CHAPTER 3

REVIEW OF LITERATURE
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3.1 Introduction

Review of literature helps a researcher to get acquainted with his/her selected research problem and also may provide some guidelines in selecting a proper research methodology. It is also helpful in finding out the research gaps in the existing literature. This will help the researcher in fine-tuning his/her research problem and methodology. Another advantage of reviewing in the existing literature is that in cases where the research problems are similar, the conclusions and findings may be easily compared. This will help the researcher in determining whether his/her findings are possible or not. The literature under review may be of two types: (i) concerning the conceptual and theoretical framework. (ii) the empirical literature dealing with the studies made in the past which are similar to the one that the researcher intended to undertake. The basic outcomes of such review will be the knowledge as to what data are available for analytical purposes, which will help the researcher to specify his/her own research problem in a more meaningful way. Thus, review of literature is helpful in formulating the research problem and also helps the researcher in deciding about the most appropriate methodology to be used. While comparing the results of the earlier studies with his/her own results, care must be taken to verify whether the objectives and methodology are similar.

3.1.1 Definitions of Warehouse Systems

Van den Berg (1999)\(^{13}\) describes a warehouse system from different perspectives and classifies such system into three groups: (1) Picker-to-product systems. (2) Product-to-picker systems. (3) Picker-less systems. The author says

\(^{13}\) Van Den Berg J.P (1999), A literature survey on planning and control of warehousing systems, IIE Transactions, Volume No. 31, PP. 751-762.
that as the name of a picker-to-product system already implies, manual order-pickers ride in vehicles along the products. There are numerous different vehicles available from manually vehicles to automated vehicles which also enable vertical movement for order-picking from elevated positions. Further, the author classifies a product-to-picker system. Such systems can be seen as an Automated Storage/Retrieval System (AS/RS). Such systems have been developed for use in factories and distribution centers because they improve inventory cost, labour cost, material tracking, space utilization, average time in the system and system throughput). Lastly, Picker-less system make use of robot-technology or automatic dispensers, whereby two product retrieval methods are distinguished: unit load retrieval systems and order-picking systems. In a unit load retrieval system complete unit-loads are retrieved. Accordingly, the vehicles either perform one stop (storage or retrieval) or two stops (storage followed by retrieval) in a single trip. In an order-picking system typically less-than-unit-load quantities are picked, so that there will be multiple stops per trip (multi-command cycle).

Zijm (1999)\textsuperscript{14} refers a warehouse system to the combination of equipment and operational policies used in an item picking or storage/retrieval (S/R) environment. Ito and Abadi (2001)\textsuperscript{15} describes in their study the definition of a warehouse system; “A warehouse system takes care of fluctuation and uncertainty of demands from customers, and provides just-in-time delivery of materials”. In case the exchange of orders and materials smoothers effectively in a warehouse system it contributes to the success of supply chain systems.

The focus of logistics is increasingly turning towards providing better services for customers instead of minimizing the total transportation or logistics costs, or maximizing total profits (Korpela et al, 2001). As a result, warehouses


are becoming to larger extent flow-through facilities that perform certain value adding functions or customer specific activities before products continue their movement through the supply chain. This, however, sets completely new challenges to warehousing operations. Rather than just picking items and sending them on to packaging prior to final shipment, something additional has to be done to the picked items.

According to Faber et al, (2002)\textsuperscript{16} in the old days of warehousing, inventory was seen to represent the wealth of a company. However, these days this is not the case anymore. Instead, many companies have noticed the high cost associated with holding inventory. In their purest form warehouses should be transshipment areas for dispatching and receiving where products remain in the warehouse for a short period of time only.

Hsieh and Tsai (2005)\textsuperscript{17} define a good warehouse system once it ensures easy and efficient access of merchandise, properly use the storage location to find the shortest path, and finally to deliver the merchandise in a reasonable time.

3.1.2 Design and Managing Warehouse

Designing warehouses is challenging because it involves so many trade-off decisions. Each warehousing function needs to be carefully implemented in order to achieve operational targets. These targets are often expressed in terms of capacity, throughput, and customer service levels. The literature also, acknowledges that the warehouse design process is highly complex.


\textsuperscript{17} Hsieh, L.F. and Tsai, L., (2005), The optimum design of a warehouse system on order picking efficiency, International Journal of Manufacturing Technology, Volume No.28, PP. 626–637.
Gray et al. (1992)\textsuperscript{18} research work aimed to study the design and operation of an order-consolidation warehouse and to develop an applicable model for effective warehouse operations. The study proposed the design and the operation of an order-consolidation warehouse. This research paper also provides a simulation model and shows its application. When the order is consolidated, the process of checking follows (packing, Shipping and Cross decking).

According to Larson, T.N, March, H. Kusiak, A (1996)\textsuperscript{19} it has been found in the literature that warehouse configurations are governed by certain policies and principles. The implied storage policies are: randomize storage, dedicated storage, and class based storage. In random location, inventory is allocated in a certain location where it is unoccupied at the moment. This is beneficial in terms of space whereas inefficient in handling. The dedicated storage policy assigns material to predetermined location based on throughput and storage requirement. The class based storage is a mix of random and dedicated, where storing is done based on some criterion such as demand, product type, size etc.

Rutner and Langley (2000)\textsuperscript{20} in their study had said that the warehouse process quality can be seen as a constrained logistics service quality problem which consists of seven quality parameters (Seven R’s): right product, right quantity, right condition, right place, right time, right customer, and right cost.

Rouwenhorst et al. (2000)\textsuperscript{21} in his research article titled “Warehouse design and control: Framework and literature review” have suggested that the warehouse

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design related issues may be situated on three different levels: strategic, tactical and operational. This hierarchical framework reflects the horizon of warehouse decisions on long-term, mid-term and short-term time frames. The approach is practical especially when information on current operations is not available or doesn’t exist (e.g. starting a new warehouse facility). Because warehouse design is often started with limited information, outlining higher level issues first provides constraints for lower level problems and the outcome should be a more coherent design plan.

(i) Strategic level represents long-term and high investment decisions which can be divided into two groups. The first group of decisions is concerned with the overall design of warehouse flows. A basic flow consists of the stages receiving, storage, order picking, and shipment. Additional processes may be included which has a straight influence on the selection of work tasks and technical equipment. For example, a sorting process will require means to batch and sort processed orders. The second group of decisions is concerned with selecting the type of warehousing systems to be used with the specified processes. The two groups of decisions are connected in the sense that selected processes dictate the need for assisting systems but a process may only be implemented if such systems are available. For example, a sorting process may be selected only if a sorter system exists that is suitable for handling products in the warehouse.

(ii) Tactical level decisions are mid-term decisions that are based on the outcomes from the strategic level. These are decisions that have less impact but still represent moderate investments. Therefore it is not worth reconsidering them too often. Tactical decisions are typically related to issues such as allocating resources, organizing warehouse layout, or determining storage rules.

(iii) Operational level includes daily working decisions that support decisions made on the previous levels. They are often made with less thought and
their impact on operations is restricted. Operational decisions can be pre-programmed, pre-made, or set out clearly in policy manuals. Decisions concerning warehousing processes on the operational level include for example allocation of free storage locations, order sequencing and assignment to pickers, and picking route decisions.

According to Aminoff et al., (2002) warehousing comprises a set of activities or processes that are performed to ensure the seamless flow of materials and information. Assessing and improving the performance of these activities requires careful study of the way warehouse flows relate to each other. Important factors influencing process efficiency in the warehousing environment are e.g. layout choices and the policies by which work routines are controlled.

Koster et al. (2007) research work aimed analysed on design and control of warehouse order picking. The study found that routing problems in warehouse are mostly solved by using these heuristics, which is due to disadvantages of optimal routing in practice. The author names that an optimal algorithm is not available for every layout and cannot take aisle congestion into account, while with heuristic methods it may be possible to avoid or reduce the aisle congestion.

Ambroziak T and Lewczuk K (2008) research paper aimed to develop a method for scheduling the goods receiving process in warehouse facilities. The paper discussed on the role of goods receiving and shipping in warehouse environments. A formal notation of schedules is proposed and the specific analytical examples were shown in this paper.

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Roodbergen and Vis (2009)\textsuperscript{25} empirical work focused on the issues of Design and control of warehouse order picking. The study found that the main advantage of class-based storage is an increased efficiency due to storing the fast-moving items near the I/O-point, while at the same time the low storage space requirements and flexibility of a random storage method apply.

Jochem Sprengers’s (2010)\textsuperscript{26} thesis report how firms should manage planning and control related activities in warehouse systems in today’s world of rapidly changing customer’s demand, small internet orders, tight delivery schedules and high service level requirements. This literature review first describes current, traditionally planning and control policies in warehouse systems, subsequently with new approaches to manage planning and control policies more efficient and to reduce response time in order to maintain warehouse performances in today’s world of rapidly changing customer’s demand. The study conclude by stating that the main savings can be derived in planning related activities and recommended to put more effort in the development of new models instead of optimizing existing ones.

Gu J, Goetschalck M, and McGinnis L. F (2010)\textsuperscript{27} research work focused on the review of concept on warehouse design and performance evaluation. The study found that the layout design of the warehouse is a key component of further optimization tasks and has a significant impact on order-picking and traveling distances in the warehouse.

\textsuperscript{26} Jochem Sprengers’s (2010), Planning and control in warehouse systems, Bachelor Thesis Organization and Strategy, Premaster Operations management and Logistics. ANR: 860755, http://arno.uvt.nl/show.cgi?fid=121828
Tommy Blomqvist (2010)\textsuperscript{28} research study aimed to develop a warehouse design framework that supports systematic decision making, and to establish a framework that can be used to reduce order processing cycle times and improve the overall performance of a warehouse. The study was conducted as a case study in a Finnish technical wholesales company. The results also imply that companies with poor information infrastructure are unable to efficiently track operations that are performed within the warehouse. This emphasizes the fact that management of information flows is becoming an increasingly important criterion to successfully plan and allocate resources within the warehouse.

Dharmapriya U.S.S. and Kulatunga A.K. (2011)\textsuperscript{29} study attempts to optimize warehouse layout: by allocating an economical place to each type of item while minimizing the honeycombing. However, due to the computational complexity of finding an optimal allocation within reasonable time frame, this is mathematically termed as NP-hard type problems. The study found in the literature that the heuristic approaches are highly attractive than the traditional approaches for this instances. The Simulated Annealing heuristic was used to determine the optimal allocation of each category once the initial solution is generated by greedy approach. Generating a shortest route to collect all the items of a respective order is also an objective of this study. The route was decided based on the item’s rank in the delivery route, distance in between two consecutive types of items and the weight. The improved layout was tested on several case studies and simulation results show that improved layout is beneficial in terms of travel distance (reduced by 30per cent) and resource utilization.

\textsuperscript{28} Tommy Blomqvist (2010), A warehouse design framework for order processing and materials handling improvement - Case Etra Oy, Logistics Master's thesis, Department of Business Technology, Aalto University, School of Economics.

Felix T.S. Chan and H.K. Chan (2011)\textsuperscript{30} research work focused on how to improve the productivity of order picking of a manual-pick and multi-level rack distribution warehouse through the implementation of class-based storage. The authors comment that one vital area determining the efficiency of warehouse is the determination of the proper storage locations for potentially thousands of products in a warehouse. Various factors affecting the storage assignment like order picking method, size and layout of the storage system, material handling system, product characteristics, demand trends, turnover rates and space requirements are been extensively studied. It has been suggested that selecting appropriate storage assignment policies (i.e. random, dedicated or class-based) and routing methods (i.e. transversal, return or combined) with regards to above factors is a possible solution to improve the efficiency.

3.1.3 Effective Management of Warehouse Infrastructure

Effective Warehouse Management is an attempt to maintain a systematic and well organized infrastructure and an orderly inventory system. It is also concerned with the adequate supply of goods in the warehouse, while minimizing inventory costs at the same time. Few literature reviews pertaining to this topic is discussed in this sub-section of the study.

Faber, Nynke, De Koster, Rene B. M. (2002)\textsuperscript{31} says that the use of information systems for warehouse management is studied extensively in literature. Complexity of warehouse management is indicated among others by amount and heterogeneity of handled products, the extent of overlap between them, amount and type of technology as well as characteristics of associated


processes. As the complexity increases it becomes necessary to use Warehouse management systems for handling warehouse resources and to monitor warehouse operations. The warehouses with a high amount of processed order lines and amount of stock keeping units will be best supported by customized software. It is difficult to update daily operations of inventory level, locations of forklifts and stock keeping units (SKUs) in real-time by using the bar-code-based or manual-based warehouse management systems.

According to Heung Suk Hwang, Gyu Sung Cho (2006) warehousing takes up to between 2per cent and 5per cent of the cost of sales of a corporation and with today’s highly competitive global business environment organizations are emphasizing on Return on Assets, and hence minimizing warehousing costs has become an important business issue. Many firms are automating their basic warehousing functions to achieve the increase in throughput rates or inventory turns required for their warehousing operations to be cost effective.

Gu et al’ s (2007) research article aim to summaries various reviews of earlier research work on effective warehouse operations. The authors says that the adoption of new management philosophies such as Just-In-Time (JIT) or lean production creates new challenges for warehouse systems, including tighter inventory control, shorter response time, and a greater product variety. On the other hand authors also have commented that the implementation of new information technologies (IT), such as bar coding, radio frequency communications (RF), and warehouse management systems (WMS), provides new opportunities to improve warehouse operations. These operations of a warehouse consist of four basic functions: receiving, storage, order picking and shipping.

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According to McGinnis (2007)\textsuperscript{34} RFID technologies is adopted to facilitate the collection and sharing of data in a warehouse. Tests are performed for evaluating the reading performance of both the active and passive RFID apparatus. Implementing RFID technologies requires a thorough cost and benefit analysis of implementation. The costs of RFID implementation include tag reader costs, communication costs and other infrastructure costs. RFID can improve the automatic checkout process at a retail store, so it can reduce inventory costs as a result of more efficient shelf replenishment. RFID technologies can support the redesign of business processes; improve data quality; real-time data collection; synchronization and information sharing between the players of supply chain.

Wamba, T.R. Coltman, and K. Michael (2008)\textsuperscript{35} are of the opinion that RFID implementation can also bring about additional benefits such as reduction losses due to shop lifting and increased use of point of sale applications.

Poon (2009)\textsuperscript{36} is of opinion that it is necessary to allocate warehouse resource s efficiently and effectively to enhance the productivity and reduce the operation costs of the warehouse. Implementation of Warehouse Management System (WMS) will necessarily provide an increase in accuracy, reduction in labor costs if the labor employed to maintain the system is less than the labor saved on the warehouse floor and a greater ability to service the customer by reducing cycle times. WMS will not only lead in inventory reduction but also in greater storage capacity. An increase in accuracy and efficiency of the receiving process might lead to reduction in level of safety stock required. But the consequence of this reduction will hardly be visible to the overall inventory levels. WMS might just


not affect the factors (lot sizing, lead times and demand variability) controlling the inventory levels. However WMS is instrumental in more efficient and organized that leads to increased storage capacity.

Strack and Pochet (2010)\textsuperscript{37} research work aimed to develop an integrated model for warehouse and inventory planning. According to Strack and Pochet (2010) warehouse and inventory issues are handled in a pyramidal top-down approach where the flexibility of decisions decreases from top to bottom. Consequently, strategic decisions are taken first into account which creates limits to decisions at the tactical and operational levels. As an example the authors refer to a warehouse whereby the size and design are fixed. These decisions will have to be respected when replenishment policies have to be designed as well as when the size of the different warehouse areas has to be optimized. The study aimed to change this traditionally decision process for the planning of inventory models to evaluate the value of integrating tactical warehouse and inventory decisions. The authors reported a mathematical model, whereby two solutions methodologies were developed which offer different level of integration of warehouse and inventory decisions. As a result, the authors concluded that the total cost of the inventory and warehouse systems can be reduced drastically by taking into account the warehouse capacity restrictions in the inventory planning decisions, in an aggregate way. Moreover additional inventory and warehouse savings can be achieved by using more sophisticated integration methods for inventory and warehouse decisions.

Tompkins et al. (2010)\textsuperscript{38} research work focused on facilities to be available in a warehouse. The author suggests that the work simplification method can be used to minimize the total process flow. This approach includes: (i) Delivering


materials, information and people to the point where actual processes happen and eliminating any intermediate steps (ii). Planning for the flow between two consecutive points to take place in as few movements as possible (iii) Combining flows and operations whenever possible by planning the movement of materials, information, and people to be combined with the processing steps.

Lakmal and WADN Wickramarachchi’s (2011) research paperwork aimed to document empirically the relation between factors affecting warehouse efficiency/effectiveness and the overall performance of the warehouse operation. It has studied three factors which affect efficiency and effectiveness of the warehouse operations in Sri Lanka with respect to Fast Moving Consumer Goods (FMCG) industry. Such as, simplicity/complexity of the Warehouse Management Systems (WMS), Product slotting techniques and layout planning of the warehouse. Findings indicate the expected significant correlation between factors affecting warehouse efficiency/effectiveness and the overall performance of the warehouse operation. The results of the research revealed that three factors which have studied, has positive impact to the performance of each warehouse operations. Research findings further revealed other related issues which has been affecting to the effectiveness of the operation. Most of the warehouses do not understand the importance of adopting best practices or may not be successfully implemented in order to increase the level of productivity. So that, this research has provided some recommended practices to the local warehousing sector as well.

Ramaa.et.al (2012) research paper aimed to evaluate the performance levels and enhance productivity of the manual warehouses by developing a WMS framework and cost benefit analysis. The study concludes by stating that

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39 AGDP Lakmal and WADN Wickramarachchi (2011), Enhancing the Effectiveness and Efficiency of Warehouse Operations in FMCG Sector in Sri Lanka, 17th ERU Research Symposium, Faculty of Engineering, University of Moratuwa, Sri Lanka


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warehousing influences the performance of an entire supply chain. With the boom in organized retailing it becomes necessary for the players to continuously improve their process. The retailers have to strive continuously to reduce their costs. Technology being an enabler improved technology has to be incorporated into the current processes. Also the processes have to be designed in such a way that they provide for incorporating changes.

Jan Kar´asek (2013) research paper presents an overview related to warehouse optimization problems. The problems are divided into several groups. First, the basic technical structure of warehouse is described. Second, the standard operational and organizational framework of warehousing company is characterized, which is in special attention in this work. Third, the coordinating and controlling systems for warehouse operations is briefly mentioned, and typical warehousing operations dependent on technical and operational structure are described. The main contribution of this paper is to show the current state of the art in optimization in mentioned three groups of interest in logistic warehouses and distribution centers.

Knight Frank (2014) research report shares comprehensive analysis of the warehousing markets of Pune and Mumbai through. The report stated that the Indian businesses for long have ignored the significance of the logistics sector that continues to remain one of the most under invested sectors in the country. While markets, the inefficiencies in managing it could lead to severe disruption in the entire supply chain network. In India, the experience with regards to this sector has not been very encouraging, thus leading to colossal losses during transportation, distribution and storage of goods. Today, given the substantial growth in organised retail and manufacturing activities in India, the warehousing

market has gradually gained steam within the supply cycle that further drove demand for warehousing, thereby giving huge impetus to the overall market.

3.2 Research Gap

The detailed review of literature throws light on the operational definition of the concept warehousing, warehouse design & management and effective management of warehouse infrastructure. The literature reviews have drawn an elaborate discussion on between factors affecting warehouse efficiency/effectiveness and the overall performance of the warehouse operation in developed and developing countries, but few studies were focused on the influence of professional infrastructure on effective and efficient operations in a world class warehousing either in international concept or focusing India in specific. The identified research dearth has motivated researcher for conduct of this study. This study aims to analyse the whether professional infrastructure influence on effective and efficient operations in of world class warehousing across Indian.