Optimization of Inventory Cost Using Computer Simulation: A Case Study

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Abstract: Inventory Management is a part of supply chain management process which in the current business scenario decides the success and failures of many organizations (Jeremy & Stephen, 2009; Willems, 2011). Inventory Management with respect to raw materials procurement involves planning of optimal quantity of items to be ordered and periodicity we need to order them to meet a certain demand. With business supply chains turning global the management of optimal inventory by organizations is turning to be a very challenging task. Information Technology always render a helping hand for easing out complex business problems while simulation is one such technology that helps in modeling or imitating a new or an existing system to pre-validate and optimize decisions before implementing, in a virtual risk free environment (Stewart Robinson, 1993). This study is over Optimizing Inventory Cost using Computer Simulation in a leading Indian Pump Manufacturing Company called Deccan Pumpsets Ltd. Model developed is unique for the company but it can be applied to any pump manufacturing company by making relative changes to it.

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1. Introduction

Inventory Management is a part of supply chain management process which in the current business scenario decides the success and failures of many organizations (Jeremy & Stephen, 2009; Willems, 2011). Inventory Management with respect to raw materials procurement involves planning of optimal quantity of items to be ordered and periodicity we need to order them to meet a certain demand. With business supply chains turning global the management of optimal inventory by organizations is turning to be a very challenging task. Information Technology always render a helping hand for easing out complex business problems while simulation is one such technology that helps in modeling or imitating a new or an existing system to pre-validate and optimize decisions before implementing, in a virtual risk free environment (Stewart Robinson, 1993). This study is over Optimizing Inventory Cost using Computer Simulation in a leading Indian Pump Manufacturing Company called Deccan Pumpsets Ltd. Model developed is unique for the company but it can be applied to any pump manufacturing company by making relative changes to it.

2. Supply Chain Simulation: A Literature Review

Review research made by (Abo-Hamad & Arisha, 2011) identifies a huge research gap in using simulation for optimizing supply chain. Statistical data provided in the study shows that the number of research papers published in general using simulation for optimization during the period of 2001-2009 is 5929 and for supply chain management papers published are 3432 where as for Supply chain Simulation it is just 60.

With the minimum literature a further study revealed that supply chain simulation can be effectively used to measure information sharing (Huang & Gangopadhyay, 2004), to study the aspects of complexity in supply chain (Wu et al., 2001), to manage inventory (Zhang & Tom, n.d.) (Laith, Rabadi, & Soussa-Poza, 2006), to design, implement and evaluate the performance of logistics (Manuj, Mentzer, & Bowers, 2009), to plan and schedule production systems (Marvel, Schaub, Pleasant, & Weckman, 2007) etc.

In the study by (Chang & Makatsoris, n.d.), researchers identify the frequent experiment questions pertaining to supply chain simulation are related to

- Supplier policy that is achieving best delivery performance for the given demand pattern.
- The most robust supplier policy under demand fluctuation.
- Most cost saving inventory policy under the given demand pattern.
- Impact on profit on capacity addition.
- Trade-off between delivery performance and inventory cost when building more inventories and Impact of information accuracy on the manufacturing companies.

Of the above questions this study experiments the most cost saving inventory policy under the given demand pattern. SimQuick , an Microsoft-Excel based software is used for modeling and simulating.

3. Overview of Deccan Pumpsets Limited

Deccan Pumpsets Limited is one of the leading pump manufacturers in the Indian city of Coimbatore producing pumpsets of different kinds for the last three decades. Deccan's products have presence in the more than 30 countries and the company has various accolades for its contribution to the industry. Open-Well Submersible, Bore-Well, Mono-Block are the major products of the company while each product has different sets of models under it. Open-well submersible is the major focus of the company where a higher sale takes place and for this study we have considered only the Open-Well Submersible and its 31 models which have higher movement in the market.

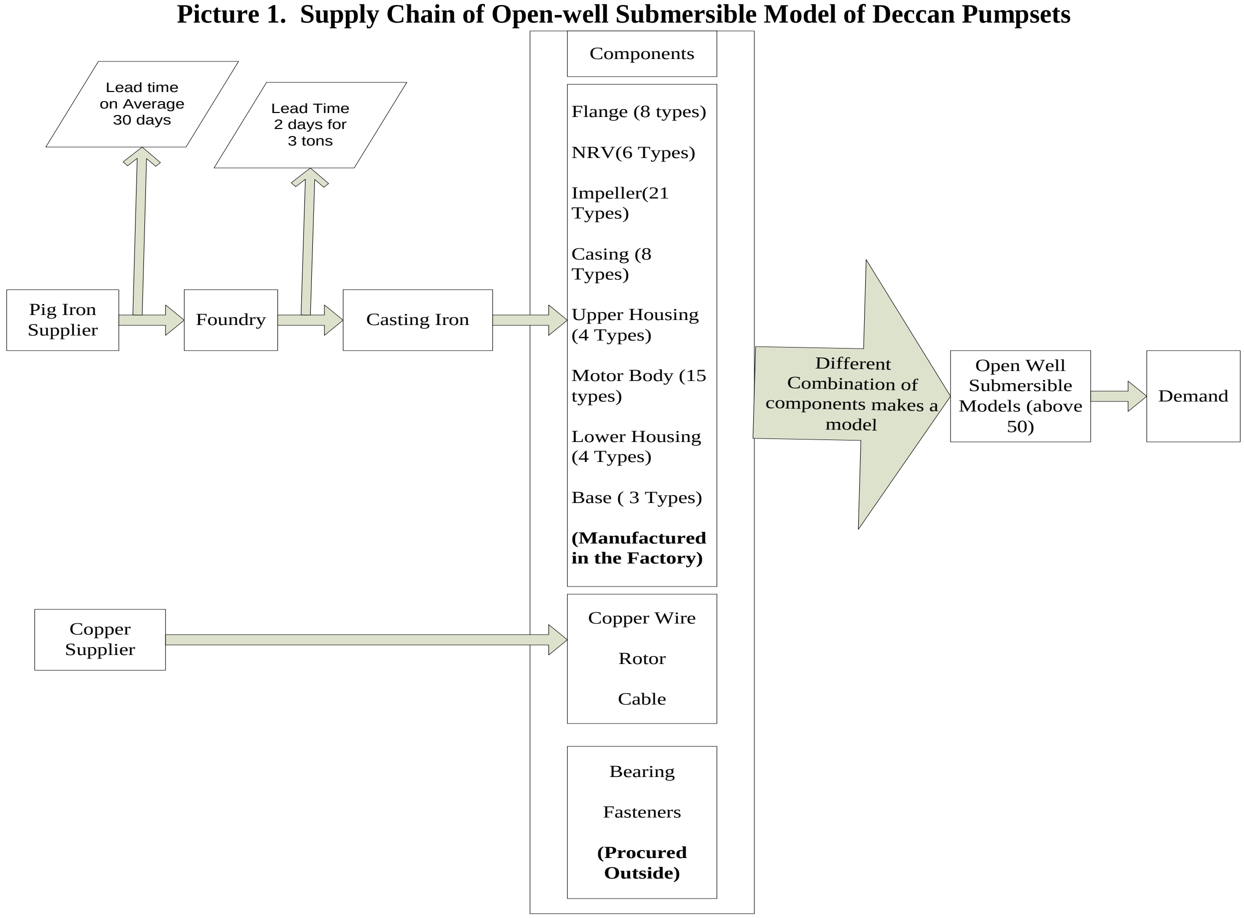
4. Supply Chain of Deccan's Open-Well Submersible

Deccan's procures Pig Iron and Copper which are the major raw materials of the company. Pig Iron which is used by majority of the components is converted to Casting Iron by sending it to the foundry directly after procurement. After getting it as Casting Iron (CI) it is used to manufacturer Flange, NRV, Impeller, Casing, Upper Housing, Motor Body, Lower Housing and Base which are the various components of the pump sets.

5. Deccan's Raw Material Order Policy

Company follows periodic review policy where orders are placed at predetermined times usually once in the month. Average lead time for getting Pig Iron is 30 days and for every two days they get 3 tons of casting iron from the foundry. The detailed supply chain of Open Well Submersible is depicted below Picture 1.

Picture 1. Supply Chain of Open-well Submersible Model of Deccan Pumpsets



6. Data Processing

Demand forecast is always done for 3 months and it is based on previous year's sales. The estimated demand for to be simulated months, and the pump set models and the corresponding types which uses Casting Iron as Raw Material are shown in the Table 1.

Table 1. Models and their Corresponding Component Types which uses Casting Iron as the Raw material

Model	Flange	NRV	Impeller	Casing	U/Hsg	Body	L/Hsg	Base	Demand
10DE	3	3	2	4	2	4	2	2	35
10DP	4	4	7	1	2	4	2	2	16
10DQ	2	3	2	4	2	4	2	2	46
10DT	3	3	3	4	2	4	2	2	32
10DX	2	3	4	4	2	4	2	2	18
12DE	3	3	2	4	2	4	2	2	6
12DQ	3	3	2	4	2	4	2	2	10
12DT	3	3	3	4	2	4	2	2	6
12DX	2	3	4	4	2	4	2	2	6
15DE	3	3	3	4	2	5	2	2	10
15DQ	2	3	2	4	2	5	2	2	12
15DT	3	3	3	4	2	5	2	2	6
15DX	2	3	9	4	2	5	2	2	10
20DE	4	4	7	1	2	6	2	2	6
20DEH	3	3	3	4	2	6	2	2	6
20DQ	2	3	3	4	2	6	2	2	9
20DT	4	4	11	1	2	6	2	2	9
20DX	2	3	2	4	2	6	2	2	6
3DE	1	1	14	2	1	1	1	1	12
3DO	3	2	20	5	1	1	1	1	8
3DT	2	2	15	3	1	1	1	1	72
5DAM	5	6	21	8	1	2	1	1	9
5DE	2	2	15	3	1	2	1	1	75
5DO	3	2	3	5	1	2	1	1	14
5DQ	1	2	15	3	1	2	1	1	30
5DT	2	2	16	3	1	2	1	1	635
6DT	2	2	20	3	1	2	1	1	10
7DE	2	2	17	3	1	3	1	1	200
7DOK	3	2	7	5	1	3	1	1	25
7DQ	1	2	15	3	1	3	1	1	54
7DT	2	2	20	3	1	3	1	1	370

7. Calculation of Estimated Demand

Each component type varies by their size and weight. From the above Table 1 based on their estimated demand the total requirement for a component type is calculated and their details are presented in the following Table 2 individually with their respective weights.

Table 2. Total Demand Estimation

Component	Weight in Tons
Flange	3
Impeller	4
Casing	12
Lower Housing	6
Motor Body	28
NRV	12
Upper Housing	49
Base	10
Total Estimated Demand	**124**

8. Modeling the Process

Table 3. Simulation Scenarios

Scenario	Order Size	Pig Iron Reorder Level	Casting Iron Stock
1	20	35	25
2	25	30	20
3	30	25	15
4	30	15	15
5	30	10	15
6	35	15	10

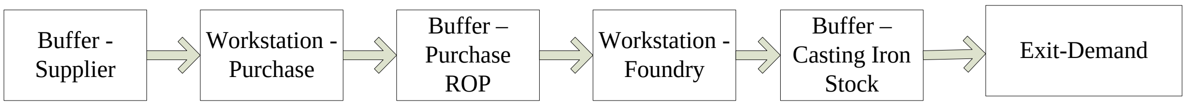
For Estimated demand of Casting Iron the Optimum order size and the reorder level is simulated for the scenarios shown in Table 3. The statistics considered are

1. The lead time to get Pig iron from the Supplier is 30 days.
2. The lead time to get Casting Iron from Foundry is 30-45 days but for every 2 days 3 tons is

supplied regularly by the Foundry.

3. The company incurs $418 per order for Freight.
4. The carrying cost of Pig iron is 3% on the total cost where per ton of Pig Iron costs $51.
5. The inventory cost of Casting Iron is 3% on the total converting cost i.e the cost incurred to convert pig iron to casting iron, where one ton of converting cost is $391.

The Process flow map of the above process in SimQuick is shown in the following Picture 2.



Picture 2. Process Flow Map

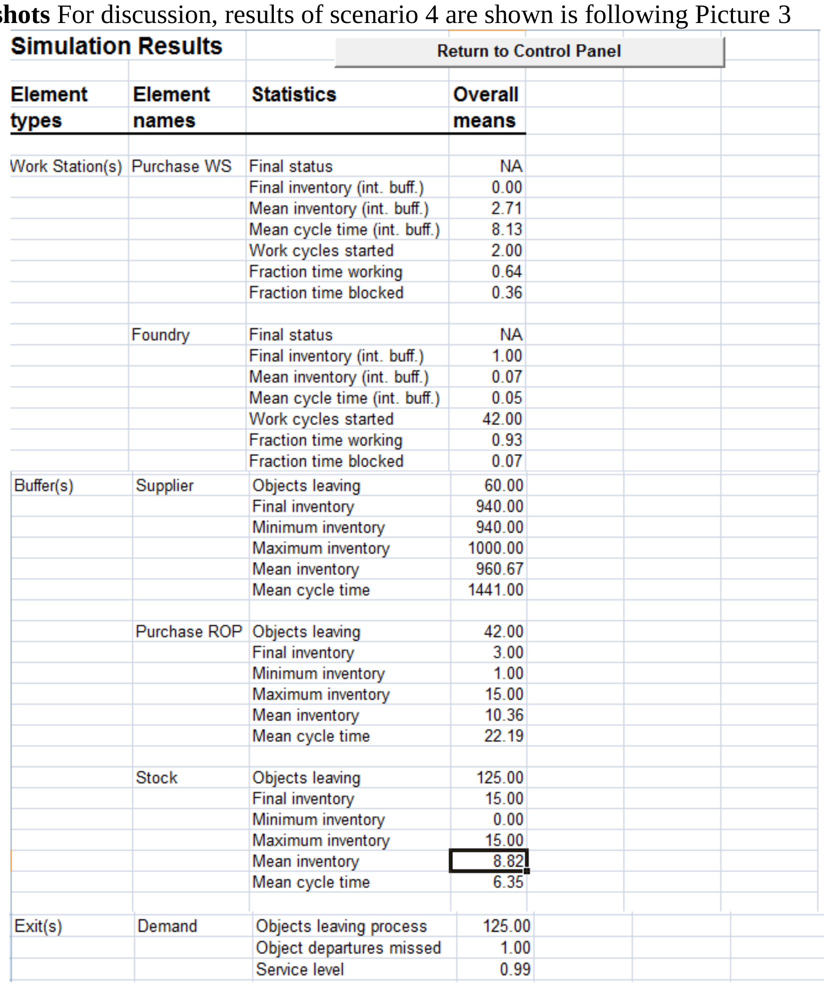
9. Simulation Outcome

By running the simulation for above scenarios we were able to come up with the following results as shown in table 4. The simulation was set to run for 90 days for 50 times and average of all is taken into account.

Table 4. Simulation Outcome

Scenario	Ordering Cost	Inventory Cost	Total Cost	Service Level
1	$1255	$269	$1523	100
2	$836	$202	$1039	100
3	$836	$136	$972	99
4	$836	$121	$957	99
5	$836	$105	$941	90
6	$836	$90	$927	84

Result Screenshots For discussion, results of scenario 4 are shown is following Picture 3



Simulation Results Return to Control Panel

Element types	Element names	Statistics	Overall means
Work Station(s)	Purchase WS	Final status	NA
		Final inventory (int. buff.)	0.00
		Mean inventory (int. buff.)	2.71
		Mean cycle time (int. buff.)	8.13
		Work cycles started	2.00
		Fraction time working	0.64
		Fraction time blocked	0.36
	Foundry	Final status	NA
		Final inventory (int. buff.)	1.00
		Mean inventory (int. buff.)	0.07
		Mean cycle time (int. buff.)	0.05
		Work cycles started	42.00
		Fraction time working	0.93
		Fraction time blocked	0.07
Buffer(s)	Supplier	Objects leaving	60.00
		Final inventory	940.00
		Minimum inventory	940.00
		Maximum inventory	1000.00
		Mean inventory	960.67
		Mean cycle time	1441.00
	Purchase ROP	Objects leaving	42.00
		Final inventory	3.00
		Minimum inventory	1.00
		Maximum inventory	15.00
		Mean inventory	10.36
		Mean cycle time	22.19
	Stock	Objects leaving	125.00
		Final inventory	15.00
		Minimum inventory	0.00
		Maximum inventory	15.00
		Mean inventory	8.82
		Mean cycle time	6.35
Exit(s)	Demand	Objects leaving process	125.00
		Object departures missed	1.00
		Service level	0.99

Picture 3. Simulation Results for Scenario 4

10. Discussion of Results

Calculation of Ordering Cost

Number of Work cycles under Purchase WS depicts number of times order been placed

Total Ordering Cost= Number of Work Cycles * $418

Calculation of Inventory Cost

Buffers refer to storage and for calculating Total Inventory Cost, Inventory in Buffers of Purchase ROP and Stock are taken into account.

Inventory Cost of Pig Iron= (Mean Inventory in Purchase ROP* $51 *3/100)

Inventory Cost of Casting Iron = (Mean Inventory in Stock*$391*3/100)

Total Inventory Cost= Inventory Cost of Pig Iron + Inventory Cost of Casting Iron

Total Cost= Total Ordering Cost + Total Inventory Cost

11. Conclusion

After simulating the different scenarios, it is suggested to Deccan to take up scenario four in Table 3 which has the order size of 30, Pig Iron Reorder Level of 15 and Cast Iron Stock Level of 15 for the estimated demand as the total cost is optimal when compared to other scenarios with the service level of 99% as shown in the Table 4. The Company is advised to follow reorder policy for ordering raw materials instead of periodic ordering policy they follow now, to have better control over their inventory cost.

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