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Employee Utilization Model for the Recreational Center of Portland State University (PSU)

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Abstract

This paper attempts to propose a framework to optimize the ‘employee utilization’ for the Portland State University Campus Recreation Center reception/front desk. In the due course of the research for this paper, many strategies, various models, many distinctive types of data and different methods for operations research have been considered and studied. Crystal Ball has been used to simulate the framework, based on data collected by several iterations of interviews with CREC employees. It also becomes evident, that using the proposed framework can result in substantial monetary saving for the CREC management in terms of employee wages. Thus optimizing usage of employees leads to savings in wages and better hourly scheduling at the CREC front desk. Furthermore, the report investigated the possibility of enhancing the service and easing up the load on the main entry desk employees, such that more users are to be served by less number of employees, which can also result in a higher budgetary saving.

1. Introduction

Portland State University is the largest university in the State of Oregon; this means that it has a very large number of enrolled students. Up to the last few years, the Recreation Center was based in the Stotts Center Building. This facility slowly became inadequate as the number of students increased and PSU’s athletics also increased their enrollment. This forced PSU and its students to look at other options and hence unanimously decide to build a new facility which would be well planned and have most modern equipment [1].

The new Recreation Center is a 5-story building having multiple departments and unique facilities that cater recreation from aquatics, athletics, all the way to rock climbing. This new facility has a large number of employees (permanent and students) that try to run this facility most efficiently. The Rec Center has a student lounge, swimming pool, Jacuzzi, jogging track, cardio center, yoga classrooms, courts and multiple numbers of gym machines.

This facility has around a 150 employees, out of which almost 80 are part-time students. These students form the first tier of employees that a direct interface with the users and manage the facility on a day-to-day basis. All these observations justify the extremely complex management of this facility and the justification to apply advanced analytical approaches to break down the problem and improve efficiency and optimization. This study applies Linear Programming in order to optimize the number of hours-employees in the facility.

2. Recreation Center PSU

According to Portland State University website [1], it was in 1987 that the PSU Presidential Task Force concluded that the university needed a new facility that replaced the Peter Stott Center, which did not meet the needs of the students at that time. There was a serious thought toward to the creation of a new building to meet everybody's needs

The Peter Stott Center was built in 1965 when students' population was only 8,000. Later in 1997 enrollment level at Portland State University became 14,000 students and currently, PSU has around 30,000 students [2]. In 2007 the decision to build the new facility was finally made. Special attention was taking in count for the construction of the facility such as the use of sustainable design features, the use of Oregon products and businesses, partnership with the University in providing academic classrooms and the School of Social Work [1].

The project has a great percentage of funding from students. In order to get the money, Associated Student of Portland State University (ASPSU) elections passed a referendum for every student to pay a minimum of $41/per quarter towards construction and long-term maintenance of the Student Rec Center with $5 increase per year from Aug 2009. The $41 fee does not cover the entire cost of running the building and programs associated with it so the remainder of the costs is to be covered by revenue generation and a student incidental fee allocation.

Some contradictors expressed their concerns considering the new facility an unnecessary and costly endeavor. In 2005, Brailsford & Dunlavey Inc surveyed over 2600 students and found a 66% approval rating. In that same year Oregon Legislature approves $42 million in bonds for the entire building and finally in 2010 the Rec Center was open to the public. An amount of $52 million was invested in the new building, and $9-10 million came from the City of Portland [2].

Table 1 summarizes the main stakeholders and its respective contribution. As this table shows, the only stakeholders that support that maintenance and monthly running of the recreation center are the students, since a cost reduction would impact mainly to them.

Stakeholder	Contribution
PSU Students PSU	$42 per quarter with a $5 increase per year
The City of Portland	$9.1 million for the city archives.
Oregon University System (OUS)	$6 million for constructing the Chancellor's Office
Portland Development Commission	$2 million for the construction project
Retail Tenants	5 retail outlet
Neighborhood Associations	livability of the area and the impact of the construction project on their property

Table 1. Stakeholder and contribution

3. Problem Statement

The uniqueness and the complexity of this new building are evidenced in the many stakeholders with varying interests. After successfully completing the construction stage on time and budget, the efforts now focus in finding the way to optimize the use of resources to decrease the cost of operation and maintenance in annual bases. In order to understand the different source of expenses, Table 2 breaks down the different sources of cost and its respective percentage the total annually expenditure.

Concept	2011-2012 Final Allocation	Percentage of total expenditure
Expenditures		
Personnel		
Unclassified Salaries	$669,027	24%
Other Unclassified Pay	$2,400	0%
Classified Salaries	$116,400	4%
Graduate Assistant Stipends	$12,602	0%
Stipends	$12,408	0%
Student Wages	$848,256	30%
Other Payroll Expenses	$540,662	19%
Subtotal, Personnel Costs	$2,201,755	78%
Services and Supplies	$374,839	13%
Merchandise for Resale	$26,550	1%
Other Expenditures	$92,205	3%
Sub-Total Expenditures	$2,695,349	95%
*General Administrative Overhead	$133,440	5%
Student Fee Support		
Total Expenditures	**$2,828,789**	**100%**
Total Revenue	**$475,966**	**17%**
Total SFC support	**$2,352,823**	**83%**

Table 2. Expenditures and Revenue

Interesting values were obtained for Total amount in Personnel (78%) and student wages (30%) as percentage of total expenditures. Also the revenues cover only 17% of the total expenditures.

It means that by optimizing this variable, the recreation center could have a substantial reduction of operational cost and can be reflected in the student fee.
In addition to the problem of labor cost presented in the previous analysis, the students/faculties have not the expected number of visits to the facility it was calculated at the beginning of the project. The facility has been largely underused by the students/faculty, and a re-evaluation of the use of resources such as employees must be developed in order to decrease the cost of operation (Table 3). The capacity is heavily underutilized and management is seeking to increase membership and daily visitors or reduce redundant activities.

Member Statistics	Min	Max	Type
Total Members : All Registered students (with more than 5 credits/quarter)	28,000	35,000	Annual
Total Members Visiting Center Facility	7000	9600	Annual
Facility Per Day Capacity	0	3500	Daily
Facility Per Day Utilized	40	450	Daily
Quarter	275	1904	Daily

Table 3. Total members in the facilities.

3.1. Identifying Opportunities for Improvements

Like any complex organization, there were many factors and options available to explore avenues where applications of methodologies to improve the existing SOP's are feasible. Taking notice of the current economics situation and financial considerations, it was natural focus on the reduction of cost as the primary objective. Reduction of cost was a very vast statement considering the complexity of the organization.

As slowly data gathered was developed, it was understood that there was already a very fixed amount being used for maintenance and utilities. Therefore, the scope to minimize, what was already minimum was negligible. Furthermore, most of the data was not readily available and not easy to be broken down. For instance, the maintenance costs are fixed and paid in an annual lump sump for the whole building. Also, utilities and power bills are all amortized for the whole facilities, and cutting down its costs would require discontinuing some of the facilities or equipment, which was opposed by the management.

Moreover, space optimization was also considered such that efficient utilization of the given building can be re-evaluated. Ideas of reducing the space, restructuring of the equipment, rearrangement of the facilities and lessening the underutilized programs was also proposed. However, the recreation managements discernibly opposed such ideas as they are always after expanding and promoting different programs to invite more users, even though it can lead to extra costs.

This lead the study to focus on operation cost, which include labor cost as the major factor. Hence, we started focusing on minimization of labor expenses. Several meetings with different management personnel were held to understand the operation of different sectors within the recreation center. The below management staff has contributed to understanding a lot of different operation segments:

1- Todd Bauch, Assistant Director of Operations
2- Jessie Belter, Aquatics & Safety Coordinator
3- Erin Ornorf, Fitness & Helath Promotions Coordinator
4- Joelle Kenney, Office Coordinator
5- Ashley Campell, Member Services Coordinator
6- Hari Shankar Raghavan, Web Coordinator

Each facility is run separately, and the required manpower of each facility differs. However, for the professional personnel such as the trainers, instructors, paramedics, and others are optimized in such a way that they are only called when there are enough interested participants. As for the health and fitness centers, only one supervising person is required during all open hours. The same rule applies in the aquatic center, as two lifeguards are required during the operational hours. The only available and apparent opportunity that was suggested is to focus on the main entry staff, since they are rotating, and they depend heavily on the number of users, number of scheduling required, and the number of activities taking place in the rec. center.

3.2. Optimization Approach

The focus of this optimization study is to use the same parameters and governing requirements that are currently used by the recreation coordination managements. Due to complexity and variability from one day to another, and from one week to another, the management aims on satisfying their customers by taking into consideration the peak days and reflecting it on the rest of the week days. They run only four different staffing schedules, one that consider the weekdays (Monday through Thursday), Friday Schedule, Saturday and Sunday schedule since they all have different operating hours.

However, looking at the current practice, it was discerned that the Rec. Center management manually allocates the required number of employees with a shift of 3 hours per each employee as a governing constraint. The study will focus firstly on how to restructure the staffing of each of the four different scheduling segments. Thus, the optimization approach, will investigate the effectiveness of breaking the 3-hour shift requirements, and the potential savings. Furthermore, it was also realized that the management foresees that each employee can serve up to 50 users in any given hour due to the varying expected number of services required. Thus, the optimization approach will also investigate how this constraint can be relaxed, and what potential outcome can this relaxation bring.

3.3. Objective of the study

Optimize labor hours in order to minimize the cost using Linear Programming Model.

4. Model Development

The objective function for the optimization of labor hours can be formulated as follow:

$$Min \sum_{i} C \cdot X_i$$

where C is the minimum wage per hour ($10/hr)

X_i is the number of workers assigned to shift i

shift 1 : work from 6 AM to 9 AM
shift 2 : work from 7 AM to 10 AM
shift 3 : work from 8 AM to 11 AM
shift 4 : work from 9 AM to 12 AM
shift 5 : work from 10 AM to 1 PM
shift 6 : work from 11 AM to 2 PM
shift 7 : work from 12 PM to 3 PM
shift 8 : work from 1 PM to 4 PM
shift 9 : work from 2 PM to 5 PM
shift 10 : work from 3 PM to 6 PM
shift 11 : work from 4 PM to 7 PM
shift 12 : work from 5 PM to 8 PM
shift 13 : work from 6 PM to 9 PM
shift 14 : work from 7 PM to 10 PM
shift 15 : work from 8 PM to 11 PM

4.1. Constraints

i) The front desk requires a minimum of one employee at all times

$$R_j \geq 1 \quad \forall j \quad [R_j \text{ is the required number of worker in time segment } j]$$

$$X_i, R_j \text{ must be integer}$$

ii) There are mainly several expected tasks to be run by such employees. They are responsible for

- One employee for scanning the ID's of the users.
- Providing helps with regards to assigning lockers to users
- Giving information, answering questions with regards to the facilities, activities, training rules, user's guidelines…..etc.

There are two different cases for the staffing requirements:

Case 1) when the load is expected to be high on the service providers "Front Desk Employees" when the below conditions exist:

If there are more than 30% of the available lockers, or there is an intramural activity going on, then use the ranges below:

The service rate for each employee can usually take a maximum of 2 minutes per each user (since they give only directions and answering questions, usually the users are responsible for filling out the forms), and the probability there are one in each two persons requesting such help and the other person such get the ID scanned.

Thus, the required number of workers is as follows;

- For an expected number of users between 0 and 50, at least one employee should be present.
- For an expected number of users between 51 and 100, at least 2 employees should be present.
- For an expected number of users between 101 and 150, at least 3 employees should be present.
- For an expected number of users between 151 and 200, at least 4 employees should be present.
- For an expected number of users above 201, at least 5 employees should be present
.

$$S_j - 50 * R_j \leq 0 \quad \forall j \quad [S_j \text{ is the simulated number of people in segment } j]$$

Case 2) such requirements are used during the holidays and summer term. This takes place when most (more than 70%) of the lockers are taken during the quarter, and no activity is going on, then each employee can serve up to 100 users (the service rate is assume to increase since the kind of services given is only to give directions, or information (less than a minute/user).

$$S_j - 100 * R_j \leq 0 \quad \forall j \quad [S_j \text{ is the simulated number of people in segment } j]$$

iii) In regards to shift, following constraints should be satisfied.

- Each employee has a shift of 3 consecutive hours.
- The number of employees at the front desk should be greater than or equal to required number for each time segment.

$$X_1 \geq R_1$$

$$X_1 + X_2 \geq R_2$$

$$X_1 + X_2 + X_3 \geq R_3$$

$$X_2 + X_3 + X_4 \geq R_4$$

$$X_3 + X_4 + X_5 \geq R_5$$

$$X_4 + X_5 + X_6 \geq R_6$$

$$X_5 + X_6 + X_7 \geq R_7$$

$$X_6 + X_7 + X_8 \geq R_8$$

$$X_7 + X_8 + X_9 \geq R_9$$

$$X_8 + X_9 + X_{10} \geq R_{10}$$

$$X_9 + X_{10} + X_{11} \geq R_{11}$$

$$X_{10} + X_{11} + X_{12} \geq R_{12}$$

$$X_{11} + X_{12} + X_{13} \geq R_{13}$$

$$X_{12} + X_{13} + X_{14} \geq R_{14}$$

$$X_{13} + X_{14} + X_{15} \geq R_{15}$$

$$X_{14} + X_{15} \geq R_{16}$$

$$X_{15} \geq R_{17}$$

4.2. Analysis

The data we got from the front desk is as follows;

Average Check Ins/Outs							
time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
6 to 7	20	20	10	10	7	0	0
7 to 8	45	30	10	10	8	0	0
8 to 9	80	65	50	50	5	10	0
9 to 10	120	100	110	100	10	10	0
10 to 11	130	90	120	45	10	20	10
11 to 12	115	75	15	15	10	25	20
12 to 1	40	10	10	10	10	10	20
1 to 2	89	30	10	10	10	30	40
2 to 3	110	60	100	90	10	20	50
3 to 4	120	80	100	90	40	30	20
4 to 5	160	90	100	115	60	40	20
5 to 6	205	100	80	150	70	20	70
6 to 7	215	100	100	140	40	50	20
7 to 8	205	200	200	200	20	10	10
8 to 9	140	100	70	80	20	0	10
9 to 10	70	30	30	60	10	0	10
10 to 11	40	20	20	35	0	0	0
	1904	1200	1135	1210	340	275	300

Table 4. Dataset for the model

Monday to Thursday

For weekday analysis, we calculated average number (likeliest) of each time segment and put them with maximum & minimum number in order to run simulation assuming the number of people coming to the front desk follows triangular distribution. From 1,000 times of random number generations, we could come up with simulated mean (S_i) of each time segment i for our optimization model. The results are shown as follows;

Shift	Time segment																	Worker
	6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	
1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1
4	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1
7	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	3
10	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	3
13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	2
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Employee #	1	2	3	3	2	2	1	1	3	3	3	3	5	5	3	1	1	
Rqrd #	1	2	3	3	2	2	1	1	2	3	3	3	4	5	3	1	1	
50*Rqrd #	50	100	150	150	100	100	50	50	100	150	150	150	200	250	150	50	50	
Simulated Mean	14.98	26.35	63.72	108.96	90.75	61.18	22.68	45.10	86.97	99.45	121.92	140.88	151.12	202.09	102.92	49.18	29.80	$420
Max	20	45	80	120	130	115	40	89	110	120	160	205	215	205	140	70	40	
Most likely	15	23.75	61.25	107.5	96.25	55	17.5	34.75	90	97.5	116.25	133.75	138.75	201.25	97.5	47.5	28.75	
Min	10	10	50	100	45	15	10	10	60	80	90	80	100	200	70	30	20	

Table 5. Model for Monday thru Thursday

The required number of labor hours = 42 labor hours, so the objective function gave \$420/day. However, with the 3-hour shift requirement, the Objective function “daily cost” is driven up from \$400 to \$420 due to the 3-hour shift requirement (overstaffing can be noticed).

The proposal is to pay the affected employees (who will work less than 3 hours per day) a premium so that their minimum pay would be \$11 instead of \$10.

This proposal was discussed with the management, and we found the minimum wage is set to \$10/hour but they have the flexibility to increase the salaries as deemed necessary. Moreover, the affected employees were asked (a sample of 9 employees) to express their position toward this proposal. The students (employees) did not show any objections as long as it works with the class schedules. Some (3) of the employees expressed that this proposal would give them flexibility to accept more work hours, since the 1hr shift can fit between classes.

With this incentive, the total cost would be;
\$400 + 2(number of affected employees) * 2(maximum number for premium pay) * \$1 = \$404
There is a daily saving of \$16(\$420 - \$404).
This is applicable through the business days (Monday thru Thursday)
Summary of the costs;

Daily Required Cost	\$ 400
Cost Required with 3-Hr Shift	\$ 420
Cost with Premium Incentive	\$ 404

Friday

As for Friday, the gym opens at 6am and closes at 10pm. Therefore we used 16 time segments and 14 shifts. We also got minimum and maximum number of people coming to the front desk for the simulation. The rest processes were same as weekday analysis. The results are shown below;

Shift	Time segment																Worker
	6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	
1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1
8	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	2
12	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Employee #	1	1	1	1	1	1	1	1	1	1	3	3	2	1	1	1	
Rqrd #	1	1	1	1	1	1	1	1	1	1	2	3	1	1	1	1	
50*Rqrd #	50	50	50	50	50	50	50	50	50	50	100	150	50	50	50	50	
Simulated Mean	8.00	9.00	5.00	11.00	11.00	11.00	11.00	11.00	11.00	43.00	65.00	102.00	43.00	22.00	22.00	11.00	\$210
Max	10	11	7	14	14	14	14	14	14	55	83	134	55	28	28	14	
Most likely	7	8	5	10	10	10	10	10	10	40	60	97	40	20	20	10	
Min	6	7	4	9	9	9	9	9	9	34	51	80	34	17	17	9	

Table 6. Model for Friday

The required number of labor hours = 19 labor hours, so the objective function gave \$190/day. However, with the 3-hour shift requirement, the Objective function “daily cost” is driven up from \$190 to \$210 due to the 3-hour shift constraint.

With incentive suggested earlier, the total cost would be;
\$190 + 2(number of affected employees) * 2(maximum number for premium pay) * \$1 = \$194
There is a daily saving of \$16(210 - 194).
Summary of the costs;

Daily Required Cost	\$ 190
Cost Required with 3-Hr Shift	\$ 210
Cost with Premium Incentive	\$ 194

Saturday

As for Saturday, the gym opens at 8am and closes at 8pm. Therefore we used 12 time segments and 10 shifts. Likewise, we also got minimum and maximum number of people coming to the front desk for the simulation. The rest processes were same as former analysis. The results are shown below;

Shift	Time segment												Worker
	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	
1	1	1	1	0	0	0	0	0	0	0	0	0	1
2	0	1	1	1	0	0	0	0	0	0	0	0	0
3	0	0	1	1	1	0	0	0	0	0	0	0	0
4	0	0	0	1	1	1	0	0	0	0	0	0	1
5	0	0	0	0	1	1	1	0	0	0	0	0	0
6	0	0	0	0	0	1	1	1	0	0	0	0	0
7	0	0	0	0	0	0	1	1	1	0	0	0	1
8	0	0	0	0	0	0	0	1	1	1	0	0	0
9	0	0	0	0	0	0	0	0	1	1	1	0	0
10	0	0	0	0	0	0	0	0	0	1	1	1	2
Employee #	1	1	1	1	1	1	1	1	1	2	2	2	
Rqrd #	1	1	1	1	1	1	1	1	1	1	2	1	
50*Rqrd #	50	50	50	50	50	50	50	50	50	50	100	50	
Simulated Mean	11.00	11.00	22.00	27.00	11.00	11.00	22.00	32.00	43.00	22.00	54.00	11.00	\$150
Max	14	14	28	35	14	41	28	41	55	28	69	14	
Most likely	10	10	20	25	10	30	20	30	40	20	50	10	
Min	9	9	17	21	9	26	17	26	34	17	43	9	

Table 7. Model for Saturday

The required number of labor hours = 13 labor hours, so the objective function gave \$130/day. However, with the 3-hour shift requirement, the Objective function “daily cost” is driven up from \$130 to \$150 due to the 3-hour shift constraint.

With incentive suggested earlier, the total cost would be;
\$130 + 2(number of affected employees) * 2(maximum number for premium pay) * \$1 = \$134
There is a daily saving of \$16(150 - 134).
Summary of the costs;

Daily Required Cost	$ 130
Cost Required with 3-Hr Shift	$ 150
Cost with Premium Incentive	$ 134

Sunday

Finally for Sunday, the gym opens at 10am and closes at 10pm. Therefore we used 12 time segments and 10 shifts. Likewise, we also got minimum and maximum number of people coming to the front desk for the simulation. The rest processes were same as former analysis. The results are shown below;

Shift	Time segment												Worker
	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	
1	1	1	1	0	0	0	0	0	0	0	0	0	1
2	0	1	1	1	0	0	0	0	0	0	0	0	0
3	0	0	1	1	1	0	0	0	0	0	0	0	2
4	0	0	0	1	1	1	0	0	0	0	0	0	0
5	0	0	0	0	1	1	1	0	0	0	0	0	0
6	0	0	0	0	0	1	1	1	0	0	0	0	1
7	0	0	0	0	0	0	1	1	1	0	0	0	1
8	0	0	0	0	0	0	0	1	1	1	0	0	0
9	0	0	0	0	0	0	0	0	1	1	1	0	0
10	0	0	0	0	0	0	0	0	0	1	1	1	1
Employee #	1	1	3	2	2	1	2	2	1	1	1	1	
Rqrd #	1	1	1	1	2	1	1	2	1	1	1	1	
50*Rqrd #	50	50	50	50	100	50	50	100	50	50	50	50	
Simulated Mean	11.00	22.00	22.00	43.00	54.00	22.00	22.00	76.00	22.00	11.00	11.00	11.00	$180
Max	14	28	28	55	69	28	28	97	28	14	14	14	
Most likely	10	20	20	40	50	20	20	70	20	10	10	10	
Min	9	17	17	34	43	17	17	60	17	9	9	9	

Table 8. Model for Sunday

The required number of labor hours = 14 labor hours, so the objective function gave $140/day. However, with the 3-hour shift requirement, the Objective function “daily cost” is driven up from $140 to $180 due to the 3-hour shift constraint.

With incentive suggested earlier, the total cost would be;
$140 + 4(number of affected employees) * 2(maximum number for premium pay) * $1 = $148
There is a daily saving of $32(180 - 148).
Summary of the costs;

Daily Required Cost	$ 140
Cost Required with 3-Hr Shift	$ 180
Cost with Premium Incentive	$ 148

The total weekly saving can be calculated as the sum of all daily savings:

$16*4 (4 days; Monday thru Thursday) + $16 (Friday) + $16 (Saturday) + $32 (Sunday)
Total weekly saving = $128 for each week.
The monthly saving = $ 544

4.3. Other Optimization proposal

The other optimization efforts can be thought of infiltrating through the second constraint such that the loads on these employees can be lightened. (This will reduce the arrival rate of students who require help (using the same requirement of case 2, when the load is minimal) and to also increase the service rate (since the nature of the services to be provided will be easy to conduct)

Figure 1. Auto-scanning system

Rec. management can construct an automatic scanning entrance, which can take care of recording the users' ID's. Also, for the locker's assigning sheets and other activities registration, the Rec. management can have online web based registration process that can ease up the loads. After implementing these proposals the constraint of having one employee per 50 users can be increased to 100. This relaxation of the second constraint can result in higher saving as follow:

Monday Thru Thursday	**Labor-Hour**	**Daily Cost**
Required # of employees (hourly shift)	27	$270
Required No. of Employees (3-hour shift)	30	$300
Friday		
Required # of employees (hourly shift)	17	$170
Required No. of Employees (3-hour shift)	18	$180
Saturday		
Required # of employees (hourly shift)	13	$130
Required No. of Employees (3-hour shift)	15	$150
Sunday		
Required # of employees (hourly shift)	12	$120
Required No. of Employees (3-hour shift)	12	$120

Table 9. Results of 100 users/employee model

Now we can calculate and summarize the total saving from relaxing both constraints as follow:

Scheduling Segment	Current Daily Cost (50/Emp. + 3-H shift)	Daily Cost with Relaxing 3-H shift & paying 1$ bonus	Daily Cost with Relaxing both Constraint (3-H shift & increasing serviceability to 100/emp.)
Monday Thru Thursday	$420.00	$404.00	$276.00
Friday	$210.00	$194.00	$172.00
Saturday	$150.00	$134.00	$134.00
Sunday	$180.00	$148.00	$120.00

Total weekly saving by relaxing both constraints	$690.00
Total monthly saving by relaxing both constraints	$2,942.00

Table 10. Final results

5. Conclusions and Recommendations

In conclusion, it can be noticed that any optimization study starts with a thorough understanding of the factors that contribute to the costs. Afterward, the focus is put on how these factors interrelate, what the governing constraints are, and how they can be disengaged from one another. In this optimization study, the problem was narrowed down to focus on the main entry desk due to different reasons such as the availability of data, the blatancy of contributing factors, the accessibility of the shareholders and decision makers.

After deep analysis of the given problem, the main governing constraints were identified, and the use of OR techniques were used by constructing a Linear Programming Model. After running the model, the constraints, were analyzed, and logical and practical relaxations were investigated. It was shown that around $2,942 of a monthly saving can be achieved by rational relaxation of both constraints.

6. Future Research

Future Research can be focused in the Queue Theory Model application, thus it is imperative to first explain the main entry queue configuration. It is a rich area of research and optimization, and there is a lot of investigation to be carried out [4]. The main entry desk has (mostly) two different queue configurations. This is due to the different nature of the tasks conducted by the main desk staff.

- The first queue configuration is set for the main entrance for scanning the users' ID's. Usually only one employee has the scanner with a single row. This is chosen as the scanning service takes seconds to conduct and does not require other employees. Nonetheless, as the queue gets longer, other employees can also help in scanning.
- The second queue configuration has also one queue, where the users come and wait in a single line that leads to a row of service providers. This service is segregated from the other line since it is relatively a slow line. The services provided include questions for directions, activities registrations, locker assignments…etc.

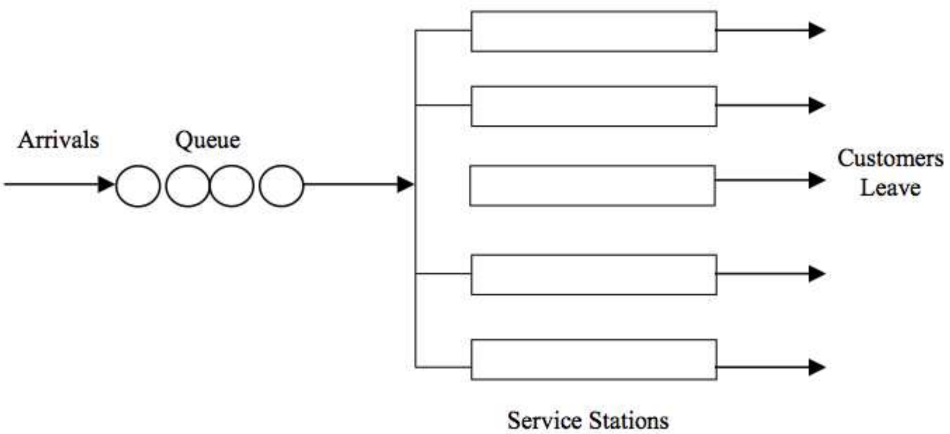

Figure 2. One line - Multi-servers queuing system

- The third queue configuration is used, when the queue gets large enough (mostly around 40 to 50 users), and they add another queue, or a third one, but waiting at a single line to be called by the next available service provider.

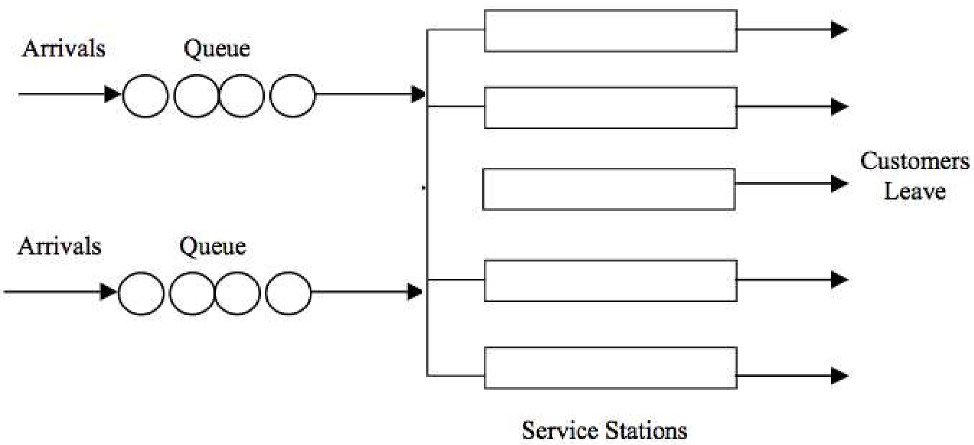

Figure 2. Multi lines - Multi-servers queuing system

7. References

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