Analysis and Challenges in Cross Docking

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DECLARATION

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CERTIFICATE

This is to certify that the dissertation report on **"ANALYSIS AND CHALLENGES IN CROSS DOCKING"** has been completed and submitted to University of Petroleum and Energy Studies, Dehradun by **Mr. Immanuel Jose Joseph** for the partial fulfillment of the requirement for the award of degree of **MASTER OF BUSSINESS ADMINISTRATION (Logistics and supply Chain Management),** 2o13-2o15 is a bona fide work carried out by him under my supervision and guidance.

To the best of my knowledge and belief the work has been based on investigation made, data collected and analyzed by him and this work has not been submitted anywhere else for any other university or institution for the award of any degree/diploma.

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Executive Summary

Cross docking is the transfer of goods and materials from an inbound carrier to an outbound carrier, without goods or products actually entering the warehouse or being put away into storage. The products "cross the docks" from the receiving dock area to the shipping dock area. Cross docking can provide significant inventory savings. There is no routing to storage areas, no subsequent retrieval from storage racks, and no rerouting back to dock areas. Both the costs of handling the inventory is eliminated or reduced. Cross – docking enhances lean manufacturing, through minimization of time wasted, equipment, labor, thus optimizing the distribution process. The factors that have to considered, so that cross-docking is properly implemented, are the effective products' and information flow, the use of information technology, the distance between suppliers and their customers, the location of the cross-docking terminal, the coordination between inbound and outbound flows and the demanded quantity of goods.

Advantages of cross-docking are the decrease in overall supply chain cost, decrease in the cycle time of order, improved customer service, reduction in inventory and storage space. Nevertheless, cross-docking is not always suitable for all organizations. The establishment of advanced, and thus expensive, information technology constitutes an obstacle.

The distribution process of a retail supply chain has to meet the following requirements:

(i) Distribution of products with small lots and short life cycle; (ii) reliability of supply; (iii) flexibility of the distribution related operations;(iv) decreased lead-time; (v) reliable identification; (vi) up-to-date quality assurance system.

For retail, cross docking is concerned with receiving goods from multiple suppliers, sorting them and shipping them to different stores. In fact, cross docking system has been successfully applied in many industries and several famous companies such as Wal-Mart, Home Depot, Costco, Canadian Tire, FedEx Freight, Toyota, Goodyear GB Ltd

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CHAPTER 1
INTRODUCTIoN

The pressure that is dealt by logistics operations in the current supply chain scenario focuses upon an efficient and economical manner to be achieved. one of the efficient manners to achieve efficiency is to reduce the inventories at every phase of processes. Storage and order picking are most costly process in logistics. That’s where cross docking come into play. Cross docking is a logistics technique that eliminates the storage and order picking functions in the warehouse while still allowing it to serve its receiving and shipping functions. The basic idea is to transfer shipments directly from the inbound to outbound trucks without any storage. Cross docking is an important logistics strategy for many firms in the retail, grocery and other distribution industries. Advanced information systems and improved supply chain coordination have drastically lowered transaction costs which have led to smaller shipment sizes and a need for consolidation to regain transportation economies. Material handling in a cross docking is labor intensive as the freight is oddly shaped, so flexibility is required as products in retail are seasonal in nature. Automation requires a huge fixed cost, which many firms are reluctant to incur.

Some factors that influence the suitability of cross-docking compared with traditional distribution. First important factor is the **product demand rate**. If there is an imbalance between the incoming load and the outgoing load, cross-docking will not work well. Hence, goods that are more suitable for cross-docking are the ones that have demand rates that are more or less stable (e.g. grocery and regularly consumed perishable food items). For these products, the warehousing and transportation requirements are much more predictable, and consequently the planning and implementation of cross-docking becomes easier. The **unit stock-out cost** is a second important factor. Because cross-docking minimizes the level of inventory at the warehouse, the probability of stock-out situations is higher. However, if the unit stock-out cost is low, the benefits of cross-docking can outweigh the increased stock-out cost, and so cross-docking can still be the preferred strategy. The traditional warehousing is still preferable for the opposite situation with an unstable demand and high unit stock-out costs. For the two other cases, cross-docking can still be used when proper systems and planning tools are in place to keep the number of stock-outs to a reasonable level. Some other factors that can influence the suitability of cross- docking are the **distance to suppliers and customers** (higher distances increase the benefits of consolidation),**the product value and lifecycle** (a larger reduction in inventory costs for products with a higher value and shorter lifecycle),**the demand quantity** (a larger reduction in inventory space and costs for products with a higher demand),**the timeliness of supplier shipments** (to ensure a correct synchronization of inbound and outbound trucks),etc.

Some other factors that can influence the suitability of cross docking are the **distance to suppliers and customers** (higher distances increases the benefits of consolidation), the demand quantity, the timeliness of supplier shipments to ensure a correct synchronization of inbound and outbound trucks, etc.

CHAPTER 2

LITERATURE REVIEW

Authors	Context	Description
Janat Shah	Supply chain management: Texts and cases. Pg 115-125	Defines what cross docking is
Belle Jan Van, Paul Valckenaers et.al (2o13)	Cross docking: state of the art(2o12)	Guidelines for the successful use and implementation of cross docking is discussed and several characteristics are described
Dwi Agustina, C. K. M Lee, Rakesh Piplani	Scheduling and vehicle routing model of cross docking	Vehicle routing and scheduling cross docking operation at a major automotive manufacturing plant is compared to a newly designed plant.
Zhengping Li, Cheng Hwee et.al	A solution for cross docking operations planning, scheduling and coordination	
John T. Bartholdi, Steven T. Hackman(2oo1)	Warehouse and distribution science	In a high volume cross dock the turnover times may be measured in hours. There is no storage provided in a cross dock.
John j. Bartholdi, Kevin r. Gue.(2oo7)	The best shape fo a cross dock	Within both retail distribution and LTL transportation

		networks cross docks vary greatly in shape. Docks in the shape of an I, L or T are prevalent.
Dragen Vasilijivic, Hiroslav Stepanovic et al	Cross docking implementation in distribution of food products	Defining circumstances where cross docking can be suitable tool for food distribution.
John Joseph Vogt (2oo4)	The design principles and success factors for the operation of cross docking facility in grocery and retail supply chain	Research on the design principles and success factors of implementing cross docking in retail supply chain. A unique new classification for docks is derived.

2.1 origin

The most probable origin of the term cross dock comes from the American railroad usage. Two freight trains parked on either side of a dock at a station could be unloaded and goods moved across the dock. The sort would occur from the one train to the other. The concept may equally be from the shipping era, where the port dock was used for the same purpose.

2.2 Development

Cross dock capability was developed initially as a means to take goods from one transport party and to sort and assemble these goods into the required groupings for other transport parties to distribute the goods further. For example, this would in simple terms be the transport depot, where a larger truck delivers goods to a central depot and the goods are then sorted and assembled for smaller trucks to deliver locally. This would also be applicable to the collection of goods from many sources to a local depot, where the goods will be assembled into larger loads for movement via larger, more economical transport to further destinations.

With the advent of rail and shipping increased the size of the delivered load. The depot on the wharf became the port terminal where the mode changed from sea to land, and the onus was to take goods from the ship and then to distribute these goods utilising both long distance and short distance transport.

The advent of information systems and scanning technology, in the last 15 years or so, has made the monitoring of high volumes of items feasible and promoted the cross dock, which is dependent on this capability. The process has been enhanced in the last decade or so to include the distribution of goods received from suppliers to the retail outlets. The use of the cross dock in this process is ideal for high volume products, short life cycle products and for reduced inventory for high value products. The cross dock service in retail supply chains has altered from the initial change of mode focus, to include the aspects of marketing and effectiveness by providing these high volume products more efficiently and high value products with reduced inventory costs

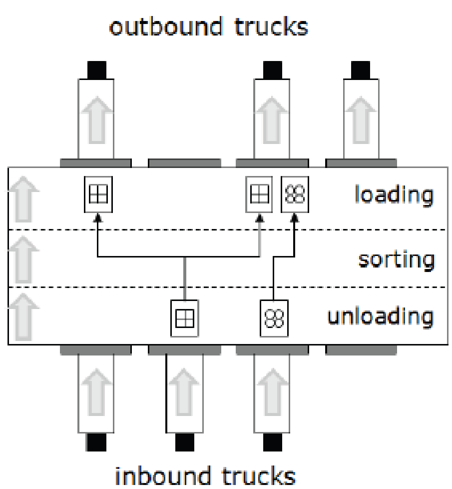


Figure 1: Schematic representation of a cross docking terminal

Cross docking is a popular logistical strategy by which packages of products are unloaded from the inbound vehicle and then are almost directly uploaded into the outbound vehicle with little or no storage in between. As a practical real-world industrial practice, cross docking has attracted substantial attention from both the academy and the industry. A definition of cross docking provided by Kinnear is: “receiving product from a supplier or manufacturer for several end destinations and consolidating this product with other suppliers’ product for common final delivery destinations”.

The focus is on the consolidation of shipments to achieve economies in transportation costs. The Material Handling Industry of America (MHIA) defines cross-docking as ‘‘the process of moving merchandise from the receiving dock to shipping [dock] for shipping without placing it first into storage locations’’. The focus is now on transshipping, not holding stock. This requires a correct synchronization of incoming (inbound) and outgoing (outbound) vehicles. However, a perfect synchronization is difficult to achieve. Also, in practice, staging is required because many inbound shipments need to be sorted, consolidated and stored until the outbound shipment is complete. So, this strict constraint is relaxed by most authors. Cross-docking then can be described as the process of consolidating freight with the same destination (but coming from several origins), with minimal handling and with little or no storage between unloading and loading of the goods. If the goods are temporally stored, this should be only for a short period of a time.

An exact limit is difficult to define, but many authors talk about 24 hrs.’, if the goods are placed in a warehouse or on order picking shelves or if the staging takes several days or even weeks, it is not considered as cross docking but as traditional warehousing. However even if the products are staged for a longer time, some companies still consider it cross-docking, as long as the goods move from supplier to storage to customer without being touched except while at truck loading.
The terminal for cross docking is known as a cross dock. Most of these cross docks are long, narrow rectangles (I shaped), though other shapes are also used (L,T,X,etc.). A cross dock has multiple loading docks where trucks can be loaded or unloaded. Incoming trucks are asligned with a strip door where the freight is unloaded. The goods are moved to its significant stack door and loaded to an outgoing truck. There is no special infrastructure to stage freight.

2.3 Prerequisites of Cross-Docking

The prerequisites of cross docking with certain challenges are as follows;

- Partnership requirement: CD requires total commitment and continuous monitoring at all times by the parties involved in the CD initiative.
- Communication between parties should be efficient: the information flow need to be operated smoothly requiring investment for information system.
- Complexity in managing operations: a serene coordination is needed for material flow due to absence of inventories. Mathematical models can be used for interrelated supply chain decisions which are interrelated and that needs resource and time constraint.
- Sharing costs and benefits of CD: a successful cross dock implementation helps in saving costs and risks involved in the supply chain. Example, decreased inventories, labor, and storage requirements. A prior agreement with the parties involved can result in sharing of investment.
- Perfect quality requirements: to maintain fast product flow at the cross docks suppliers need to adhere to quality norms for inspection purposes.

2.4 Industries application of cross docking

Cross docking has found extensive applications in retail industry, by companies including Wal-Mart (Stalk *et al.*, 1992), Asda (White, 1998), and Sears (Richardson, 2oo4). Automotive companies reported to implement cross docking are Toyota and Mitsubishi (Witt, 1998). Cross docking is also popular in telecommunications and electronics industries, being implemented by companies such as Ericsson (Cooke, 1999) and National Semiconductor (Richardson, 2oo4). Another industry where cross docking is adapted is apparel industry (Morton, 1996; Shanahan, 2oo2). Third-party logistics (3PL) companies, and especially less-than-truckload (LTL) companies, are frequently found to operate under cross docking.

2.5 Benefits and Drawbacks of Cross docking

The benefits of cross docking can be listed as follows (Napolitano, 2ooo; Aichlmayr, 2oo1):
Cross docking

- Decreases inventory levels due to elimination of storage.

- Enables faster product flow (by eliminating “dwell”, the situation of products waiting statically at the same location) .
- Enables more frequent deliveries.
- Enables faster completion of incomplete orders due to more frequent deliveries (White, 1998).
- Decreases inventory obsolescence due to reduced inventory and faster product flow.
- Decreases labor requirements and costs due to decreased material handling (through elimination of put away to storage and order picking).
- Decreases inventory damage costs due to less material handling.
- Decreases the amount of space required, and thus increases the handling capacity of the facility.
- Supports Just-in-Time (cross docking is frequently referred to as the “JIT in distribution”).

- Accelerates payments to suppliers (which are an important argument that can be used to convince suppliers to participate in cross docking).
- Improves the relations with the supply chain partners.

The major drawbacks of cross docking occur when the prerequisites listed earlier are not met. other drawbacks, which can be considered as challenges, can be listed as follows:

- *Stock-out Risk*: Since the CF with effectively zero inventory replaces the warehouse with positive inventory, any sudden increases in demand, any unavailability of the product at the suppliers, any delays in the supply chain, or any failure to coordinate perfectly results in costly stock-out.
- *Union resistance*: The main savings in cross docking come from decreased inventory and labor costs, where the latter may cause strong resistance among the workforce.

2.5 Cross-dock Characteristics

Several characteristics can be considered to distinguish between various types of cross-docks. A common distinction made in the literature is based on the number of touches or stages. In one-touch cross-docking, products are touched only once, as they are received and loaded directly in an outbound truck. This is also called **pure cross docking**. In a two-touch or single-stage cross-dock, products are received and staged on the dock until they are loaded for outbound transportation. Usually, the goods are put in to zones corresponding to their strip or stack door. In the case of a multiple-touch or two-stage cross-dock, products are received and staged on the dock, then they are reconfigured for shipment and are loaded in outbound trucks. In a typical configuration, the incoming freight is first put in zones corresponding to the strip doors. The goods are then sorted to the zones corresponding to the stack doors.

Another distinction can be made according to when the customer is assigned to the individual products. In pre-distribution cross-docking, the customer is assigned before the shipment leaves the supplier who takes care of preparation (e.g. labeling and pricing) and sorting. This allows faster handling at the cross-dock. on the other hand, in post-distribution cross-docking, the allocation of goods to customers is done at the cross-dock. Still some other distinctions are possible. The German super- market retailer Metro-AG for instance distinguishes source-oriented and target-oriented cross-docking based on the location cross-docking. Ina two-touch or single-stage cross-dock, products are received and staged on the dock until they are loaded for outbound transportation. Usually, the goods are put in to zones corresponding to their strip or stack door.

In the case of a multiple-touch or two-stage cross-dock, products are received and staged on the dock, and then they are reconfigured for shipment and are loaded in outbound trucks. In a typical configuration, the incoming freight is first put in zones corresponding to the strip doors. The goods are then sorted to the zones corresponding to the stack doors. Another distinction can be made according to when the customer is assigned to the individual product. In pre-distribution cross-docking, the customer is assigned before the shipment leaves the supplier who takes care of preparation (e.g. labeling and pricing) and sorting. This allows faster handling at the cross-dock. on the other hand, in post-distribution cross-docking, the allocation of goods to customers is done at the cross-dock.

The characteristics can be divided into three groups: physical characteristics, operational characteristics and characteristics about the flow of goods

2.5.1 Physical characteristics

The **physical characteristics** are characteristics of the cross- dock that are supposed to be fixed (for a rather long time).The following physical characteristics are considered.

Shape: Cross-dock scan have a large variety of shapes. The shape can be described by the letter corresponding to the shape: I, L, U, T, H, E, . . .

Number of dock doors: Across-dock is also characterized by the number of dock doors it has. In practice, cross-docks range in size from 6to8doorstomorethan2oodoors, and even a cross-dock with morethan5oodoorsexists. In the literature, sometimes the number of dock doors is limited to only 1or2. In these cases, the idea is not to model a realistic cross-dock, but to gain some insight by studying a simplified model.

Internal transportation: The transportation inside the cross- dock can be executed manually (e.g. by workers using forklifts) or there can be an automated system in place (e.g. a network of conveyor belts).The available infrastructure will of course be dependent on the type of freight that is handled in the cross-dock. For instance, LTL carriers handle mostly palletized freight and so make use of forklifts. Conveyor systems on the other hand are among others used by parcel carriers, as they deal with many (small) packages. A combination of both transportation modes is also possible.

2.5.2 operational characteristics

Some operational decisions can influence the functioning of the cross-dock. These operational constraints lead to the following characteristics.

Service mode: According to Boysen and Fliedner, the service mode of a cross-dock determines the degrees of freedom in assigning inbound and outbound trucks to dock doors. In an exclusive mode of service, each dock door is either exclusively dedicated to inbound or outbound trucks. If this service mode is used, mostly one side of the cross-docking terminal is assigned to inbound trucks and the other side to outbound trucks. A second mode is mixed mode. In this mode, inbound and outbound trucks can be processed at all doors. These two modes can also be combined. In this combination mode, a subset of doors is operated in exclusive mode while the rest of the doors is operated in mixed mode.

Pre-emption: If pre-emption is allowed, the loading or unloading of a truck can be interrupted. This truck is then removed from the dock and another truck takes its place. The unfinished truck has to be docked later on to finish the loading or unloading.

2.5.3 Flow characteristics

The characteristics of the flow of goods that have to be processed by a cross-dock can be very different.
The following characteristics are distinguished.

Arrival pattern: The arrival times of the goods are determined by the arrival times of the inbound trucks. The arrival pattern can be concentrated at one or more periods if the inbound trucks arrive together at (more or less) the same times. For instance, a cross-dock in the LTL industry serving a certain geographical area usually receives freight at two periods. Goods that have to be transported from inside that area to another area are picked up during the day and all pickup trucks arrive in the evening at the cross-dock.

The goods are then sorted during the night and the outbound trucks leave in the morning. To simplify the problem, several papers assume that the inbound trucks arrive together (at the beginning of the time horizon). on the other hand, freight from outside the region but destined for that are arrives in the early morning and is then distributed during the day. Another possibility is that the arrival pattern is scattered and the inbound trucks arrive at different times during the day. The arrival pattern has an influence on the congestion of the cross-dock and on the scheduling of workers and resources.

Departure time: The departure times of the trucks can be restricted or not. In many cases there are no restrictions and the trucks leave the cross-dock after all freight is loaded or unloaded. However, it is also possible that the trucks have to depart before a certain point in time, for instance in order to be on time for a next transportation task. In this case, there can be restrictions imposed on the departure times of the inbound trucks only, so that these trucks have to be unloaded on time.

It is possible that only the outbound trucks have to leave the cross-dock before a certain moment. For instance, in the parcel delivery sector, the outbound trucks usually leave at a fixed point in time. Parcels arriving late have to wait until another truck departs for the same destination. It is also possible that both inbound and outbound trucks have restricted departure times.

Product interchangeability: The freight handle data cross-dock is in general not interchangeable. In this case, all products are dedicated to a specific destination or a specific outbound truck (pre-distribution). Information about the destination or the dedicated truck is normally known before the products arrive at the cross-dock. It is however also possible that interchange ability of products is allowed (post-distribution).In this situation, only the type of products to be loaded on the outbound trucks and the corresponding quantity is known .When the products are interchangeable, usually some value-added activities (e.g. labeling) need to be performed.

Temporary storage: In pure cross-docking, the arriving freight is directly transported to outbound trucks, so no storage is needed. In practice however, this is rarely the case. In general, the goods are temporarily stored on the floor of the cross-docking terminal (e.g.in front of the stack doors) or even in a (small) warehouse. However, it is possible that goods are not allowed to be stored. For instance, if refrigerated product shave to be cross-docked in an on cooled terminal, these product shave to be directly moved from a cooled inbound to a cooled outbound truck.

2.6 Suitability for a cross docking retail facility

According to Apte and Viswamathan most important factors that can determine the suitability of applying cross docking is discussed and compared it with other strategies and traditional distribution centres. one of the most critical factors in this regard is demand rate of products. Mostly cross-docking implementation is suggested for stable demanded product such as grocery that uses perishable foods. Cross docking is not suitable for products that there is no balanced between incoming and out coming products. Another important factor is stock-out cost. Since cross-docking minimize the level of inventory at the warehouse the risk of stock-out is also higher but the cost of stock-out play an important role. Cross docking is suitable for stable product demand and low unit stock-out cost and the customary warehouses are suggested for the opposite situation. For the subsequence cases cross docking can be appropriate when system and planning tools are in place to keep the number of stock-outs at proper level. There is also another factor that required to be considered in this case in which is product life cycle, cross docking distance from suppliers and demand quantity.

		Product demand rate	
		Stable and constant	Unstable or fluctuating
Unit stock-out costs	High	Cross-docking can be implemented with proper systems and planning tools	Traditional distribution preferred
	Low	Cross-docking preferred	Cross-docking can be implemented with proper systems and planning tools

Figure 2: Suitability of cross docking products

Since operational decision has a great impact on cross docking efficiency some works have been performed in operational level of decision making in order to improve efficiency of cross docking. Next, strategic problems which deal with location and layout of cross docking will be discussed. Finally, tactical problems which related to cross docking network determine and finally operational decision and its related problems will be discussed.

A. Location

Tactical decision level consider midterm planning in which mainly focuses and addresses problems regard of layout and location of cross docking in order to improve effectiveness and throughput of the operation of cross docking.

In location area of cross-docks in supply chain network design, Jayaraman et al., (2oo3) determine an assessment of new heuristics solution procedures. optimal distribution system designed and utilization strategies utilized the simulated annealing (SA) methodology and explained as two heuristics solution in this paper. This study significantly contributes in two ways. First, they follow the location problem in cross-docking and distribution center. Second, for better understanding of interaction aspects among the several factors, the computational performance is principally evaluated in network design location model but they don’t considered scheduling of cross docking, however the location and routing scheduling problems in cross-docking are studied by Mousavi et al., (2o13) in order to minimizing fixed costs and transportation costs from pick up process to the customer locations, penalty costs for lateness in delivering and operational costs are the objective of this research.

Location of numerous cross-docks and vehicle’s scheduling routing problem are also considered under a fuzzy environment by Mousavi et al., (2o13). The related objectives for their two-phase model are minimizing transportation and fixed costs of cross-docks and also operational costs of vehicles. For solving this problem they propose a new fuzzy mathematical programming. After that Mousavi et al., (2o14) submit two mixed-integer linear programming (MILP) models that mix for the location of various cross-docking centers and the vehicle routing scheduling problem. Developed Hybrid fuzzy possibility-stochastic programming is presented to solve these models. Finally, diverse problems are applied to evaluate appropriateness of the new two-phase MILP model.

B. Layout

Cross-docking faces several problems during the design and operational phase and has to deal with many decisions. Efficiency has been always influenced by these decisions so it is really important to make a good one. one of the first strategic decisions that be taken are what is the best layout of a cross-dock. After determining the cross dock's location, choosing the layout of the cross-dock is one of the important decision. The configuration of the internal cross-dock zone and their arrangement is considered as well as the shape of the cross dock in layout.

Hauser and Chung (2oo6) applied genetic algorithms (GA) which has become very popular as instruments for optimization in order to optimizing of lane layout related to the cross-docking at the Toyota Motor manufacturing plant is determined as an objective. They show GA solution can be achieved so fast, whereas a complete search needs so many times to solve the problem. They obtain a decrease in workload in the cross-docking zone and then reduce lead time. This achievement is due to rearrangement of the lanes. As we are mention previously one of the significant points in warehouse operations is warehouse layout problem. Therefore Önüt et al., (2oo8) consider cross-docking layout as a distribution-type warehouse. Multiple type products are received from suppliers and then delivered to customers are examined in this research. They design a shape of warehouse shelf for minimizing the carrying costs is determined as an objective.

Turnover of products are considered and classified based on distances between the shelves and docks. They use particle swarm optimization algorithm (PSo) to solve mathematical model for achieving the optimal layout. Increasing the two dimensional warehouse designs to several levels is defined as one of the contribution of this research. They discuss that tradeoff between handling cost and vehicle waiting cost when the dock number increases can be considered as a future work.

Using cross docking facilities as a distribution center where products receive and leave in the same day generates dynamic environment for reducing the response times. Vis et al., (2o11) studied these dynamic situations, flexibility and comfort ability in reconfiguring storage area layouts is really significant. They represented a dynamic design methodology to choose policies and specify layout rules which can help to determine an effective layout for storage area is defined as an objective in this paper. Royal Horticultural Company Lemkes's cross docking center in the Netherlands is used as the foundation for analyzing the proposed layout procedures.

Saving 16% of total travel distances of employees is achieved by implementing this design methodology.

C. Scheduling

Indeed, the assignment problem can be put into scheduling problems by which categorized into operational problem of cross docking and mainly focuses on dock door assignment issue. Generally, the most crucial issue in door assignment problem is to find travel time parallel to travel distance of cargo inside the facility. Poor scheduling brings many disadvantages such as increasing make span that increase the operational cost .Therefore the main goal for scheduling is to decrease the make span as much as possible that effects on cost of operation as well. Saharidis et al., (2o12) has presented two new mathematical formulations in which can be used for the scheduling of inbound trucks to doors at a cross-docking facility, and also made comparisons to formulation of the classical machine scheduling. Their first formulation deals with continuous time that is considered and in the second formulation, a discrete time representation is proposed. In addition terminated exact algorithm accompany with numerical results are presented to illustrate and critically evaluate each of the formulation.

Boysen et al., (2o1o) studied scheduling trucks regard of cross docking terminals and presented a model, in which relies on some simplifying assumptions with the goal of deriving fundamental insights into the underlying problem's structure such as its complexity, and to develop a building block solution procedure, that can be used to solve more sophisticated truck scheduling problem. Saharidis et al., (2o12), Boysen et al., (2o1o), and Mohammadi et al., (2o1o) also studied scheduling problems of cross docking system with temporary storage and developed some models to solve trucks sequencing assignment to dock door. Shakeri et al., (2oo8) supposed two phase heuristic algorithm for assigning trucks to doors in which the number of truck considerably overweighed the number of dock doors in order to solve cross docking scheduling problems. Mohammadi et al., (2o1o) focused on minimizing delayed occurring inside cross docking product arrangement to optimize makes pan instead of finding the best trucks sequencing.

Both Ting et al., (2o12) and Hu et al., (2o13) worked on the coordination inbound and outbound problems ,even though Ting et al., (2o12) mostly considered minimizing total system cost and

Hu et al., (2o13) focused on optimizing overall make span and travel distances. Regard of vehicle scheduling coordination Ting et al., (2o12) considered three different operation strategies and developed a heuristic algorithm to improve both inbound and outbound headway. Li et al., (2oo4) represented a model in order to minimize makes pan based on the just in time concept but they main objective was minimizing the penalty incurred by earliness and tardiness of outgoing and incoming trucks and that it has been modeled through Integer Programming. In order to solve these problems they propose metaheuristic algorithm in which embedded in Genetic Algorithm and Linear programming

D. Transshipment and vehicle routing problem

Generally, transshipment model aim is to find the best flow of products, allocation of product between nodes with best routes .Consequently, when inbound and outbound truckloads are synchronized, transshipment process have to proceed efficiency in order to on time delivery and keeping intermediate inventory inside the facility as low as possible based on the concept of cross docking. Larbi et al., (2oo9) studied the transshipment problem and considered single strip and stack door and proposed a graph in order to find minimum routes between nodes in which results in minimum cost of transshipment. After that Yu et al., (2oo8) begin to work on transshipment problem of cross docking with the goal of increase efficiency of cross docking. They determined the sequence of truck in order to minimize make span. Miao et al., (2oo9) also studied the same issue as Larbi et al., (2oo9) with the goal of minimizing transshipment cost. They proposed an Integer Programming model and solved it with Genetic algorithm in order to achieve minimum cost of intermediate inventory transportation coats and holding penalty. Larbi et al.,(2o11)worked on transshipments problem in a single receiving and shipping door of cross dock and regarded three different scheduling policies.

In the first policy they supposed complete information for the order of arrivals and the contents of all inbound trucks. But in the other policies they supposed the availability of partial and without complete information on the sequence of upcoming trucks. Finally they presented optimal graph based model for the full information case, and a polynomial time algorithm is presented. They developed Heuristics for the other two cases. Consequently they made comparison of the costs parallel to each policy in order to help evaluating the value of information in cross dock scheduling problems.

The vehicle routing problems is scheduling and planning of routes between different nodes in order to fulfill set of customers order. Vehicle routing problems cope with allocating products between customers. Generally, vehicle routing problem is related to paling problem of finding the best routes to meet the set of customers and mainly deals with distributing one product to the all customers. In this case there are possibilities to have time window and capacity limitation to meet customers need.

E. Cross docking models

In the past few decades utilizing cross docking has increased due to its advantages that brings about. Many company applied cross docking to increase productivity of their companies. Some of important researches goals for investigating cross docking exhibited in table below which is minimizing total cost, optimizing travel time and distance and minimizing operational time.. Based on literature the biggest opportunities for cross-docking costs savings are transportation related issues. The better transportation utilization means less cost spend on the fuel. Considerable freight savings also can be achieved by consolidating LTL shipments into TL to the cross-dock and, whenever possible, combining outbound shipments with those of multiple vendors going to the same destination. Cross-docking can also help to Control overall logistics costs.

Charkhgard and Tabar (2o11) formulated distribution planning problem of cross docking, they formulated it through integer nonlinear programming and solve it by heuristic algorithm in order to minimize transportation costs. Whilst many companies are concern about cost saving but it is not the only goal for cross docking improvement. Recently as the business market become highly competitive the time even become more critical and companies who operates faster can survive. So numerous researchers focused on scheduling of cross docking rather cost only. In the latter environment there may be a predefined sequence and departure time for the outgoing trucks, any item which does not arrive to the loading dock before the departure time will be delayed for the next day, so the performance measure in the problem will be (total weighted) number of delayed shipments. other researches aim is to minimize the scheduling time span of cross docking using non-linear programming based on optimization of number of delayed product. The objective of the vehicle routing problem is to minimize the total travel time while respecting time window constraints at the nodes and a time horizon for the whole transportation operation. This general claim for synchronization can be operationalized by minimizing the total completion time of operations, which are also referred to as make-span in scheduling literature.

CHAPTER 3

RESEARCH METHODOLOGY

Research methodology is a way to systematically solve the research problem. It may be defined as the science of studying how research is done scientifically. The process used to collect information and data for the purpose of making business decisions is known as research methodology. It involves the efficient, hypothetical investigation of the routines and methods applied to a field of study etc. It typically, encompasses concepts such as standards, phases, theoretical model, and quantitative or qualitative techniques

3.1 Need for the study

Whether its car parts, perishable foodstuffs, staples, or supplies en-route to a pharmacy, getting products to consumers on time and in great condition is the most essential task of suppliers and the customers they serve. While pursuit of the perfect order will be a daily challenge, today's global marketplace requires companies to be in pressure for fulfilling product orders across complex networks and to dos they need not make costly errors. Cross docking is an important mechanism in the warehouse, being so with respect to the retail industry in mind the challenges that make it a phenomenon in the retail industry and how it impacts efficiency. A study has been undertaken to understand cross docking and its challenges it meets on its way and how efficiency is impacted.

3.2 Research objective

- To study the challenges met while implementing a cross docking model.
- To analyze the factors of efficiency impacting retail distribution by cross docking

3.2.1 Scope of the study

It is out of the scope of this research to determine the exact level of employee involvement that influences the achievement of a positive safety culture. It is difficult to determine the extent of changes to safety performance and safety culture through increased level of involvement. A future research might want to go further in-depth to test the extent of dependency of both variables. The overall aim of the research which was to establish the significance that cross docking gives to retail warehouses.

3.3 Research techniques

3.3.1 Data collection

- Sequential sampling***:*** The ultimate size of the sample under this technique is not altered ahead of time, yet is resolved according to mathematical decision rules on the basis of information yielded as survey advances. This is normally embraced if there should arise an occurrence of acknowledgement sampling plan in context of statistical quality control. Thus, in brief, we can say that in sequential sampling or consecutive inspecting, one can continue taking samples in a steady progression as long as one desires to do so.

- Simple Random Sampling: In simple random sampling the probability of selecting any sample is equal and is the simple way of selecting a sample in the defined space. This sampling is used to select responses from the survey checklist that has been circulated.

Type of Research Design	**Descriptive research**
Type of Data	**Primary and Secondary**
Methods of Data Collection	**Questionnaires, company data, journals, research papers, white papers.**
Tools for Data Analysis	**Survey**

Table 3.1.

CHAPTER 4

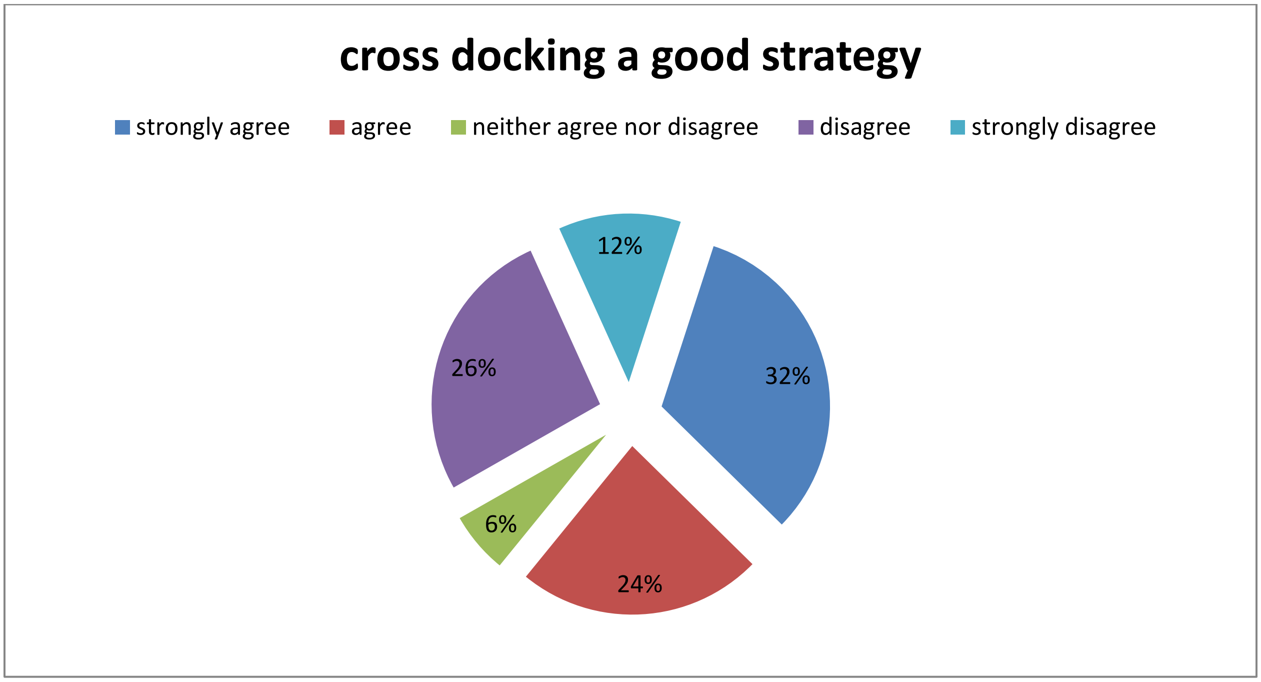
ANALYSIS oF DATA

4.1 Do you think cross docking is a good strategy in the warehouse?

Table 4.1

Parameters	No of respondents
Strongly agree	11
Agree	8
Neither agree nor disagree	2
Disagree	9
Strongly disagree	4

Figure 4.1



Result

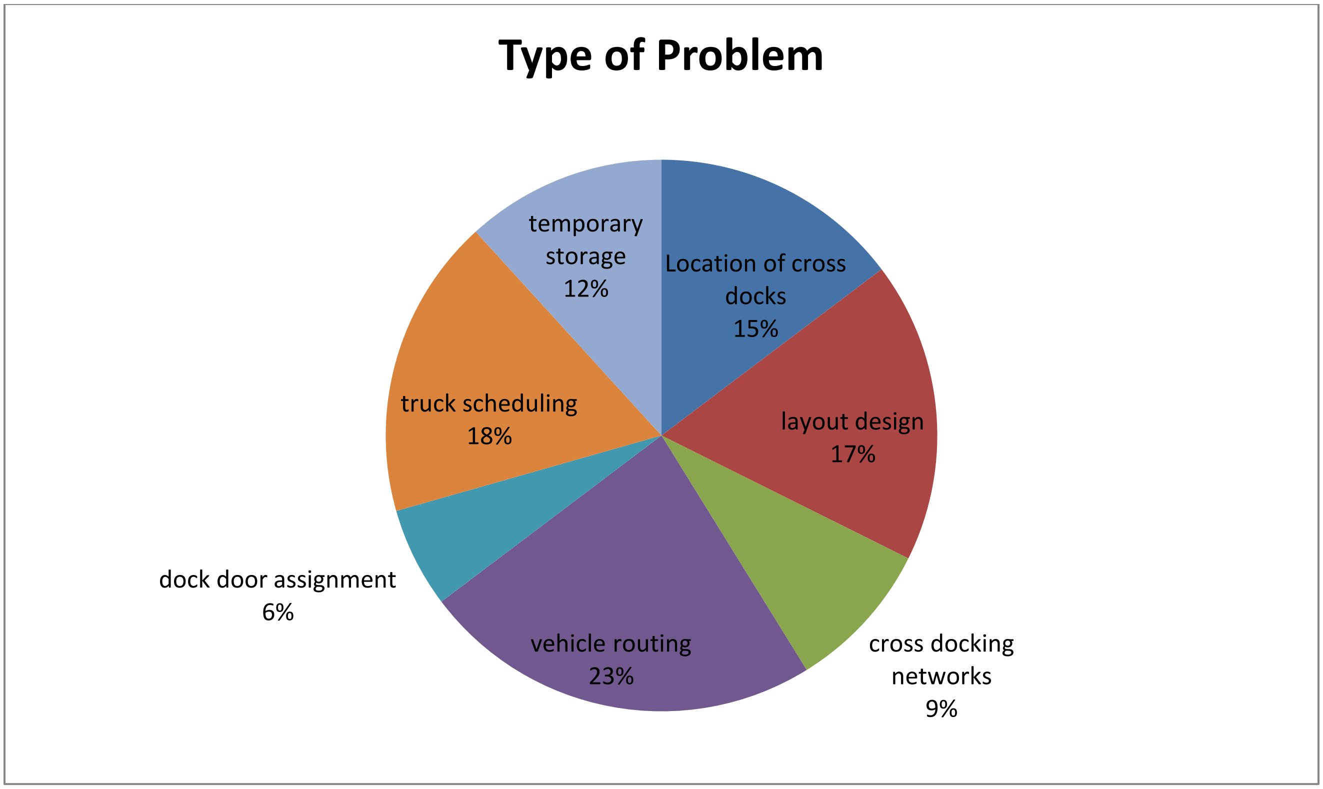
According to 32% of the respondents, cross docking is a good strategy and it should be implemented across warehouses in some way or the other. 26% do not agree that cross docking is a good strategy for a warehouse.

4.2 Where is the major problem in cross docking?

Table 4.2

Problems	no. of respondents
Location of cross docks	5
layout design	6
cross docking networks	3
vehicle routing	8
dock door assignment	2
truck scheduling	6
temporary storage	4

Figure 4.2



Result

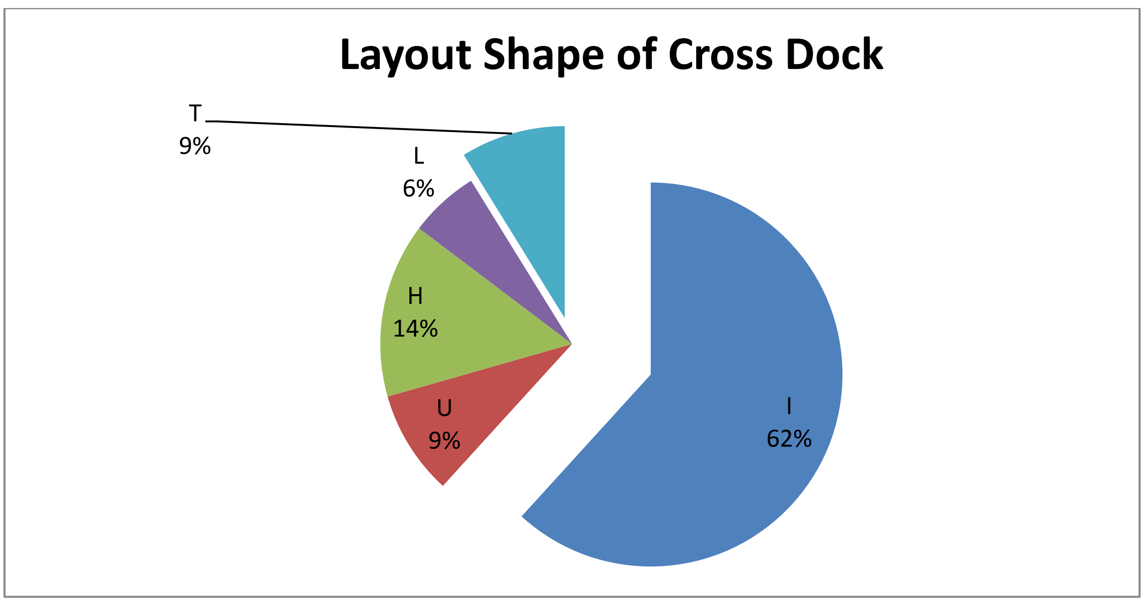
Around 23% of the respondents believe that the major problem arising from cross dock is from vehicle routing followed by truck scheduling (18%). Layout designh is another problem that needs emphasis.

4.3 If you practice cross docking in your warehouse, which type of layout shape will you prefer?

Table 4.3

Type of shape	No. of respondents
I	21
U	3
H	5
L	2
T	3

Figure 4.3



Result

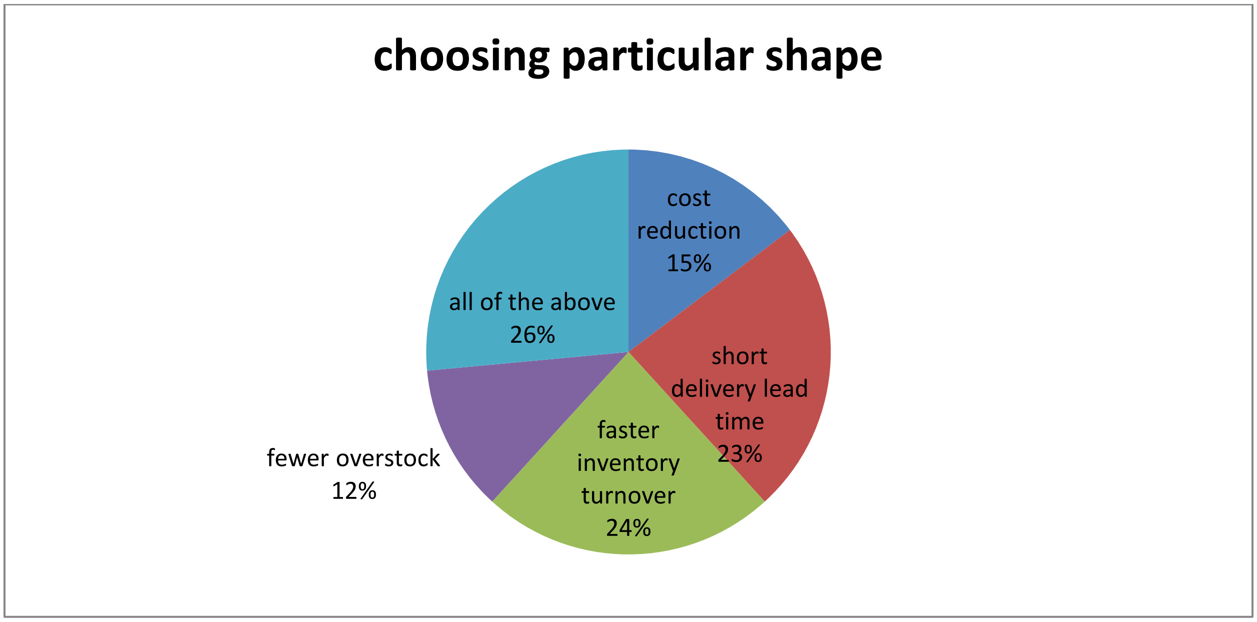
The layout design shape is an important part of cross docking problem. I-shaped layout is a preferred design consisting of a support of 62% of respondents, followed by H-shaped layout (14%).

4.4 The reason for choosing the concerned layout shape.

Table 4.4

Reason	No of respondents
Cost reduction	5
Short delivery lead time	8
Faster inventory turnover	8
Fewer overstock	4
All of the above	9

Figure 4.4



Result

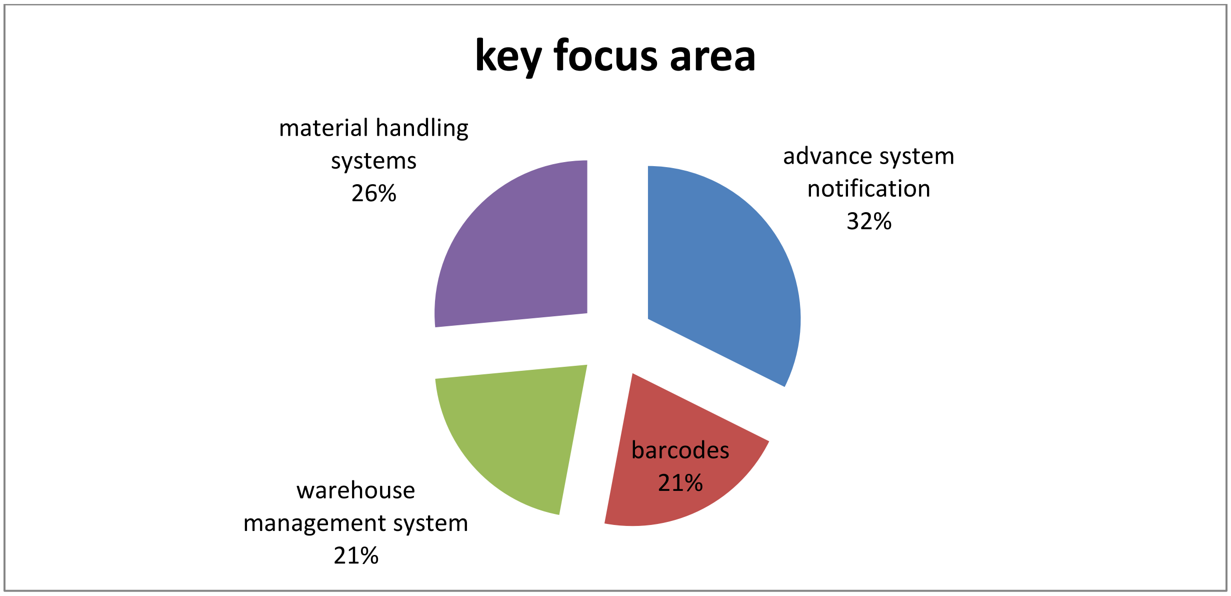
Majority of the respondents (26%) believe that the reason why they choose different shaped layouts are due to faster inventory turnover(24%), short deliver lead time(23%). Fewer overstock as a reason comprises of 12% respondents.

4.5 To improve cross docking what must be the key focus area

Table 4,5

Parameters	no of respondents
advance system notification	11
barcodes	7
warehouse management system	7
material handling systems	9

Figure 4.5



Result

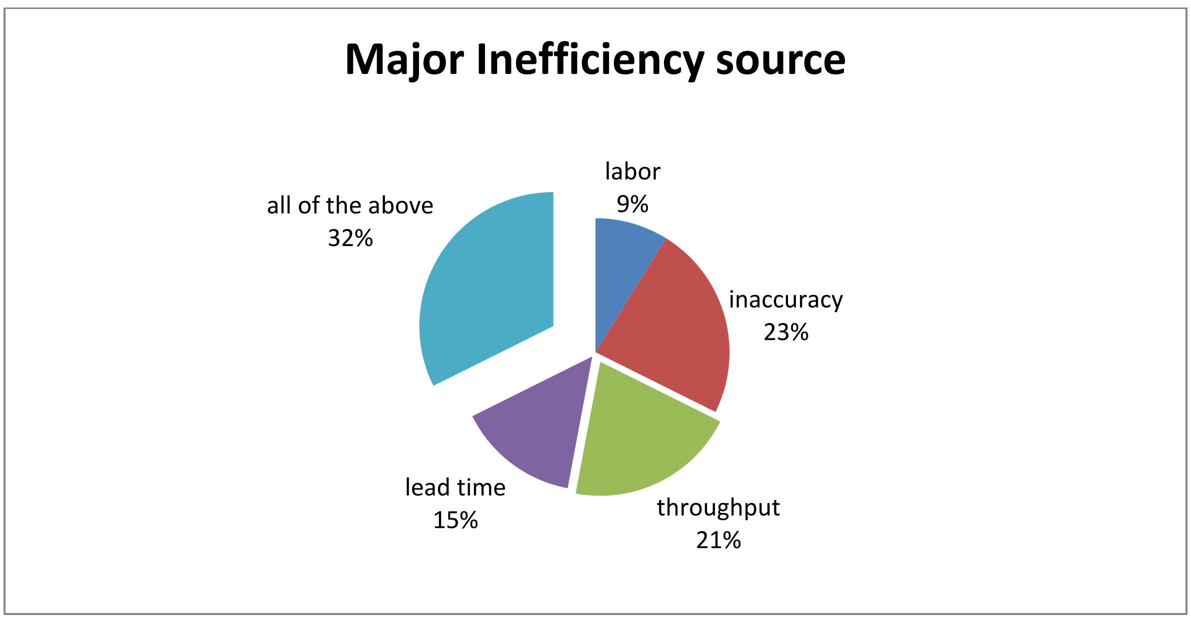
Advance system notification (32%) is the major focus area for improving cross docking followed by material handling systems (26%) followed by warehouse management system(21%) and barcodes(21%) based on the survey conducted.

4.6 What is the major source of inefficiency found in a warehouse which focuses on cross docking?

Table 4.6

Major source of inefficiency	no of respondents
labor	3
inaccuracy	8
throughput	7
lead time	5
all of the above	11

Figure 4.6



Result

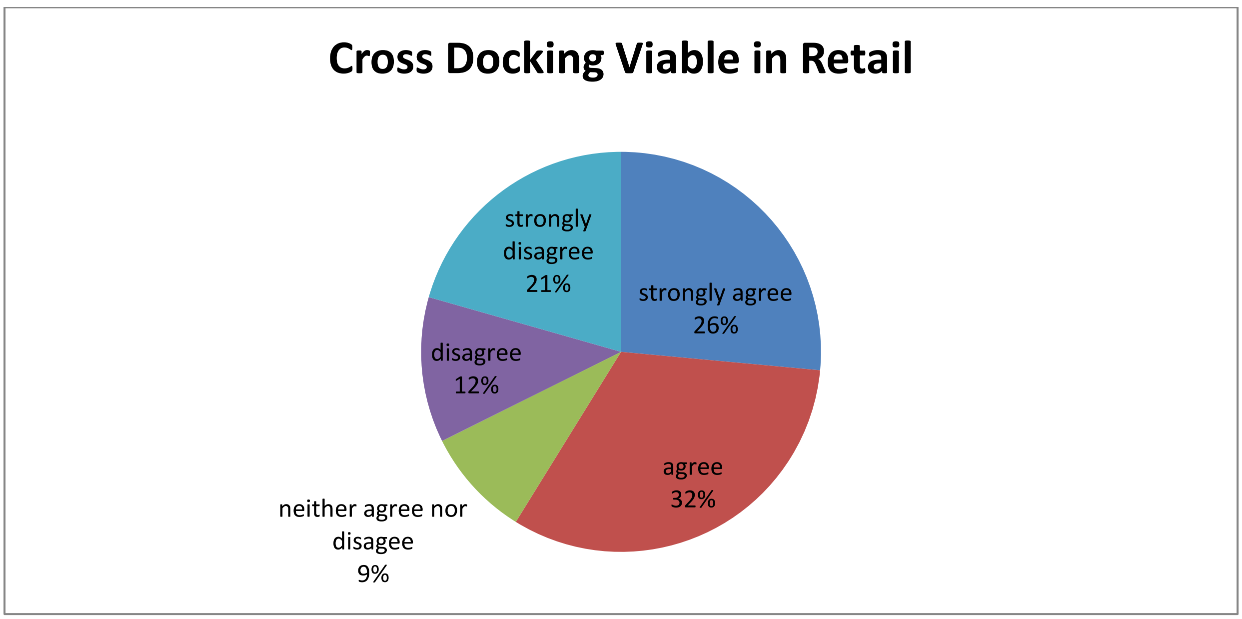
Majority of the respondents (32%) conclude that the major source of inefficiency in cross docking lies in all the above concerned parameters. Respondents who say inaccuracy in the processes as the major source of inefficiency is 23%.

4.7 Is cross docking viable for retail industry?

Table 4.8

Parameters	No. of Respondents
strongly agree	9
agree	11
neither agree nor disagree	3
disagree	4
strongly disagree	7

Figure 4.8



Result

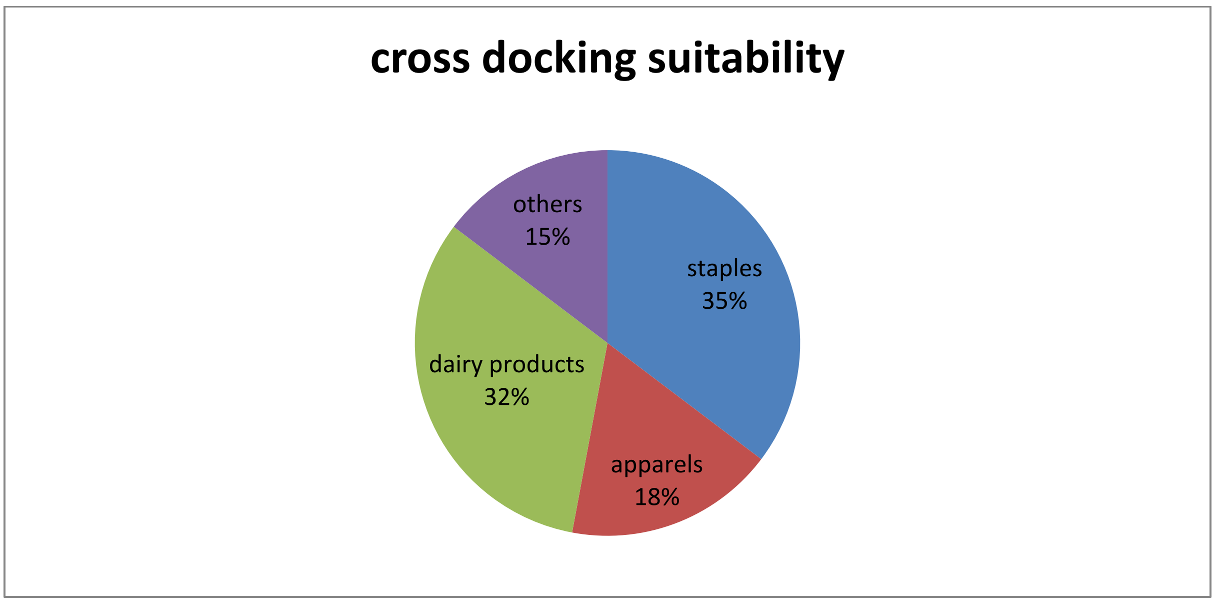
Majority of the respondents agree (32%) that cross docking is very much viable for retail industry. Around 26% of the respondents strongly disagree that cross docking is suitable for retail products.

4.8 What type of retail items can cross docking be efficiently used for?

Table 4.8

Items	no of respondents
staples	12
apparels	6
dairy products	11
others	5

Figure 4.8



Result

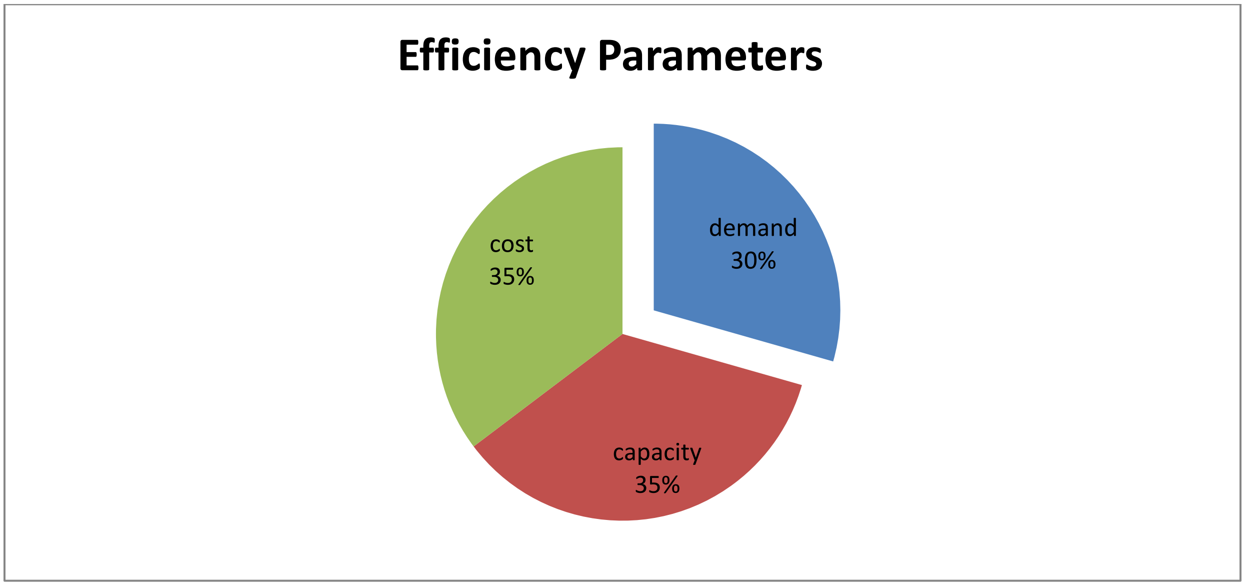
Majority of the respondents believe that staples (35%) are the items that are suitable for cross docking strategy, followed by dairy products (32%). others include

4.9 What parameters you will look for in finding a cross docking facility?

Table 4.9

Efficiency parameter	no of respondents
Demand	1o
Capacity	12
Cost	12

Figure 4.9



Result

Capacity and cost go in hand in hand while checking efficiency parameters (35%).

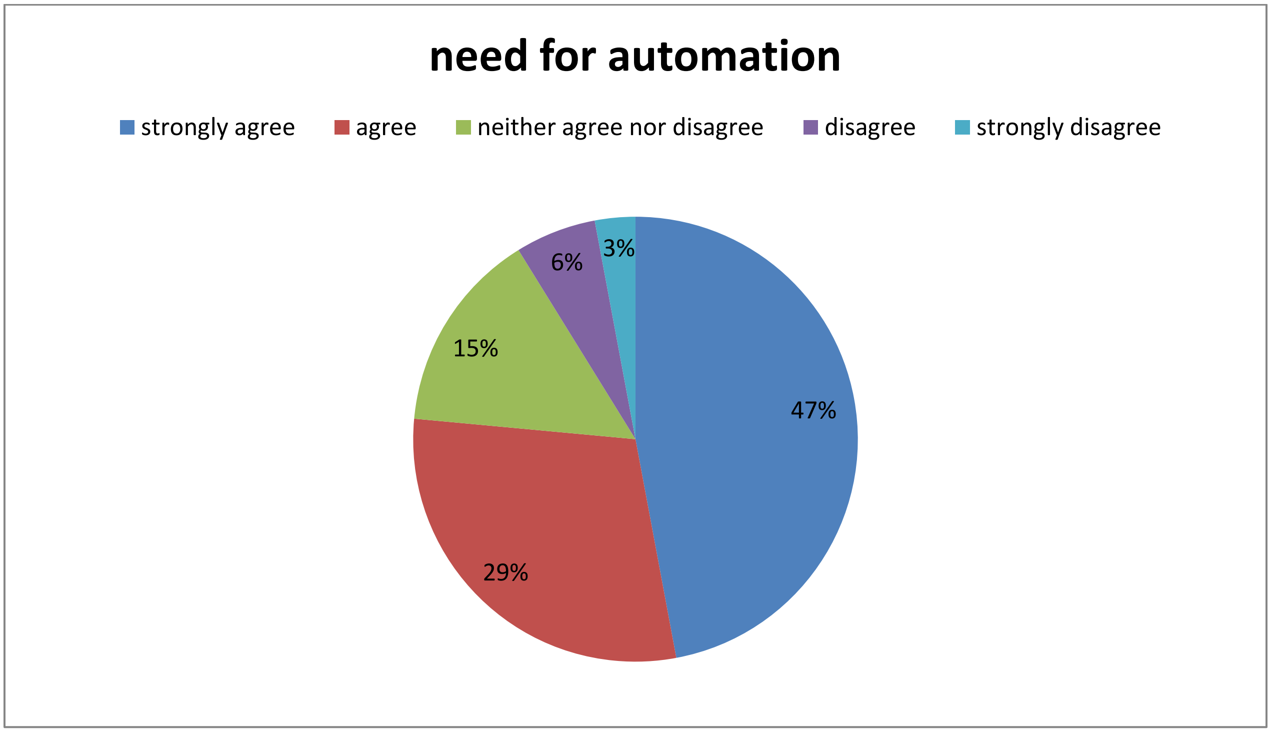
Demand (3o%) is another parameter that is looked upon while measuring efficiency.

4.10 Do you believe automation is the need of the hour for an efficient cross dock

Table 4.1o

Parameters	no of respondents
strongly agree	16
agree	1o
neither agree nor disagree	5
disagree	2
strongly disagree	1

Figure 4.1o



Result

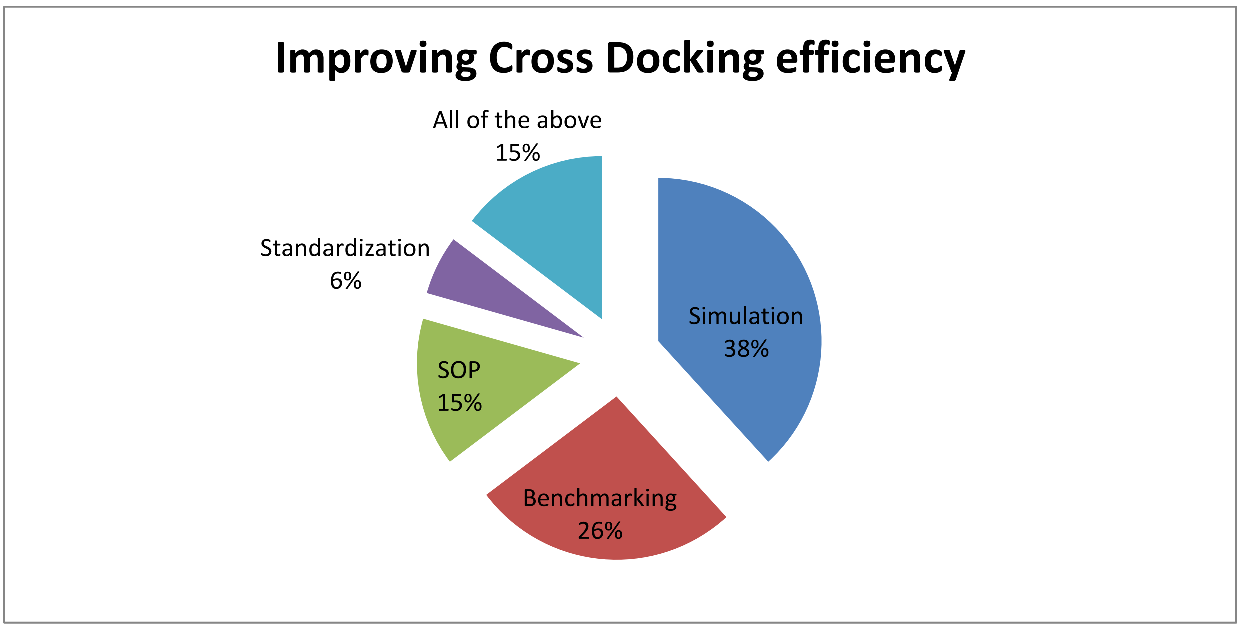
47% of the respondents strongly agree that cross docking needs automation and 3% strongly disagree. Automation will surely help in an efficient cross docking strategy.

4.11 What according to you can improve cross docking efficiency?

Table 4.11

Tools/ Techniques	No. of Respondents
Simulation	13
Benchmarking	9
SoP	5
Standardization	2
All of the above	5

Figure 4.11



Result

Simulation (38%) is the sure winner here for improving the efficiency of cross docking followed by benchmarking (26%).

CHAPTER 5
FINDINGS AND RECoMMENDATIoNS

Findings

- Cross docking is a strong strategy that can be implemented at the operational level.
- I-shaped cross dock layout is the most preferred form of layout design.
- Automation is the need of the hour with respect to labor cost and lead time.
- Basic groceries, staples which have stable product demand and low unit stock cost are the preferred items that are relevant for cross dock.
- Simulation is the best tool for measuring and changing inefficiencies in a cross docking environment.
- Labor, inaccuracies, throughput and lead time are the major discrepancies that hinder efficient mechanism of cross docking.
- Faster inventory turnover is another main reason for adopting cross docking models.
- Vehicle routing and scheduling are the major problem that arises in cross docking other than layout design, dock door assignment, temporary storage, location of cross docks etc.
- The single greatest challenge for cross docking is unpredictable customer demand.

Recommendation

- Cross docks are more successful when they are aligned with business objectives and measured accordingly.
- A person dealing in retail distribution can outsource to 3 PL's to conduct the day to day operation.
- Despite being capital intensive, cross dock is beneficial in the long run.
- Technology is an important part of cross docking operations. Bar coding and RFID tags can be utilized to increase efficiency and easy processing of shipments. RFID are better than bar code scanning as they can scan multiple bags.
- Integrating systems can provide a powerful remedy for critical areas like labor expense, throughput, and accuracy.

- Retailers should use ASNs, barcoded freight and automated sortation systems to expedite the receiving process in the distribution center.

CHAPTER 6
CoNCLUSIoN

Cross docking eliminates the costly hassle and need for storing items in the warehouse between modes of transit, increases the speed of unloading scanning, sorting and loading onto the next mode of transport. The aim of this research project is to understand cross docking in a wholesome manner. The proper processes, systems and supply chain relationships must be in place to successfully cross dock on large scale. The systems that help to maintain relationships between supply chain partners are automated material handling, warehouse management systems and order processing.

Traditional warehousing had seen as high- cost function, but with cross docking warehousing is now recognized as a vital value adding link between firms and supply chain. Cross docking requires good information systems and synchronization of inbound and outbound shipments.

Cross docking can be subject to organizational and management approaches and different objectives can be achieved. Dealing with uncertainty has become essential and flexibility with regard to that has become a going concern. It poses a great challenge during the design stage as well at the operation level.

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APPENDIX

Considering cross docking is a very viable and important tool in the retail distribution industry, the need for finding what challenges arise while implementing a cross docking model needs to be analyzed.

This survey is to assess what challenges arise during implementation of cross docking and how it impacts efficiency in the retail distribution. All responses will be strictly used for academic purpose only. Please spare 2 minutes of you valuable time for responding to this survey.

1. Do you think cross docking is a good strategy in the warehouse?
   - ☐ Strongly agree
   - ☐ Agree
   - ☐ Neither agree nor disagree
   - ☐ Disagree
   - ☐ Strongly disagree

2. Where is the major problem in cross docking? (Multiple answers accepted)
   - ☐ Location of cross docks
   - ☐ Layout design
   - ☐ Cross docking networks
   - ☐ Vehicle routing
   - ☐ Dock door assignment
   - ☐ Truck scheduling
   - ☐ Temporary storage

3. If you practice cross docking in your warehouse, which type of layout shape will you prefer?
   - ☐ I
   - ☐ U
   - ☐ H
   - ☐ L
   - ☐ T

4. The reason for choosing the above concerned layout shape….
    - ☐ Cost reduction
    - ☐ Short delivery lead time
    - ☐ Faster inventory turnover
    - ☐ Fewer overstock
    - ☐ All of the above

5. To improve cross docking what must be the key focus area
    - ☐ Advanced system notification
    - ☐ Barcodes
    - ☐ Warehouse management system
    - ☐ Material handling systems

6. What is the major source of inefficiency found in a warehouse which focuses on cross docking?
    - ☐ Labor expense
    - ☐ Inaccuracy
    - ☐ Throughput
    - ☐ Lead time
    - ☐ All of the Above

7. Is cross docking viable for retail industry?
    - ☐ Strongly agree
    - ☐ Agree
    - ☐ Not agree nor disagree
    - ☐ Disagree
    - ☐ Strongly disagree

8. What type of retail items can cross docking be efficiently used for?
   - ☐ Staples
   - ☐ Apparels
   - ☐ Dairy products
   - ☐ others

9. What parameters you will look for in finding a cross docking facility?
   - ☐ Demand
   - ☐ Capacity
   - ☐ Cost

10. Do you believe automation is the need of the hour for an efficient cross dock
   - ☐ Strongly agree
   - ☐ Agree
   - ☐ Neither agree nor disagree
   - ☐ Disagree
   - ☐ Strongly disagree

11. What according to you can improve cross docking efficiency?
   - ☐ Simulation
   - ☐ Benchmarking
   - ☐ SoP Preparation
   - ☐ Standardization
   - ☐ All of the above