Application of SRA for selection of correct mode for registering complaint to Municipal Council for execution of maintenance work

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Abstract- This work is for the identification of the problems occurring in the Warehouse of the Municipal Council, Jamul (C.G.) and solving the same, so as to find the right order picking system i.e. to find the right materials at the right time from the right place and to minimize the transportation lead time and cost of Warehousing operations. This work gives the solution for the upcoming problems in the Warehouse of the Municipal Council, Jamul C.G. (INDIA) by the application of the Shortest Route Algorithm. The warehousing operation starts as soon as the complaint is registered in the Municipal Office. There were three modes of registering the complaint in the Municipal Office. This research work finds the best way by which the upcoming problems are solved in the best possible way with proper data and survey work with the presence and absence of order picking system, thus minimizing the lead time and increasing the efficiency of work.

I. INTRODUCTION

Introduction to Warehouse & Warehousing:

Warehouse refers to a storehouse for wares, or goods and merchandise. And Warehousing refers to the act of placing goods in a warehouse, or in a customhouse store. In other words, Warehousing refers to the performance of administrative and physical functions associated with storage of goods and materials. These functions include receipt, identification, inspection, verification, putting away, retrieval for issue, etc.

Warehouse Management System, or WMS, is a key part of the supply chain and primarily aims to control the movement and storage of materials within a warehouse and process the associated transactions, including shipping, receiving, put away and picking. The systems also direct and optimize stock put away based on real-time information about the status of bin utilization. Warehouse management systems often utilize Auto ID Data Capture (AIDC) technology, such as barcode scanners, mobile computers, wireless LANs and potentially Radio-frequency identification (RFID) to efficiently monitor the flow of products. Once data has been collected, there is either a batch synchronization with, or a real-time wireless transmission to a central database. The database can then provide useful reports about the status of goods in the warehouse.

Objective & purpose of a warehouse management system:

The objective of a warehouse management system is to provide a set of computerized procedures to handle the receipt of stock and returns into a warehouse facility, model and manage the logical representation of the physical storage facilities (e.g. racking etc.), manage the stock within the facility and enable a seamless link to order processing and logistics management in order to pick, pack and ship product out of the facility. Warehouse management systems can be stand alone systems or modules of an ERP system or supply chain execution suite. Warehouse management = "Management of storage of products and services rendered on the products within the four walls of a warehouse". It involves the physical warehouse infrastructure, tracking systems, and communication between product stations. Warehouse management deals with receipt, storage and movement of goods, normally finished goods, to intermediate storage locations or to final customer. In the multi-echelon model for distribution, there are levels of warehouses, starting with the Central Warehouse(s), regional warehouses serviced by the central warehouses and retail warehouses serviced by the regional warehouses and so on. The objective of warehouse management is to help in optimal cost of timely order fulfillment by managing the resources economically. Warehouse management takes Inventory transfer to another level by tracking the goods in-transit between warehouse locations.

The primary purpose of a WMS is to control the movement and storage of materials within a warehouse. Inventory management, inventory planning, cost management, IT applications & communication technology to be used are all related to warehouse management. Warehouse design and process design within the warehouse (e.g. Wave Picking) is also part of warehouse management. Warehouse management is part of Logistics and SCM. The container storage, loading and unloading are also covered by warehouse management today. Warehouse management today is part of SCM and demand management. Even production management is to a great extent dependent on warehouse management. Efficient warehouse management gives a cutting edge to a retail chain distribution company. Warehouse management does not just start with receipt of material but it actually starts with actual initial planning when container design is made for a product.

Important consideration in design of Warehouse management includes:

- choice of technology for warehouse operations
- physical design and layout of floor space and work stations
- choice of furnishings and equipment
- methods of handling books and materials
- systems for coding information about materials
- devices for moving materials
- organizational issues, such as the design of job tasks and scheduling

Role of warehouse in municipal council:

The Warehouse comes into play as soon as there arises the requirement of materials for the fulfillment of the necessities of the public, viz. street lights, electricity poles, water supply materials, etc. for different wards (areas) as per required.

The Warehouse now comes into action. A record is maintained in stock register for all the materials received by the suppliers and the materials issued for the respective areas as per required in the wards (areas); i.e. a record is maintained for all the entry and dispatch materials as well as for the materials in stock. Therefore the warehouse is responsible for the management of the materials received, materials dispatched and the materials in stock.

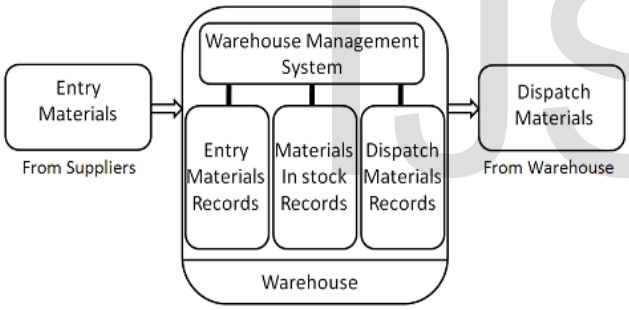


Figure:2 Role of Warehouse in Municipal Corporation / Council (C.G.)

Improvement in warehousing of materials:

Warehouse improvement requires optimizing material flow, order picking, replenishment, and dock operations. Although many traditional lean techniques may be difficult to apply, the concepts of improving material flow and eliminating waste can be used to make significant improvement in warehouse lead time.

.II. LITERATURE REVIEW

History of warehouse management:

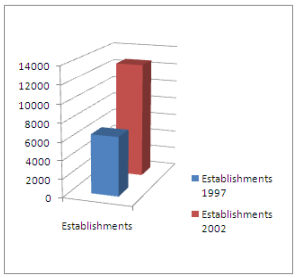
Warehouse management is the process of coordinating the incoming goods, the subsequent storage and tracking of the goods, and finally, the distribution of the goods to their proper destinations. As European explorers began to create shipping-trade routes with other nations, warehouses grew in importance for the storage of products and commodities from afar. Ports were the major location for warehouses. Warehousing's roots go back to the creation of granaries to store food, which was historically available for purchase during times of famine. Warehousing is the storage of goods for profit. The physical location, the warehouse, is a storage facility that receives goods and products for the eventual distribution to consumers or other businesses. A warehouse is also called a distribution center.

As railroads began to expand travel and transportation, the creation of rail depots for the storage of materials became necessary. In 1891 the American Warehousemen's Association was organized to challenge the railroad companies' control over freight depots. President Theodore Roosevelt significantly strengthened the Interstate Commerce Commission with passage of the Hepburn Act in 1906. Commercial warehousing began to grow after the government placed more restrictions on railroads.

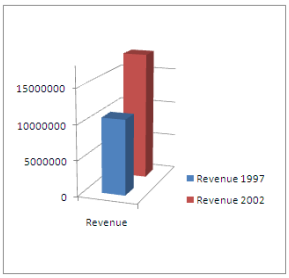
World War II impacted warehousing in several ways, including the need to increase the size of warehouses and the need for more mechanized methods of storing and retrieving the products and materials. As mass production grew throughout manufacturing, the needs of efficient and effective warehousing capabilities grew with it. The warehouse industry found itself recovering from a recession at the start of the twenty-first century, partially brought on by the hype of the dot-com bubble and the excess production created after it burst. It also coped with new methods of distribution, such as just-in-time (JIT) manufacturing—where warehousing is unnecessary because products are shipped directly to customers. Warehousing companies are now striving to become more than simply storage facilities. They are transforming themselves into "third-party logistics providers" or "3PLs" that provide a wide array of services and functions. In addition to packing and staging pallets, contemporary warehousing facilities offer light manufacturing, call centers, labeling, and other non-storage options.

Table: 1 Growth of Warehousing 1997-2002

Year	Establishments	Revenue	Annual Payroll($,000)	Paid employees
1997	6,497	10,657,925	2,926,119	109,760
2002	12,637	17,924,787	18,689,122	639,174



(a)



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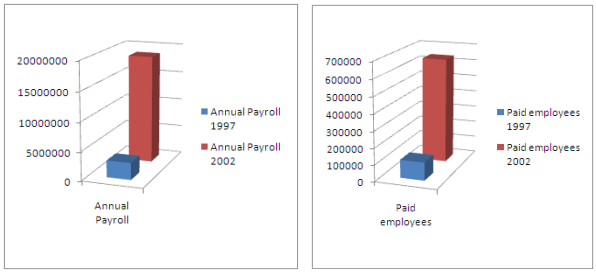

(c) (d)

Figure: 7 Growth chart of warehousing 1997-2002

(a) Comparison between Establishments of year 1997 & 2002
(b) Comparison between Revenue of year 1997 & 2002
(c) Comparison between Annual Payroll of year 1997 & 2002
(d) Comparison between Paid Employees of year 1997 & 2002

III PROBLEM IDENDTIFICATION:

Problems occurring in warehouse of municipal council:

There is a need to solve the problem of correct selection of methods for registering complaints to the Municipal Office for maintenance work.
Modes for registering complain to the Municipal Office:

(i) A telephonic complaint.
(ii) Direct complaint by the public.
(iii) The complaint by the supervisor himself.

IV METHODOLOGY:

Methodology adopted for solving the identified problems:

The Methodology adopted for solving this problem is the application of Shortest Route Algorithm. In this research, the shortest route is find out among the various routes for registering complaint to the Municipal Office, Jamul C.G. (INDIA) for minimizing the lead time and the costs associated with it. Therefore, this research work is very useful for minimizing the costs of warehousing.

The work process starts when:

(iv) A telephonic complaint is registered by the public to the Municipal Office.
(v) Direct complaint is registered by the public to the Municipal Office.
(vi) The supervisor himself finds the problem and registers the complaint to the Municipal Office.

Among the three modes for registration of the complaints to the Municipal Office, the best mode for registering a complaint to the Municipal Office is found out. Thus, helping the Municipal Council to solve the problems in a easier way and as-early-as possible by minimizing the lead time in warehousing operation.

Shortest-Route Algorithm: This section presents two algorithms for solving both cyclic (i.e., containing loops) and acyclic networks:

1. Dijkstra's Algorithm
2. Floyd's Algorithm

Dijkstra's Algorithm: Dijkstra's Algorithm is designed to determine the shortest routes between the source node and every other node in the network. Floyd's algorithm is more general because it allows the determination of the shortest route between *any* two nodes in the network.

Dijkstra's Algorithm: Let *Ui* be the shortest distance from source node 1 to node *i*, and define *dij* (~O) as the length of arc *(i, j).* Then the algorithm defines the label for an immediately succeeding node *j* as: *[Uj, i] = [Ui + dij, i], dij* ~ 0
The label for the starting node is (0, -], indicating that the node has no predecessor. Node labels in Dijkstra's algorithm are of two types: *temporary* and *permanent.* A temporary label is modified if a shorter route to a node can be found. If no better route can be found, the status of the temporary label is changed to permanent.

Step (0): Label the source node (node 1) with the *permanent* label [0, -]. Set *i* = l.

Step (i):

(a) Compute the *temporary* labels *CUi + dij , i]* for each node *j* that can be reached from node *i, provided j is not permanentLy labeLed.* If node *j* is already labeled with *[Uj' k]* through another node *k* and if *Ui + dij < Uj*, replace *[Uj, k]* with *[Ui + dij , i].*
(b) If *aLL* the nodes have *permanent* labels, stop. Otherwise, select the label *fUr> s]* having the shortest distance (= *ur)* among all the *temporary* labels (break ties arbitrarily). Set *i = r* and repeat step *i.*

For application of the SRA, a network is to be constructed with the data collected for various departments.

Network Diagram for repairing of Pipeline items:
Note: Working time = 8 hours in a day

S. No.	Activity	Duration	Duration (in hours)	Process
1	1 - 2	10 minutes	0.166	Telephonic complain to office
2	1 - 3	1 day	8	Direct Complain to office
3	1 - 4	15 days	120	Physical survey by employee
4	2 - 5	2 hours	2	Visual inspection of site
5	3 – 5	2 hours	2	Visual inspection of site
6	4 – 5	2 hours	2	Visual inspection of site
7	5 – 6	30 minutes	0.5	Requirements of items given to storekeeper
8	6 – 7	7 days	56	Action by Engineer
9	7 – 8	3 hours	**3**	**Items issued to worker in absence of order picking system**
10	7 – 9	30 minutes	**0.5**	**Items issued to worker in presence of order picking system**
11	8 – 10	2 hours	2	Time taken by worker to reach site
12	9 – 10	2 hours	2	Time taken by worker to reach site
13	10 – 11	4 hours	4	**Repairing of pipelines**
14	11 – 12	2 days	16	Report given to CMO (in form of Paper)
15	10 – 12	30 minutes	0.5	Reports sent to CMO (in form of

				Data with the help of DBMS)

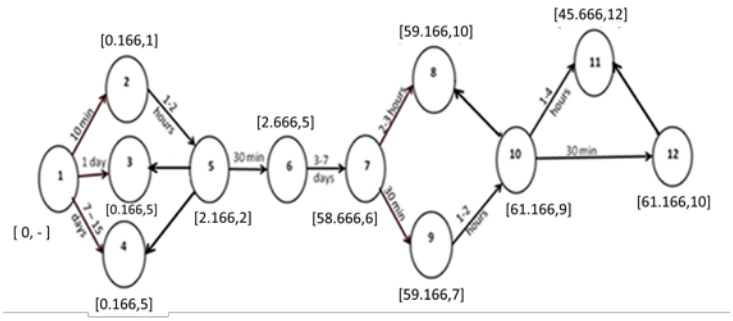

Figure 10: Network Diagram for repairing of Pipeline items

Applying Shortest Route Algorithm to above data:

Node	Label	Status
1	[0 , -]	Permanent
2	[0.166 , 1]	Permanent
3	[2.166 - 2, 5] = [0.166 , 5]	**Permanent**
4	[2.166 - 2 , 5] = [0.166, 5]	**Permanent**
5	[2.166 , 2]	Permanent
6	[2.666 , 5]	Permanent
7	[58.666 , 6]	Permanent
8	[61.166 - 2, 10] = [59.166 , 10]	**Permanent**
9	[59.166 , 7]	Permanent
10	[61.166 , 9]	Permanent
11	[61.666 - 16 , 12] = [45.666 , 12]	**Permanent**
12	[61.666 , 10]	Permanent

The following sequence determines the shortest route from node 1 to node 12:

(12) → [61.666, 10] → (10) → [61.166, 9] → (9) → [58.166, 7] → (7) → [58.666, 6] → (6) → [2.666, 5] → (5) → [2.166, 2] → (2) → [0.166, 1] → (1)

Thus, the desired route when telephonic complaint is preferred is,

1 → 2 → 5 → 6 → 7 → 9 → 10 → 12

with the duration of 61.666 hours.

Network Diagram for repairing of Electrical items:

Note: Working time = 8 hours in a day

S. No.	Activity	Duration	Duration (in hours)	Process
1	1 - 2	10 minutes	0.166	Telephonic complain to office
2	1 - 3	1 day	8	Direct Complain to office
3	1 - 4	15 days	120	Physical survey by employee
4	2 - 5	2 hours	2	Visual inspection of site
5	3 – 5	2 hours	2	Visual inspection of site
6	4 – 5	2 hours	2	Visual inspection of site
7	5 – 6	30 minutes	0.5	Requirements of items given to storekeeper
8	6 – 7	7 days	56	Action by Engineer
9	7 – 8	3 hours	**3**	**Items issued to worker in absence of order picking system**
10	7 – 9	30 minutes	**0.5**	**Items issued to worker in presence of order picking system**
11	8 – 10	2 hours	2	Time taken by worker to reach site
12	9 – 10	2 hours	2	Time taken by worker to reach site
13	10 – 11	3 hours	3	**Repairing of Electrical items**
14	11 – 12	2 days	16	Report given to CMO (in form of Paper)
15	10 – 12	30 minutes	0.5	Reports sent to CMO (in form of Data with the help of DBMS)

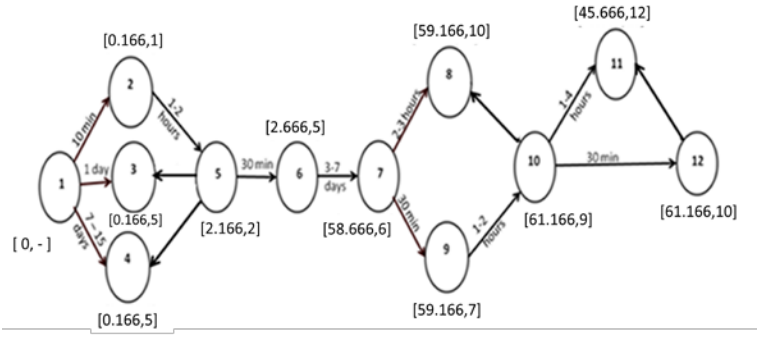

Figure 25: Network Diagram for repairing of Electrical items

Applying Shortest Route Algorithm to above data:

Node	Label	Status
1	[0 , -]	Permanent
2	[0.166 , 1]	Permanent
3	[2.166 - 2, 5] = [0.166 , 5]	**Permanent**
4	[2.166 - 2 , 5] = [0.166, 5]	**Permanent**
5	[2.166 , 2]	Permanent
6	[2.666 , 5]	Permanent
7	[58.666 , 6]	Permanent
8	[61.166 - 2, 10] = [59.166 , 10]	**Permanent**
9	[59.166 , 7]	Permanent
10	[61.166 , 9]	Permanent
11	[61.666 - 16 , 12] = [45.666 , 12]	**Permanent**
12	[61.666 , 10]	Permanent

The following sequence determines the shortest route from node 1 to node 12:

(12) → [61.666, 10] → (10) → [61.166, 9] → (9) → [58.166, 7] → (7) → [58.666, 6] → (6) → [2.666, 5] → (5) → [2.166, 2] → (2) → [0.166, 1] → (1)

Thus, the desired route when telephonic complaint is preferred is,

1 → 2 → 5 → 6 → 7 → 9 → 10 → 12

with the duration of 61.666 hours.

Network Diagram for repairing of Public Health work items:

Note: Working time = 8 hours in a day

S. No.	Activity	Duration	Duration (in hours)	Process
1	1 - 2	10 minutes	0.166	Telephonic complain to office
2	1 - 3	1 day	8	Direct Complain to office

3	1 - 4	15 days	120	Physical survey by employee
4	2 - 5	2 hours	2	Visual inspection of site
5	3 – 5	2 hours	2	Visual inspection of site
6	4 – 5	2 hours	2	Visual inspection of site
7	5 – 6	30 minutes	0.5	Requirements of items given to storekeeper
8	6 – 7	7 days	56	Action by Engineer
9	7 – 8	3 hours	**3**	**Items issued to worker in absence of order picking system**
10	7 – 9	30 minutes	**0.5**	**Items issued to worker in presence of order picking system**
11	8 – 10	2 hours	2	Time taken by worker to reach site
12	9 – 10	2 hours	2	Time taken by worker to reach site
13	10 – 11	7 days	56	Repairing of Construction/Public Health works
14	11 – 12	2 days	16	Report given to CMO (in form of Paper)
15	10 – 12	30 minutes	0.5	Reports sent to CMO (in form of Data with the help of DBMS)

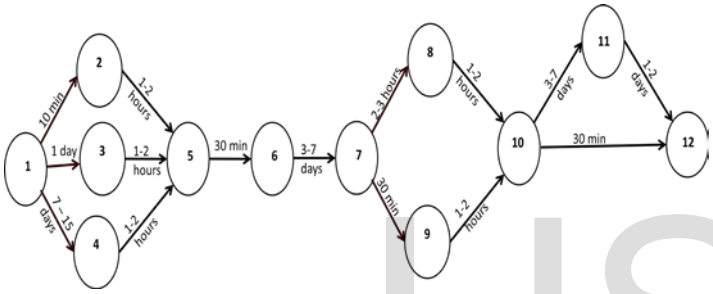

Figure 32: Network Diagram for repairing of Public Health work items

V RESULTS:

Result Analysis for Critical Path:

Modes of Registering complaint to the Municipal office	Time Consumed for completion of work when Telephonic complaint is preferred (in Hours)	Time Consumed completion of work when Direct complaint is preferred (in Hours)	Time Consumed completion of work when complaint by supervisor is preferred (in Hours)
For Repairing of Pipelines items:	83.666 hours	91.5 hours	203.5 hours
For Repairing of Electrical items:	82.666 hours	90.5 hours	202.5 hours
For Repairing of Public Health Work items:	135.666 hours	143.5 hours	255.5 hours

Result Analysis for Shortest Path:

Modes of Registering complaint to the Municipal office	Time Consumed for completion of work when Telephonic complaint is preferred (in Hours)	Time Consumed completion of work when Direct complaint is preferred (in Hours)	Time Consumed completion of work when complaint by supervisor is preferred (in Hours)
For Repairing of Pipelines items:			
	61.666 hours	69.5 hours	181.5 hours
For Repairing of Electrical items:			
Shortest Path	61.666 hours	69.5 hours	181.5 hours
For Repairing of Public Health Work items:			
Shortest Path	61.666 hours	69.5 hours	181.5 hours

VI CONCLUSIONS:

1. The time for warehousing operation (in hours) is minimized to 20 – 29 hours of its total time.
2. The time for warehousing operations (in %) is minimized to 10.81 – 32.6 % of its total time.
3. The efficiency of the work is increased by 10 %.
4. Work can be completed faster.

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