2000, despite increased marketing efforts. For example, the 2006 profit margin of Korea's Bennigans was –4.47 percent; Sizzler, –4.23 percent; and TGI Friday's, –3.08 percent. Those negative margins were below the average profit margin of 6.54 percent for other audited Korean restaurant chains for that year and far below the 20 percent average profit margins experienced by such restaurants in the late 1990s (Choi et al. 2007). Those negative results may result in part from the inflexibility of the chains' operating systems. Restaurant companies free from such ironclad contracts generate higher profits than do those held to such contracts (Choi et al. 2007; Klonowski, Power, and Linton 2008). Additionally, in Korea, global chain restaurants' low profitability is also influenced by particularly high labor costs due, in part, to an increase in employee benefits mandated by Korean labor regulations.

The restaurant industry makes heavy use of part-time employees because of its budget constraints and irregular operating hours (Love and Hoey 1990). Although part-time employees help create flexible capacity, they also mean a more complicated scheduling task. Moreover, the proportion of part-time employees to full-time employees in a restaurant may interfere with maintaining service quality (on the principle that full-time servers have more expertise). Thus, any schedule should maintain a reasonable proportion of full- and part-time employees (Mabert and Raedels 1977; Bechtold 1988).

The restaurant in this study has encountered the same problem of low profitability as have other global chain restaurants and, thus, must focus carefully on labor as part of its cost control strategy. Setting appropriate schedules has been recognized as the most effective way of controlling labor costs (Thompson 2003). For this selected restaurant, we sought to address the staffing and scheduling issues over both the week (or the number of consecutive days worked, which we call the tour) and each day (that is, the shift). We further wanted to establish a schedule that would identify the correct number of full- and part-time employees, when each type of employee should be scheduled, and the shift to which each should be scheduled. Finally, we ran the resulting schedule in our test restaurant to assess the cost reductions arising from a schedule that adopted our constraints.

Literature Review

Numerous studies have been conducted on labor scheduling (Beaumont 1997; Bechtold, Brusco, and Showalter 1991; Bechtold and Jacobs 1990; Brusco and Jacobs 1993, 1998; Easton and Rossin 1991; Goodale and Tunc 1998; Li, Robinson, and Mabert 1991; Loucks and Jacobs 1991; Thompson 1990, 1993, 1995a, 1995b, 2004). Most studies have focused on scheduling in other industries, including airline crews (Arabeyre et al. 1969; Bodin et al. 1983; Gamache and Soumis 1998), nurses in hospitals (Aickelin and White 2004; Bradley and Martin 1991), and service clerks in call centers (Mehrotra 1997). We have seen few studies investigating labor scheduling in hospitality services. Among the few, Love and

Hoey (1990) demonstrated reduced payroll costs and saved management time as benefits of using a microcomputer-based scheduling system in McDonald's restaurants. Likewise, Hueter and Swart (1998) showed a $53 million savings in labor costs at a Taco Bell restaurant following implementation of a labor scheduling system designed to determine the optimal labor hours required to provide desired customer service (in this case, a three-minute wait time) and the optimal allocation of labor in different job categories to minimize labor cost.

In a series of articles published in this journal, Thompson details a four-step labor scheduling method specifically for the hospitality industry. In part 1, he identifies forecasting customer demand as a first step in labor scheduling and suggests that an appropriate forecasting model needs to capture variable demand in hospitality services (Thompson 1998a). In part 2, he identifies translating the demand forecasts into employee requirements as a second step (Thompson 1998b). In part 3, he compares two traditional frameworks for labor scheduling, one developed by Dantzig (1954) and one by Keith (1979); discusses their limitations; and then suggests two new scheduling approaches. These two new approaches, one of which uses optimal service standards as its goal and other of which aims for the highest economic benefit from the schedule, take into consideration the interdependence of staffing decisions across planning periods (Thompson 1999a). Part 4 of Thompson's series deals with assessing the deviation between planned and actual scheduling in comparison with customer demand and controlling the scheduling in real time (Thompson 1999b). Although he shows the benefits of the new scheduling frameworks, Thompson does not demonstrate the specific outcomes of his scheduling approach on an actual restaurant.

Thompson (2004) examined other aspects of restaurant scheduling and identified an appropriate planning-interval duration in labor-shift scheduling. He found five-minute planning intervals profitable and fifteen-minute intervals most effective. Goodale, Verma, and Pullman (2003) developed a market-based labor scheduling model that incorporates customer service preferences into scheduling of frontline service providers at fast-food restaurants. The model factors the impact of staffing on customers' expected wait time into a dynamic scheduling model. Perhaps because they focused on quick-service operations, their scheduling model focuses only on part-time labor.

When the focus turns to table-service restaurants, we find no study that has focused on a scheduling model that incorporates a mix of both part- and full-time employees, even though most researchers recognize the importance of this mix on service quality. To provide high-quality service, it is desirable to control the proportion of part-time employees in the mix of labor (Mabert and Raedels 1977; Bechtold 1988). Although Easton and Rossin (1991) used heuristics that accommodate a mix of full- and part-time employees to solve scheduling problems, they applied their model to a hypothetical case, not to a real service setting. In solving the issues of tour scheduling in a bank's lockbox department, Li, Robinson, and Mabert (1991) also used heuristic methods that factored in employees who differ in hourly cost.

The Restaurant

Moving beyond existing studies, we wanted to develop a scheduling model that addresses the distinct nature of the restaurant industry, including its highly variable and random demand and its variable service times. Other elements that a scheduling model must include are the fact that restaurant work shifts vary from a few hours to as much as eight to ten hours in length, restaurants hire more part-time employees than other service industries (Love and Hoey 1990), and restaurants must maintain service standards in the face of those uncertainties. We also wanted to incorporate the concept raised by Li, Robinson, and Mabert (1991) regarding scheduling of days on and days off. The restaurant that is the focus of this study is located in the business district in downtown Seoul, Korea. As we mentioned at the outset, the restaurant is a globally branded, multiunit chain restaurant that has been operating for eight years.

We consider this restaurant to be representative of all the units in the chain. Like all restaurants, this one requires effective labor scheduling to control its labor cost percentage. Standing at 31.56 percent at the time of our study, the restaurant's labor cost is slightly higher than the average labor cost percentage of the other chain restaurants (29.01 percent) and well within the range of chain restaurants in Korea, which is 28 to 40 percent (Korea Food Service Information 2006). Because it is located in a downtown business district, the restaurant has a more variable demand pattern than do similar units located in suburban areas. Considering the challenges of scheduling with variable demand, we determined that this restaurant was a good candidate for receiving the benefit of effective labor scheduling.

The restaurant's workforce consists of twenty-six servers (seven full-time and nineteen part-time employees) and twenty-three cooks (all full-time). The majority of customers during the week are white-collar employees who work in the surrounding downtown area, which causes congestion during lunch hours. Weekend business is oriented more toward families.

As with most Korean restaurants, this restaurant relies heavily on managers' experience for setting schedules. Using managers' judgment regarding necessary staffing levels, the restaurant used an Excel spreadsheet to match employees with shifts. The resulting schedule was posted on a dry-erase board hung on the wall. What we observed is that these less than scientific methods have resulted in frequent overtime among servers, a decline in servers' morale, and high labor costs (due to payment of overtime). This approach also absorbed considerable time, as the managers attempted to schedule employees fairly and sought to reduce the number of complaints by servers about last-minute schedule changes during the restaurant's busiest hours.

Labor Scheduling Model Using Integer Programming

In developing a labor scheduling model to minimize the study restaurant's labor costs, we particularly sought to identify which full- and part-time servers should be assigned to each given work shift. This model had to take into consideration work shifts of various lengths of time, and it had to account for days on and days off work—all within an overall rubric of customer service standards.

The model we developed uses integer programming (IP). Although similar to linear programming, IP considers decision variables to be integers. This makes sense because the number of employees must be an integer (since one cannot schedule 1.5 people). IP uses the objective function and the constraints shown in Exhibit 1, as we explain next.

The objective (1) in the model expresses the goal of minimizing total labor cost over the scheduling horizon (one week). The first constraint (2) ensures sufficient staffing for each day; the next constraint (3) ensures meeting the minimum staffing requirements for each day; and the final

Exhibit 1:
Labor Scheduling Model Developed Using Integer Programming

(1) Min $$\sum_{i\in S,\, j\in T} c_{i,j}x_{i,j} + d_{i,j}y_{i,j} + \sum_{i\in S} e_i z_i$$

subject to

(2) $$\sum_{i\in P_k,\, j\in D_l} (x_{i,j} + y_{i,j} + a_l z_i) \ge \max\{b_{k,l}, m\} \text{ for } k\in P, l\in T$$

(3) $$(1-r)\times \sum_{i\in S_k,\, j\in D_l} x_{i,j} \ge r\times \sum_{i\in S_k,\, j\in D_l} (y_{i,j} + a_l z_i) \text{ for } k\in P, l\in T$$

(4) $$x_{i,j}, y_{i,j} \ge 0, z_i \ge 0 \text{ and integer for } i\in S, j\in T$$

where

S = set of shifts; Shift I (8:00~14:00), Shift II (12:00~21:00), Shift III (14:00~23:00)
T = set of tours; 1(Mon), 2(Tue), 3(Wed), 4(Thu), 5(Fri), 6(Sat), 7(Sun)
P = set of service periods; P_1, P_2, P_3, P_4
S_k = set of shifts containing service period k
D_l = set of starting days of five (5) consecutive day schedules that include day l; i.e.
D_1={Thu, Fri, Sat, Sun, Mon}, D2={Fri, Sat, Sun, Mon, Tue}, $\cdots$, D_7={Wed, Thu, Fri, Sat, Sun}
$c_{i,j}$ = labor cost for full-time employees working shift i during tour j (i.e. 5,500 Won)
$d_{i,j}$ = labor cost for part-time employees working shift i during tour j (i.e. 4,500 Won)
e_i = the number of part-time employees assigned to shift i during weekend
$x_{i,j}$ = the number of full-time employees assigned to shift i during tour j
$y_{i,j}$ = the number of part-time employees assigned to shift i during tour j
z_i = labor cost for part-time employees working shift i during weekend
$b_{k,l}$ = the number of employees required in service periods k and during tour l
m = the minimum number of employees required throughout the operation hours; 2
r = the proportion of full-time employees to total employees; 0.6
a_l = 1 if tour l is weekends. 0 otherwise

constraint (4) is nonnegative and integral numbers.

The model makes the following assumptions. The ratio of full- to part-time employees is 6:4, as determined by management based on their observation of the most effective mix needed to ensure high-quality service. We agree that this ratio could be considered subjective, but other research supports the idea that it is desirable to control the proportion of part-time employees in the mix of labor to provide high-quality service (Mabert and Raedels 1977; Bechtold 1988). In his scheduling study, for example, Thompson (1997) used a range of ratios for full- and part-time employees. While many restaurants have excellent part-time servers, most part-timers consider the job to be temporary and do not have the professional experience of full timers. Our model thus assumes that the full-time employees have greater productivity levels than do the part-time employees and are paid higher wages. It is also assumed that employees are homogeneous within their job categories.

With regard to employee tours, our model also assumes that each employee

Exhibit 2:
Shift Type and Service Periods

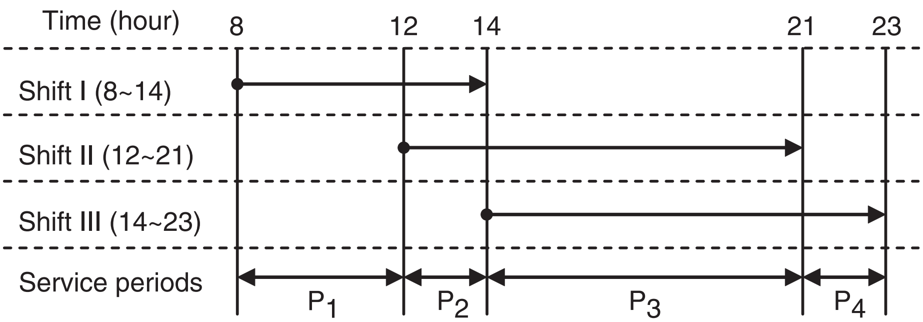


Exhibit 3:
Maximum Hourly Customer Counts during Each Service Period (Unit: Count)

	Mon	*Tue*	*Wed*	*Thu*	*Fri*	*Sat*	*Sun*
P_1(8:00~12:00)	9.40	12.60	11.30	10.50	9.75	2.00	4.00
P_2(12:00~14:00)	40.20	57.60	55.90	58.37	60.50	45.25	35.12
P_3(14:00~21:00)	37.10	53.70	58.50	60.75	62.75	61.75	50.50
P_4(21:00~23:00)	13.00	14.60	26.90	22.00	33.75	21.62	15.00

works five consecutive days. For example, an employee whose tour starts on Monday works through Friday for five consecutive days, but we note that not all employees who work on Monday started their tour on that day. They could have started as early as Thursday, for instance.

Our model divides the day into the following four nonsymmetical service periods: P_1 (8:00~12:00), P_2 (12:00~14:00), P_3 (14:00~21:00), and P_4 (21:00~23:00) (Exhibit 2). Finally, the minimum number of employees permitted on any shift is two.

Labor Scheduling in the Restaurant

This study follows the framework suggested by Thompson (1998a, 1998b, 1999a, 1999b). As noted, the labor scheduling framework is composed of four steps: (1) forecasting demand, (2) translating the demand forecasts into employee requirements, (3) comparing alternate labor schedules, and (4) implementing and evaluating the new schedule.

Forecasting Demand (Number of Customers)

For the first step in labor scheduling, we identified the number of customers to serve in the scheduling month based on Point of Sale (POS) data. Because January represents a typical business cycle for this restaurant, we analyzed four weeks of sales data from January 2007. We then calculated the maximum number of customers served each hour for each service period each day (Exhibit 3). While the peak hour for lunch (P_2) is busy enough, the peak hour for the afternoon shift (P_3) is even busier, particularly late in the week. We identified these peak hours on the assumption that if our schedule can satisfy demand during the peak hour of a service period, then the schedule can maintain service standards in all time periods. Using the data of the number of customers served (customer count) during each service period, we calculated the number of employees required during each service period within each tour day.

Identification of Requirements (Number of Employees Required)

To provide high-quality service, our restaurant needed to maintain an appropriate level of employees, given the customer count. To establish the correct ratio of customers and employees, we first calculated the customer count per server (CCS) during the peak hour, simply by dividing the number of customers served in that peak hour by the number of employees. For the remainder of the schedule, we set a CCS standard equal to 95 percent of the peak-hour CCS. Based on the average of this CCS calculation for the study period, the restaurant's standard CCS is 5.5. The formula used to calculate the standard CCS is as follows:

$$\mathrm{CCS} = \frac{1}{31}\left(\sum_{i=1}^{31} c_i/s_i\right) \times \alpha$$

where $C_i(S_i)$ is the number of customers (servers) during the peak hour in day i and α is the service level.

Comparison of Alternatives (IP Model versus Existing Model)

As we said at the outset, our final model will apply an integer programming approach, but first let us examine what the schedule would look like based on the customer count per server, without the IP parameter and its various constraints. (Needless to say, the CCS approach does not schedule fractional employees, but the IP approach adds constraints not found in the CCS approach.) We can then compare that schedule with an IP schedule with the goal of minimizing labor costs while also satisfying the constraint of applying the appropriate ratio of full- and part-time servers on each work shift. After creating these two new schedules (one based on the CCS and one applying the IP constraints) we compared them to each other and to the restaurant's original schedule.

Our first comparison is the CCS schedule to the existing schedule (Exhibits 4 and 5). In the CCS-generated schedule, the number of employees required for service period 1 on Monday is two, but the management has been scheduling five people in this breakfast period. The reverse is occurring on Tuesday's lunches (service period 2), when the CCS schedule brings in eleven servers, but the existing schedule has eight people. This pattern continues generally throughout the week. The schedule based on the CCS model identified overstaffing during service periods 1 and 4 and understaffing during service periods 2 and 3. As we discuss more below, these occurrences of both understaffing and overstaffing accounted for a significant number of service failures that translated into additional costs (both in labor and product) to the restaurant.

We gained even further refinement by applying the integer programming convention. The differences between the two schedules resulted from differential constraints applied by each method. The IP method takes into consideration all the requirements of the various employee categories, as well as all the constraints that we mentioned above (e.g., consecutive

Exhibit 4:

Comparison of the Existing Schedule with the Customer Count per Server (CCS)–Generated and Integer Programming (IP)–Generated Schedules

	Mon	*Tue*	*Wed*	*Thu*	*Fri*	*Sat*	*Sun*
Existing schedule							
P_1(8:00~12:00)	5	4	4	5	6	5	4
P_2(12:00~14:00)	9	8	9	11	11	10	10
P_3(14:00~21:00)	9	10	11	10	10	11	11
P_4(21:00~23:00)	5	6	6	4	5	6	6
Schedule based on CCS							
P_1(8:00~12:00)	2	3	3	2	2	1	1
P_2(12:00~14:00)	8	11	11	11	12	9	7
P_3(14:00~21:00)	7	10	11	12	12	12	10
P_4(21:00~23:00)	3	3	5	5	7	4	3
Schedule based on integer programming: total number of employees (full-time/part-time)							
P_1(8:00~12:00)	4 (3/1)	4 (3/1)	5 (3/2)	5 (3/2)	6 (4/2)	3 (2/1)	3 (2/1)
P_2(12:00~14:00)	8 (5/3)	11 (7/4)	11 (7/4)	11 (7/4)	12 (8/4)	9 (6/3)	8 (5/3)
P_3(14:00~21:00)	7 (5/2)	10 (7/3)	11 (7/4)	12 (8/4)	13 (9/4)	12 (8/4)	10 (6/4)
P_4(21:00~23:00)	3 (3/0)	3 (3/0)	5 (3/2)	6 (4/2)	7 (5/2)	6 (4/2)	5 (3/2)

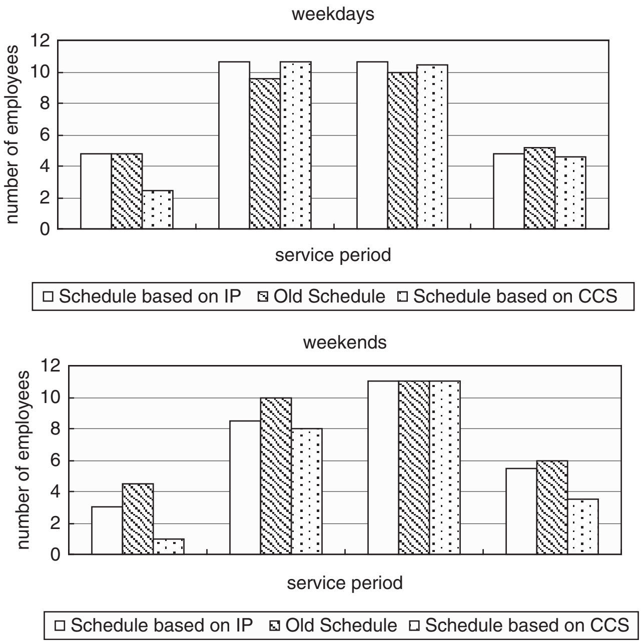
five-day schedule for each employee, ratio of full- and part-time servers). As a result, the IP-generated model produced a more effective schedule than did the model based on only CCS (Exhibits 4 and 5), not because the IP model uses fewer employees than CCS, but because the IP schedule maintains service standards and also takes into account employee tours.

In the IP-generated schedule, Monday, which has the lowest customer count, requires the lowest number of employees (twenty: thirteen full-time and seven part-time employees); and Friday, which has the highest customer count, requires the highest number of employees (thirty-five: twenty-two full-time and thirteen part-time employees). Perhaps the greatest advantage of the IP-generated schedule is that it shows a detailed distribution of full- and part-time employees during each work shift as well as each service period. For example, service period 2 on Monday requires eight employees—five full-time and three part-time, which meets the constraint of the proportion of part-time employees to the total number of employees during each shift. Without this constraint, by contrast, a schedule focused only on minimizing labor cost (while still maintaining CCS standards) would bring in no full-time employees.

The IP schedule also reveals the effects of the constraint of a five-day consecutive tour for each employee. Most notably, in contrast to the original schedule, full-time employees do not necessarily start their tours on Monday. Among the three full-time employees on shift 1, for instance, two full-time employees' tours start on Monday, but the other full-time employee's tour starts on Wednesday and ends on Sunday (instead of Monday through Saturday, as laid out by the restaurant's

Exhibit 5:

Comparisons of Overstaffing and Understaffing of the Schedule Based on Integer Programming (IP), the Old Schedule, and the Schedule Based on Customer Count per Server (CCS)



existing schedule; Exhibit 6). According to the optimal schedule generated using the IP method, no full-time employees start their tour on either Tuesday or on Thursday. A similar pattern is also observed for the schedule of part-time employees, with part-time employees' tours starting on different days. For example, part-time employees who work shift 1 begin their tours on either Monday or Wednesday. Additionally, according to the IP-generated schedule, separate scheduling for weekdays and weekends is not necessary.

Evaluation of the System Implemented

We were able to test this schedule in operation at the restaurant. When the new IP-generated schedule was implemented at the study restaurant, the restaurant saw a 5.50 percent decrease in labor costs (Exhibit 7), primarily because the new schedule decreased in number of servers from twenty-six to twenty-one. In addition to the reduction in staff, the restaurant also saved the opportunity cost of service failures from understaffing. The cost incurred due to overstaffing was calculated by multiplying the number of hours overstaffed by the hourly wage, which we calculated as a weighted average of full- and part-time employees' wages. The weighted average is 5,100 won, calculated as follows: (5,500 won [the wage for full-time employees] × 0.6) + (4,500 won [the part-time wage] × 0.4). Overall, the cost incurred due to overstaffing dropped by 3.16 percent.

Although the cost of understaffing is a real cost, it is more complicated to calculate

Exhibit 6:
Number of Servers Scheduled Based on the Optimal Schedule Resulting from Integer Programming

	Mon	*Tue*	*Wed*	*Thu*	*Fri*	*Sat*	*Sun*
Shift 1 (8:00–14:00)							
Full-timer	2	2	2	2	2		
			1	1	1	1	1
	1	1			1	1	1
Part-timer	1	1	1	1	1		
			1	1	1	1	1
Total	4	4	5	5	6	3	3
Shift 2 (12:00–21:00)							
Full-timer		2	2	2	2	2	
			1	1	1	1	1
	1	1			1	1	1
	1	1	1	1			1
Part-timer		1	1	1	1	1	
		1	1	1	1	1	
	1	1			1	1	1
	1	1	1	1			1
Total	4	7	6	6	6	6	5
Shift 3 (14:00–23:00)							
Full-timer	1	1	1	1	1		
		1	1	1	1	1	
			1	1	1	1	1
	1			1	1	1	1
	1	1			1	1	1
Part-timer			2	2	2	2	2
Total	3	3	5	6	7	6	5
Total							
Full-timer	8	10	10	11	13	10	8
Part-timer	3	4	6	6	6	5	5
Total servers	11	14	16	17	19	15	13

this value. The primary challenge is to place a direct monetary value on poor service. According to Thompson (1997), an accurate calculation of the cost of understaffing, as a cost of poor service, must include a measure of the true impact of staff size changes on customer service, and not a surrogate measure of the impact. The simplest way to calculate the cost of understaffing is to multiply the number of hours understaffed compared to the requirement and the hourly wage. A version of this method was used by Davis (1991) in his study of waiting cost. (Davis [1991] calculated waiting cost by multiplying the minutes that customers wait by the employee's wage per minute.) For our study, we calculated and compared the costs of understaffing in the original schedule and in the IP-generated schedule using this simple calculation method. According to this calculation, the restaurant reduced its costs due to understaffing by 5.78 percent by using the IP-generated schedule.

Exhibit 7:
Improvement in Cost Reduction by Optimal Scheduling Using Integer Programming

	Old schedule	*Optimal schedule*
Total labor costs		
Total number of servers scheduled	26	21
Cost of servers (won)	4,674,470	4,417,500
Cost reduction rate: 5.50%		
Cost of overstaffing		
Overscheduled hours	98	69
Cost of servers overstaffed (won)	499,800	351,900
Cost reduction rate: 29 hrs × 5,100 won/hr = 147,900 won, 3.16%		
Cost of understaffing		
Underscheduled hours	53	0
Cost (won)	270,300	0
Cost reduction rate: 53 hrs × 5,100 won/hr = 270,300 won, 5.78%		

Total improvement in cost reduction could have been higher if the ratio of full- to part-time employees were not set at 6:4. Having more full-time employees in the labor mix adds cost, but that is more than offset by cost savings from an effective schedule that prevents both overstaffing and understaffing. Overall, maintaining an appropriate proportion of full-time employees ensures higher quality service and saves on costs incurred due to poor service.

Conclusion and Study Limitations

In conclusion, the constraints embodied in the IP approach to labor scheduling resulted in reductions in overstaffing in some shifts and understaffing in others, resulting in a reduction in the restaurant's labor costs. With this new labor scheduling approach, both daily and weekly scheduling problems at the restaurant declined and the overall efficiency of restaurant operations improved. In addition, by showing that the number of servers hired by the restaurant was artificially inflated, the more effective labor schedule may also have reduced the potential costs incurred by finding and hiring new employees in a tight labor market.

We recognize several limitations of this study. First, the model we have proposed does not take into consideration the differing pay rates and skill levels of employees within each job category. Secondly, the ratio of full- to part-time employees used in this study (6:4) was based on managerial judgment and experience and, thus, may be not be the most accurate or best ratio. Furthermore, the authors recognize that other factors influence labor scheduling, such as the nature of the work (e.g., preparation or serving) and employee availability and preference. It is, therefore, essential that future studies incorporate these other influences.

Managerial Implications

Restaurant managers spend considerable time developing labor schedules. Typically, the complexity of scheduling increases with the size of the operation: the larger the operation, the more complicated the schedule, especially given restaurants' irregular shifts and part-time employees. Restaurants operating in Korea face the additional challenge of a tight labor market.

A scientific approach to labor scheduling can help managers address these challenges. The IP scheduling model proposed in this article demonstrated that cost reductions were achieved by a restaurant that used a labor scheduling approach that draws on mathematical programming and scientific methods. We showed that a scheduling model that takes the constraints of the restaurant business into consideration was more effective at controlling costs than is the traditional method of developing a schedule based on educated guesswork. The IP model is also more realistic than other methods we examined. Most notably, the model used in this study factored in the use of part-time employees in appropriate proportions to help control labor costs.

This article also demonstrated that effective labor scheduling resulted in reductions in both the cost of overstaffing and the opportunity cost of understaffing. With regard to the cost of understaffing, calculating this figure is not simple, since it is, as we said, an opportunity cost. Reductions in costs due to understaffing are nonetheless important for achieving desired service levels, particularly during peak hours, when service failures are most likely.

Last, but not least, effective labor scheduling is important to employee morale. Employees whose shift preferences are met in scheduling are more likely to be involved, to perform better, and to deliver better service than are employees who feel disgruntled by the schedule. This point was demonstrated in a recent study by Zahn and Sturman (2008), who focused specifically on the consequences of a mismatch between employees' scheduling preferences and their actual time on the job. Employees with a high morale will also be more likely to stay with the organization. Thus, effective labor scheduling can even reduce employee turnover and the consequent costs associated with high turnover.

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