Final Project:
SCM 518
PROJECT REPORT

SDFC TOWELS DISPENSARY COST MINIMIZATION PROBLEM

TEAM REPORT SUBMITTED BY

TEAM 9, COHORT A.

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Aman Kumar	Akuma185@asu.edu
Eshwar Chandra S	Echandr1@asu.edu
Xueli Zhang	Xzhan480@asu.edu
Sejal Kulkarni	Sskulk18@asu.edu

SCM 518 Class Project

Summary

The SDFC houses a couple of gyms and a dispensary for sports equipment, towels etc. Towels are used by most people and the peak times of people coming in to the gym is between 4pm-8pm.There is a shortage of towels during those hours. We came up with a solution based on how SDFC collects used towels, replace old ones, loss due to thefts, soiled and destroyed towels based on month, demand, pool parties, lifetime of towels etc. We also had parameters for washing cycle, costs of purchase, shipping etc. Keeping demand, bad towels in mind we developed an optimization model to minimize the costs of purchase, shipping and how many towels to purchase every month. The dispensary at the fitness center houses a lot of equipment, bathroom utilities etc. We want to make sure that SDFC has enough

towels for use every day and an optimum number of towels to purchase keeping investment on towels and maintenance costs minimum.

PROJECT OBJECTIVE AND GOALS

Minimize the purchase cost of towels for SDFC, keeping in mind number of towels purchased based on demand and towels going bad at the end of every month.

Assumptions taken into consideration:

1. Number of bad towels from the previous year will be recycled at the start of new batch
2. Rate of towels going bad is at 1%
3. Number of people coming in depends on the semester (maximum during the academic year, minimum during the vacation like spring break, winter break) and pool parties happen during the initial months and fade off as finals close in.
4. We've assumed a plausible per towel cost and shipping cost as in when more towels are brought in more the shipping cost, lesser the price of each towel and vice versa.
5. During 4-8pm, there is no issue with the washing machines.
6. There are two washers and two dryers each having a capacity to wash and dry 50 towels respectively. Each washing cycle is 25min and each drying cycle is 30min, so around 1hr per cycle.
7. A towel has a life of 3 months only, after which SDFC discards the towel.
8. Cost of towels is given by number of towels required at the beginning of each month times cost per towel and shipping cost.
9. Assumed cost matrix

Towels	Cost per Towel	Shipping Cost
0-5000	$ 10.00	$ 1,000.00
5000-10000	$ 8.00	$ 1,200.00
10000-20000	$ 6.00	$ 1,400.00
20000 and above	$ 5.00	$ 1,600.00

Problem Statement:

Sun Devil Fitness Center(SDFC), has a towel dispensing problem in that there is a problem with how people use towels. Some use more than one, some keep it inside their lockers and some take it home. There are some issues with keeping track of the number of towels used, stolen or lost and finances related to it. According to the manager, SDFC orders about 28,000 towels a year from a wholesale retailer in Bangladesh. The SDFC has its peak hours from 4pm-8pm. Since there is more usage of towels in these four hours, they need to be continuously washed. SDFC has two washers and two dryers which can wash and dry up to 50 towels per wash. Each washing cycle is of 25 min and each drying cycle is of 30 min. There is shortage of towels at most times. The costs of procurement of towels, maintenance etc. depends on how many people use it daily and during which months/time of the year. Approximately 300 towels are lost every month. Assuming 2000 towels are used per basket and replaced every month, SDFC wants to know the number of towels that should be purchased for the next 12 months in order to maintain sufficient number for everyone keeping in mind the costs of purchase and maintenance.

FACTORS CHOSEN

Towels Purchased
Towels Stolen per day
Towels wasted per day
Average Number of towels lost in pool party
Towels gone bad at end of the month
Starting
Towels per person
Lifetime of towel
Number Of washers
Number of Dryers

Additional Factors

Number of people coming in/day
Pool Parties
Number of days
Number of towels lost

Number of towels stolen
Wasted in pool
Towels Gone Bad at end of month
Towels Beyond Lifetime
Bad Towels
New Towels Purchased

MATHEMATICAL MODEL

Parameters:

i = Order size interval ϵ {1,2,3,4}

j = Time plot ϵ {1,2,3,4} ϵ {4-5pm, 5-6pm, 6-7pm, 7-8pm}

t = Month ϵ {1,2,3,4,5,6,7,8,9,10,11,12}

P_t = Number of people coming in per day in month t

PP_t = Number of pool parties estimated to hold in month t

W = Number of towels wasted per day, 10

S = Number of towels stolen per day, 5

L = Average number of towels lost in pool party, 50

B = Rate of towels gone bad at end of the month, 1%

ND_t = Number of days in month t

LT = Life time of towel, 3 months

NM: Number of washing/drying machines, 2

NTP_{jk}: Number of towels processed per machine in time plot j for month t

TP = The average number of towels per person used, 1.5

T_0 = The number of towels hold at the beginning of month 1

NP_{jk} = Number of towels required by people come into SDFC per day in time plot j for month k

TW_{jk} = Number of towels in washing in time plot j for month t

DT_{jk} = Number of towels become dirty in time plot j for month t

LR_i = Lower range for number of towels purchased in order interval i

UR_i = Upper range for number of towels purchased in order interval i

C_i = Cost per towel purchased in order interval i

SC_i = Shipping cost for order interval i

BT_t = Number of bad towels in month t ($BT_t = PP_t * L + W * ND_t + S * ND_t$) + TBL_t

TBL_t = Number of towels beyond lifetime in month t

($TBL_t = (TT_{t-3} – BB_{t-3}) – BB_{t-2}/2 – BB_{t-1}/3$ t = 4

$= (TT_{t-3} – BB_{t-3})/2 - BB_{t-2}/2 – BB_{t-1}/3$ t =5

$= (TT_{t-3} – BB_{t-3})/3 - BB_{t-2}/3 – BB_{t-1}/3$ t =6 onwards)

TT_t = Total towels in month t, calculated: $TT_{t-1} – TBL_{t-1} + X_t$

Decisions:

X_t = The number of new towels purchased in month t $t \in \{1,2,3,4,5,6,7,8,9,10,11,12\}$

Y_i = Whether total towels purchased for next 12 months falls in order interval i $i \in \{1,2,3,4\}$

Objective:

Min $\{\sum_t X_t * \sum_i (C_i * Y_i) + \sum_i (SC_i * Y_i)\}$

Constraints:

$X_t >= 0 \in$ Integer

$Y_i \in \{0,1\}$-Binary.

$\sum_i Y_i = 1$ (The number of total new towels to be purchased will fall in only one order interval i)

$\sum_t X_t >= LR_i * Y_i$ (For being in an order interval i, the number of total new towels to be purchased must be above the lower range for 12 months)

$\sum_t X_t <= UR_i * Y_i$ (For being in an order interval i must be below the upper range for 12 months)

$TT_t >= \sum_i (NP_{jk} – NTP_{jk} * NW)$ for all month t (The number of total towels should be more than the demand in month t).

EXCEL MODEL

Assumptions and Base requirements for Optimization

Towels Purchased			28000
Towels Stolen per day			5
Towels wasted per day			10
Average Number of towels lost in pool party			50
Towels gone bad at end of the month			1%
Starting Towel Stock	3000		
Towels used per person (avg)	1.5		
Average Lifetime of towel	3	months	Cycle Time
Number Of washers Available	2	50	25 min
Number of Dryers Available	2	50	30 min

Initial stock is 3000 towels Towels are replaced after every 3 months. Starting from Fall(August) and ending in July. One hour for every cycle to complete. Towels going bad include the ones that are wasted in the pool, stolen, destroyed or soiled.

Cost Matrix and Order Sizes

Towels	Cost per Towel	Shipping Cost					
0-5000	$ 10.00	$ 1,000.00	0	0	<=	0	<= 0
5000-10000	$ 8.00	$ 1,200.00	0	0	<=	0	<= 0
10000-20000	$ 6.00	$ 1,400.00	1	10000	<=	10000	<= 20000
20000 and above	$ 5.00	$ 1,600.00	0	0	<=	0	<= 0
			1				

Shipping costs increases as number of towels increases and price per towel drops as it increases. Optimized the number of towels to be shipped per year if SDFC goes ahead to import from the same supplier next year as well.

The Washing Issue

The towels that are washed are reused again assuming that all towels are washed and stacked by 4pm and is calculated for each month until we have to replace the towel by the end of 3 months.

	Month 1			
	4pm	5pm	6pm	7pm
Towels Required	375	375	375	375
Towels in washing	0	100	100	100
Dirty Towels	0	275	550	825
Towels comin in from washing	0	0	100	100
Towels Required	1300			

Minimizing costs based on towel usage

Our calculation involves optimizing new towels purchased based on demand from previous month. Keeping number of days in that particular month and usage of the towels based on whether it is the beginning of the semester, break, peak hours, bad towels and considering towels going bad after a particular time due to various reasons we arrived at an optimum cost for purchase and an effective number of towels to purchase per year so that SDFC can benefit from our analysis**.**

Month	1	2	3	4	5	6	7	8	9	10	11	12	
Number of people coming in/day	1843	1756	1874	1841	844	750	1834	1993	1998	1909	1815	985	
Pool Parties	4	2	2	1	0	2	2	2	3	0	0	0	
Number of days	31	28	31	30	31	30	31	31	30	31	30	31	
Number of towels lost	310	280	310	300	310	300	310	310	300	310	300	310	
Number of towels stolen	155	140	155	150	155	150	155	155	150	155	150	155	
Wasted in pool	200	100	100	50	0	100	100	100	150	0	0	0	
Towels Gone Bad at end of month	12	15	20	14	20	17	12	13	13	13	15	7	
Towels Beyond Lifetime	0	0	0	16	845	1056	238	664	478	140	326	481	
Bad Towels	665	520	565	516	1310	1606	803	1229	1078	605	776	946	
New Towels Required	1128	1002	1001	0	1038	1097	1091	923	872	1010	837	0	10000
Towels from Previous Month	0	463	945	1381	865	593	85	373	67	222	627	688	
Demand	1184	1120	1208	1184	436	364	1176	1296	1300	1232	1164	540	
Total Towels	1128	1465	1946	1381	1903	1691	1176	1296	1300	1232	1464	688	
Cost	$ 61,400.00												

Recommendations and Conclusion:

- From the solution, we can see that only 11500 new towels(approximately) need to be purchased in a year instead of 28000, which means there are

many extra towels stored in SDFC that are either unused, lost, stolen or destroyed.

- The minimized total cost on purchasing towels is $70,110.
- In the future, SDFC can also consider purchasing towels monthly instead of yearly according to the forecasting, which would be more concise and would also save storage costs handling inventories.
- SDFC can also try local buying instead of Importing it from India, Bangladesh and China to reduce overhead costs.
- SDFC can also consider increasing the size of their towels racks to accommodate the required number of towels during the peak hours.
- SDFC can also buy more washing machines and dryers to that they are able to quickly restock their washed towels and hence they must rack less number of towels at a particular point of time
- Also cutting down number of towels will greatly minimize storage costs, and gives better chance for reuse and lessen soiled, tampered towels.