ISSN NO. 2320-5407

*Journal homepage: http://www.journalijar.com*
*Journal DOI: 10.21474/IJAR01*

*INTERNATIONAL JOURNAL OF ADVANCED RESEARCH*

**RESEARCH ARTICLE**

# EFFICIENT STORAGE LOCATION ASSIGNMENT USING GENETIC ALGORITHM IN WAREHOUSE MANAGEMENT SYSTEM.

**V.UmaRani[1] , J.LinEbyChandra[2] and D.Jayashree[3]**

1. Associate Professor, Department of Computer Science and Engineering, Jaya Engineering College, Chennai, Tamil Nadu, India**.**
2. Assistant Professor, Department of Computer Science and Engineering, Jaya Engineering College, Chennai, Tamil Nadu, India**.**
3. Assistant Professor, Department of Computer Science and Engineering, Jaya Engineering College, Chennai, Tamil Nadu, India**.**

## *Manuscript Info*

***Manuscript History:***

Received: 22 April 2016
Final Accepted: 17 May 2016
Published Online: June 2016

***Key words:***
Warehouse-Management System
Genetic algorithm, Storage location.

***Corresponding Author***

**V.UmaRani.**

## *Abstract*

The Warehouse-Management System (WMS) primarily aims to organize the movement and storage space of materials within a warehouse and controls the associated transactions like receiving, put away, storage, order picking and dispatching flow of materials. This paper uses Storage Location Assignment using Genetic Algorithm (SLAG) to find the best location for goods and regulate the retrieval of goods in WMS. It reduces goods handling cost and improves space utilization. It considers the FIFO satisfaction, time of retrieval and frequency of retrieval of goods to find the best location of goods. It shows the increased performance of genetic algorithm in different frequent arrival of goods.



## Introduction:-

Data warehouse are central repositories of integrated data from one or more disparate source. A data warehouse is an integrated, subject oriented, non-volatile and time variant collection of data in support of management's decision making process. The Warehouse-Management System provides an organization with quick tangible benefits by improving warehouse operations like planning, organizing, directing, controlling and increasing efficiency of Warehouse. A Warehouse Management System (WMS) will bring in a wide range of benefits to many different types of organizations including staffing levels; Equipment levels; maximized use of facilities; effective management control and achieving inventory accuracy. The WMS is essential for distribute goods in proper place; coordinate the storage and tracking of goods. A good WMS increases the effectiveness and efficiency of handling warehouse resources and monitoring warehouse operations. Major functions are

1. Manage complex warehouse structure.
2. Store goods in tracks.
3. Process all relevant tasks and movements.
4. Handle goods placement and goods removal strategy.
5. Connection to mobile data entry and external system.

Some common issues are.

1. Inventory accuracy.
2. Inventory location.
3. Space / Capacity management.
4. Damage management.

5. Product identification.
6. Staff management including training etc.

Storage is an organization of goods in a warehouse to increase space utilization and efficient material handling. Storing a product on a shelf or moving it in and out of storage racks does not add value to the product. However, both are important elements in a WMS and play a critical role in enabling efficiency and in providing customer satisfaction. It is an important operational issue to assign stocks or goods to dedicated storage location. It specifies how much goods stored, how frequently and what time goods replenished, where it is stored, distributed and moved in a warehouse. Several storage strategies can be used such as random, class-based, an dedicated storage. In this paper, we concentrate on efficient storage of goods on racking and fast retrieval of goods which is accessed frequently.

## Related Works:-

K.L. Choy et al proposed a WMS that manages fabric resources in a fashion industry and enhances the fast retrieval of fabric using hybrid case retrieval method using case clustering and nearest neighbor algorithm. It selects the fabric based on user needs and past experiences. Francisco Ballestín et al proposed heuristic routing and sequencing the fork lift to perform static and dynamic ordering management. It takes the travel time, the waiting time, the depot time and the storage/retrieval time for scheduling and retrieval of order fulfillment.

Guofeng Qin et al developed an optimization model that heavy weight products are placed in the bottom of the shelf and light weight products are placed in the top of the shelf to reduce the cost and time of the goods retrieval. It use genetic algorithm for optimization. Yon-Chun Chou et al proposed recency-based storage assignment policy for storage assignment of inventory items in a the cascaded warehouse configuration. A cascaded design is a new form of warehouse and department organization. Here inventory items are first divided into classes and each class is assigned to a dedicated area of the warehouse. Classes are usually determined by some measures of demand frequency of the items. Configuring a warehouse cascade entails determining the number of tiers and the capacity of each tier. The cascade configuration resembles a hierarchical structure.

H.Y.Lam, K.L.Cho, et al planned a iterative dynamic partitioned clustering algorithm and the iDPC algorithm for WMS. It provides a decision support function in logistics strategy formulation. Through the analysis of the possible risks concerned when handling customer orders with special needs, the operations strategy can be formulated with consideration of customer expectations; thus customer satisfaction can be enhanced. It use radio frequency identification technology to collect logistics real time data. Esmail Khanlarpour et al determines the reorder point and optimal order quantity to avoid excessive data warehouse storage with the help of genetic algorithm and fuzzy logic. It takes order decision based on waste product cost, turn over cost and inventory difference cost.

J. J. Cárdenas et al projected the power peak module in WMS that decrease immediate power demand and maintain the performance of the system store and retrieval times. The power peak module optimizes the use of power and minimizes the timing distribution of automatic storage and retrieval machines. JunHui Wu, TongDi Qin Jie Chen, HuiPing Si, KaiYan Lin proposed a slotting optimization algorithm of stereo warehouse. The stereo warehouse were discussed to improve the storage effect in which zero's and one's are designed by real number coding. It enhances the frequency of stock in and out, increasing revenue. The stability of the shelf and efficiency of accessing the goods were improved by optimization simulation of distribution of cargo.

There are several issues in WMS, this paper focus on efficient storage and retrieval of goods in WMS using genetic algorithm. It considers the FIFO, retrieval rate and arrival rate of goods to find the location of goods. Once the goods are stored in proper place that enhance the retrieval, tracking and order picking easily.

## Proposed Model:-

The Warehouse consists of several departments; each department has n number of racks. Each department stores different kinds of goods. The SLAG assigns incoming goods to specific storage location in departments. Each department has specific policies and storage technology. It determines the physical location where incoming goods should be stored based on FIFO, retrieval rate and arrival rate of goods. The SLAG process is shown in figure 1.

It uses three processing phases, they are

1. **Information Gathering Phase:** It determines the product information that is which type of goods stored. It clusters the goods from inlet phase where goods are stored initially. It checks deficiency and sends the clustered goods to specific departments.
2. **SLAG Phase:** It found the storage location of clustered goods in department. It uses the following criteria

1. FIFO policy
2. Popularity policy
3. Cube per Order Index (COI) policy
4. Time Of Retrieval (TOR) policy.

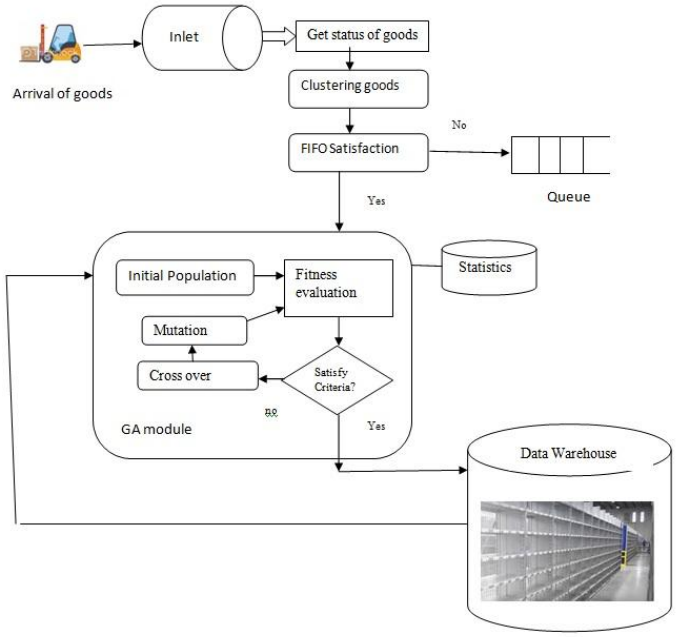


**Figure 1:-** SLAG Model.

Fitness function uses these policies to calculate probability of location. Use genetic algorithm to select the best location where goods are stored.

**First in First out Policy:-** It specifies the goods arrived first are retrieved first. It ensures the older goods are retrieved properly.

**Popularity policy:-** It specifies the number of storage /retrieval operations per unit. It specifies the frequency of retrieval of goods. It is calculated by ratio between number of goods retrieved and number of goods arrived. The front tracks stores the high frequent retrieval or high popularity goods, the subsequent tracks has lesser popularity values.

**Cube per Order Index Policy:-** The COI policy is defined as ratio of maximum allocated goods space to number of storage /retrieval operation of goods per unit time. It helps to minimize goods order picking cost. The lowest COI value is assigned to front tracks and subsequent tracks has high COI values.

**Time Of Retrieval Policy:-** The TOR policy specifies how much time taken to retrieve goods. It reduces the time taken to retrieve goods. Upper racks on shelves have high time of retrieval probability, middle layer shelf has medium time of retrieval probability, and lower layer shelf has low time of retrieval probability value.

The probability assignment of policy is defined as shown as figure 2 (a),(b) and (c).The x-axis specify the direction of racks and y-axis specify the direction of shelf.

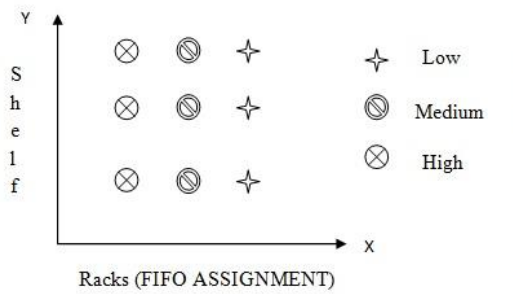


**Fig.2 (a)**

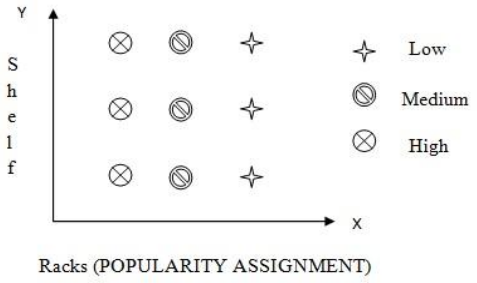


**Fig.2 (b)**

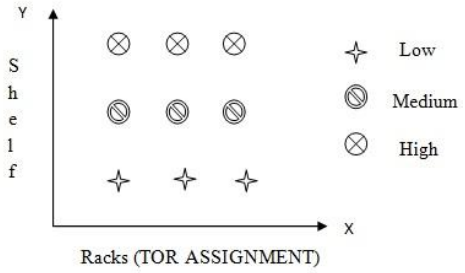


**Fig.2 (c)**

**Genetic Algorithm:-** It uses fitness function to evaluate fitness value of each location. Initial population is generated by binary strings. Each track shelf should be 0 or 1 depends on free location or filled with goods. It use three operators

**Selection:-** select the best individuals by evaluating fitness function. It uses roulette wheel selection to select location with probability $f_i / f_M$ where $f_M$ is the maximum fitness value of population, $f_i$ is the fitness value of individual i in population.
**Crossover:-** selects two populations and interchanges it to get desired fitness of location.
**Mutation:-** interchange same self to get desired fitness of location.

**Algorithm SLAG Model:-**
**Input:-** Arrival of goods
**Output:-** Location of goods
1. Get the initial population.
2. Check COI policy is unsatisfied put it in queue
3. Calculate fitness value of location L
   fitness (L) =f (FIFO, Popularity, TOR)
1. if fitness(L) is satisfied return L
2. else do 6 and 7
3. Perform crossover to selected populations.
4. Perform mutation of selected population.

**Allocation phase:-** It allocates the goods in specified location. If criteria not satisfied then do cross over and mutation until specific location found. If specific location not found then goods are put in queue until location found. Statistics database give information needed that are frequency of retrieval rate and others.

## Results and Discussion:-

Here SLAG model was implemented using ASP.NET 4.5 technology, C# programming language and SQL.

## Design view of User Interface:-

The parameters and product information's are stored in a relational table format in the data warehouse. The figure 3 shows the database view of goods information that shows goods, category of warehouse and quantity information for user.

| P_Id | P_Name | P_Desc | P_Exp_Date | P_Price | P_Category | P_Added_Date | P_Quantity | P_Warehouse |
|---|---|---|---|---|---|---|---|---|
| 1 | Formal Shirts | Formal Wear | Apr 22 2017 12:... | 1500 | Shirts | Mar 27 2016 12:... | 2 | Raymonds |
| 2 | Normal Fit Tro... | Formal Wear | Jan 10 2018 12:0... | 1700 | Trousers | Mar 27 2016 12:... | 4 | Raymonds |
| 3 | dairy milk | chocolate | Oct 30 2016 12:... | 60 | | Mar 31 2016 12:... | 10 | departmental st... |
| 4 | soap | dove | Jul 30 2016 12:0... | 40 | | Apr 3 2016 12:0... | 20 | departmental st... |
| 5 | soap | lux | Aug 27 2016 12:... | 30 | | Apr 3 2016 12:0... | 30 | departmental st... |
| 6 | Biscuits | milk bikis | Jul 22 2016 12:0... | 25 | | Apr 7 2016 12:0... | 20 | departmental st... |
| 7 | shirts | casual shirts | Sep 30 2016 12:... | 700 | Shirts | Apr 7 2016 12:0... | 10 | Raymonds |
| 8 | cake | britania | Oct 30 2016 12:... | 15 | | Apr 7 2016 12:0... | 20 | departmental st... |
| 9 | park avenue | perfume | Sep 30 2016 12:... | 100 | perfume | Apr 7 2016 12:0... | 5 | Raymonds |
| 10 | axe | perfume | Nov 30 2016 12:... | 110 | perfume | Apr 7 2016 12:0... | 5 | Raymonds |
| 11 | jeans | clothes | Sep 30 2016 12:... | 1000 | Shirts | Apr 7 2016 12:0... | 15 | Raymonds |
| 12 | regular fit form... | formal shirt | Oct 30 2016 12:... | 800 | Shirts | Apr 7 2016 12:0... | 10 | Raymonds |
| 13 | surf excel | soap powder | Dec 30 2016 12:... | 55 | | Apr 7 2016 12:0... | 20 | departmental st... |
| 14 | brown leather b... | leather | Jul 30 2016 12:0... | 1709 | | Apr 7 2016 12:0... | 10 | Asian Paints |
| 15 | tractor emulsion | paint | Sep 30 2016 12:... | 149 | | Apr 7 2016 12:0... | 10 | Asian Paints |

**Fig.4:-** Database view of Warehouse.

Each warehouse layout along with filled tracks and free location of goods are shown in figure 4.

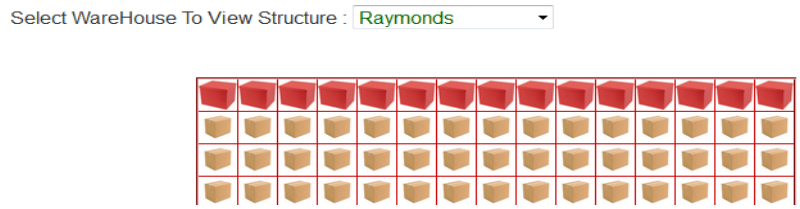


**Fig.5:-** Data warehouse view of goods.

.The location information view of goods, product information and available goods are shown in figure 5 and 6.It is used to enhance the searching process of retrieval of goods. Goods are arranged sequentially and from low level track to next level tracks based on arrival and due date. It ensures first in- first out (FIFO) retrieval of goods. The figure 4 shows the location information of particular goods and their positions.


**Fig.6:-** Location information view of goods.

The figure 7 shows the goods with available quantity information for enhancing the customer satisfaction. It also helps to know the quantity of goods in warehouse. Depending on quantity and flow rate of goods determine the frequency of usage of goods.

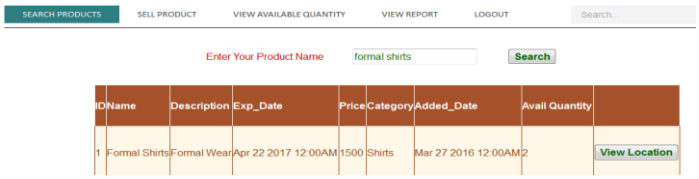


**Fig.7:-** Goods with available quantity information.

## SLAG Performance Analysis:-

Initially all goods are placed in a Inlet phase in which product information gathered and check deficiency. If deficiency found then goods are shipped to queue through which deficiency products removed. The SLAG model use genetic algorithm to find the location of goods. The fitness value can be calculated from equation (1).

$$\text{Fitness } (L) = f(\text{FIFO, Popularity, TOR}) \qquad (1)$$

Here L is a location of goods. The fitness value of location L is calculated from FIFO, Popularity and TOR probability assignment. In SLAG model is tested with 100 racks and 5 shelves for each type of warehouse. The figure 8 shows the time of retrieval for each rack.

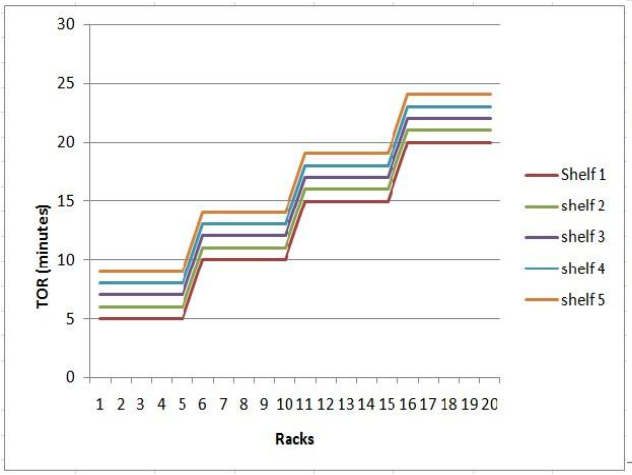


**Fig.8:-** Racks with TOR

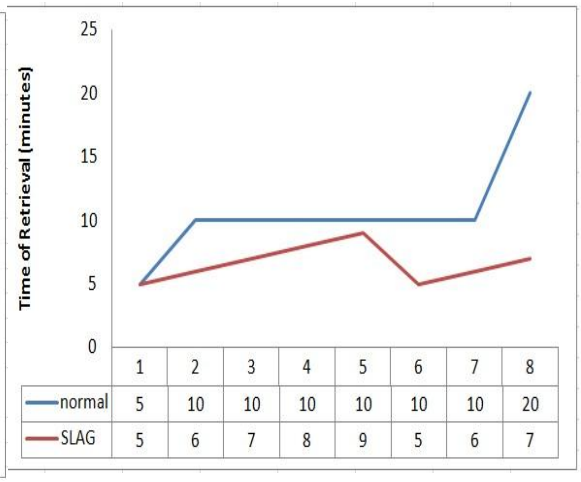


**Fig.9(a):- H**igh frequency goods retrieval

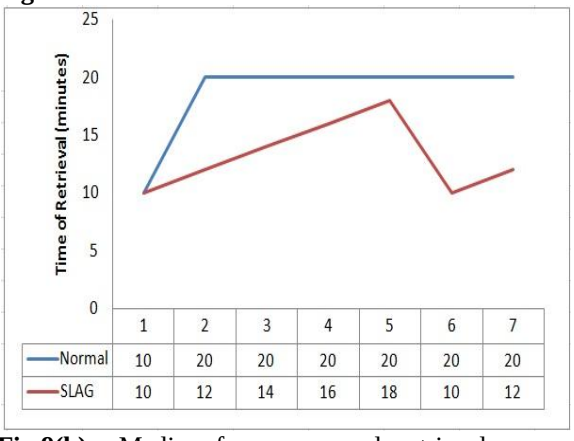


**Fig.9(b):-** Medium frequency goods retrieval

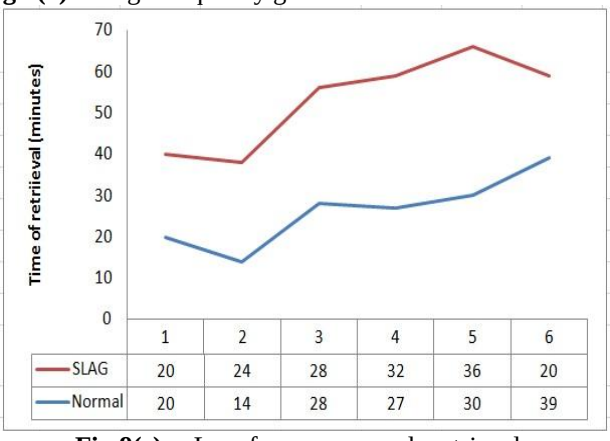


**Fig.9(c):-** Low frequency goods retrieval

The SLAG model is checked for three different kinds of goods arrival. The high frequency movements, medium frequency, low frequency of goods are stored using SLAG model and normal model which doesn't take any policy. Retrieval time of goods shows SLAG model is better than normal model shown in figure 9(a),(b) and (c). The SLAG model determines best location by placing the frequently accessed products in front of the warehouse for

quick retrieval. The goods are placed in large data warehouse by quick retrieval of products from warehouse. By means of analysis of the above stipulated parameters like fitness function, time of retrieval and fitness value, the efficiency of automatic warehouse system, allocation strategy for database storage including improved FIFO have been enhanced. The best highest function is determined by using genetic operators. It is observed that faster frequency of moving, easier location availability, better time of retrieval is obtained. In future work, focus on fragmentation issues and optimal reorder point issues can be improved for retrieval of goods in warehouse.

## References:-


1. **K.L. Choy et al (2009).**A RFID case-based sample management system for fashion product development. International J. Engineering Applications of Artificial Intelligence. 22:882-896.
2. Francisco Ballestín et al (2013). Static and dynamic policies with RFID for the scheduling of retrieval and storage warehouse operations. Computers and Industrial engineering. 66:696-709.
3. **Guofeng Qin et al.(2013)**.Warehouse optimization model based on genetic algorithm. Mathematical Problems in Engineering.1:51-56.
4. **Yon-Chun Chou et al.(2012)**. Recency-based storage assignment and warehouse configuration for Recurrent demands. Computers and Industrial engineering. 62:880-889
5. H.Y.Lam, K.L.Cho, et al (2015).A knowledge based logistics operation planning system for mitigation in warehouse order fulfilment. Int. J. Production Economics.170 :763–779
6. **Esmail Khanlarpour et al (2013)**. Designing an Intelligent Warehouse Based on Genetic Algorithm and Fuzzy Logic for Determining Reorder Point and Order Quantity. Journal of Computer Science and Information Technology.1:1-8.
7. **J. J. Cárdenas et al (2009)**.A Genetic Algorithm Approach to Optimization of Power Peaks in an Automated Warehouse. IEEE transactions.9:3297 -3305
8. **JunHui Wu, TongDi Qin Jie Chen, HuiPing Si, KaiYan Lin(2011).** "Slotting optimization algorithm of stereo warehouse. IEEE transactions.11:202 -213.
9. **Harry K.H. Chowet al (2006).**Design of a RFID case-based resource management system for warehouse operations. Expert Systems with Applications 30:561–576.
10. **Abhay Kumar Agarwal , Neelen dra Badal(2015).**A novel approach for intelligent data ware houses. Egyptian Informatics Journal.10:1110-1117.
11. **Jinxiang Gu et al.(2007).**Research on warehouse operation: A comprehensive review. European Journal of Operational Research 177:1–21.
12. **Riccardo Manzini et al (2015)**.Decision models for the design, optimization and management of warehousing and material handling systems. Int. J. Production Economics.170:711-716**.**
13. **Ramakrishnan Ramanathan et al(2014).**Adoption of RFID technologies in UK logistics: Moderating roles of size,barcode experience and government support. Expert Systems with Applications.41:230-236.
14. **C.K.M. Lee , T.M. Chan (2009).**Development of RFID-based Reverse Logistics System Expert Systems with Applications .36:9299-9307.