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Review Article

A Time Study on Dispatch and Delivery of Material in the Food Processing Sector

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Abstract *- The modern supply chain principles entail high volume distribution using minimal inventories to be delivered within a short response time.Therefore, this time study intends to identify the areas needing improvement in the bulk packing, loading, and delivery of time-sensitive materials such as raw and semi-processed food material from the manufacturing unit to the restaurants catering to the end consumers. Improving the efficiency of time-sensitive operations is crucial in helping companies gain a competitive advantage.*

The performance of warehouse operations is quantified in terms of idle time-measurement of the process of dispatch and delivery. Timed data is collected from the Dispatch schedule of the manufacturing unit of semi-processed food materials. Cycle Time is recorded for the completion of each activity, such as bulk picking, segregation, loading, and delivery, so as to measure utilization of each step for idle time calculation. Descriptive statistics are then further used for quality control charts to evaluate the efficiency.

Keywords *– Food, Delivery, Dispatch, Time.*

Average times for all steps are mapped to identify the idletime of the dispatch and delivery process. Quality control charts reveal time lag in long-distance shipments is significantly higher than that of shorter distances. Results also reveal issues with specific routes of shipments that do not meet the control expectations frequently. Dispatch and delivery process to transport semi-processed food material exceeds the allocated time capacity in specific routes of long-distance shipments. Therefore, while dry and chiller items do not face manywastages, wastages are observed more in the case of frozen materials which require to be transported below -18 degrees.The paper aims to present empirical evidence of the impact of inefficiencies in the dispatch and delivery of time-sensitive operations. Further, it opens a detailed scope for study in the semi-processed (dry, chiller, and) frozen food sector, which is a rapidly growing industry in India. Significant idle times and inappropriate allocation of resources are causing a large pool of wastage and wastages in this procedure. Tangible actions can be implemented to minimize the operations cycle.

I. INTRODUCTION

A. Time-study in logistics

In the scenario of Indian logistics, the food processing industryis facing a fresh challenge looking for improvement within their operations. The search for detecting inefficiencies in the supply chain has been more critical than ever before as the demand for ambient and chilledfood storage continues to grow. Refrigerated logistics is the management of the flow of food and semi-processed food between the point of origin and the point of consumption, i.e., the restaurants or franchises. Suchoperations are particularly time-sensitive owing to the ambient storagerequirements of the semi-processed food material. The resources managed in refrigerated logistics canincludedry items,suchasbasic paper dishes, napkins, etc., or food materials like semi-baked bread items or processed meat items requiring particular temperature control. The logistics of such items usually involve the integration of time flow, procurement, production, packaging, inventory, transportation,warehousing,andoftensecurity.This paper deals with the complexity of logisticsrelated to the transportation aspect. While previous studies have stressed more procurement and inventory management, transportation is crucial in the processed food industry. Once the items are semi-processed, the delivery timing becomes time-sensitive that has not been addressed oroptimized as much in the humid climate of India. The minimization of the use of time as a resource is a pivotal motivation in logistics for temperature-controlled items. The integration of the supply chain has become an important way for companies to save inefficiencies linked to idle time as the food-processing industry expands and includes food items that are essentially continental (non-Indian) in nature.

Supply chains responsible for the movement of processed food from the warehouse to restaurants pass through the various networks within them, including vendors, producers, and third-party logistics (TPL) service

providers. Therefore the next section gives a brief overview of the complexity involved in delivery in this sector.

B. Delivery in the food-processing sector

The study was done based on data collected from the warehouse, wherethree different categories of materials are stored in the supply chain center. Supply Chain Centre is a strategic, systemic point of coordination within the processed food supply chain for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole. The three categories of items that are dispatched and delivered from here are: Dry, Ambient, and Chilled.*Dry warehousing* is a basic part of the supply chain in any industry. It is essential that a proper environment is maintained within the facilities to ensure the continued storage of temperature-neutral products. Dry warehousing is a suitable option for dry storage products that do not require a climate-controlled environment as items generally have a long shelf life.

C. Ambient Warehouse

Indian food businesses need short and long-term temperature-controlled warehouse storage in their ongoing business operationsbased on the size of the business. Out of manybenefits for working with a short and long-term temperature-controlled warehouse storage company, it ensures the security of the safety of stored products by minimizing all risks.Ambient warehousing is crucial help in easy handling of picking, segregation, and eventual vehicle loading. Sourcing and entering products into the inventory system take a lot of time and labor. Such a setup streamlines the process of placing materials at the proper place. Temperature Controlled Facilities, especially the temperature between 1-4 °C, helps in keeping the products safe from the detrimental effects of tropical weather and ensure that they are in safe and working order when it comes time for shipment.Ambient and temperature-controlled warehouse storage solutions are food grade and capable of providing certified organic storage.*Frozen Warehouse:* The trickiest form of refrigeration are those requiring exactingfrozen storage conditions, including an uninterrupted cold chain, high storage density, and energy efficiency, short throughput times, and minimal error rates during dispatch and delivery. A temperature of -18°C is difficult to maintain while transporting the chilled food items in India's humid tropical climate. Moreover, the chilled items kept in stock are often sensitive, so they must be transferred very carefully and with fulltraceability.The key component to the warehouse is to ensure the temperature and integrity of the items is maintained till it is delivered from the warehouse to the end customer (restaurants in this case)**.**

D. Objective and problem statement

The objective was to determine areas needing improvement, wastages incurred, and overall performance of the dispatch and delivery process for dry, ambient, and chilled food shipments. The different categories of food items were individually studied along with individual variations within each.The varying number of workers and loading tools were also studied to see how they affected the efficiency of the dispatch process. From this analysis, the key areas of lowest value and most improvements were identified. Recommendations were made to improve efficiency and reduce wastes within the process.

The study seeks to identify the idle-time of operational efficiency with regards to supply Chain center such as mentioned below:

- To describe the idle-time for the dispatch process of food material.
- To identify the samples and delivery routes in which wastages are occurring.
- To identify the idle-time for long as well as short-distance transportation of food material.

II. LITERATURE REVIEW

The literature of supply chain time study has a wide repository of studies involving inventory (including production planning) and transportation management [1]. A remarkable phenomenon is that recent papers are modeling and bringing the latest insights on specialized fields and thus making new contributions to the literature.In this paper, we focus mostly on the dispatch and delivery (transportation) management of perishable products (also referred to as deteriorating products). Study on refrigerated products is a rather mature field in logistics,but they focus mostly on replacement policies rather than time optimization. Nahmias[2] is one of the early seminal papers a comprehensive survey of research published. Goyal and Giri[3]studied the issues with deterioratinginventoryafter which then, considerable attention is drawn to this line of research.Meta-analytical studies in recent years on the perishable inventory models can also be found in Raafat[4]. Blackburn and Scudder's [5] paper reveals a more updated collection of reviews on this domain. However, new models need to bestudied with regard to idle-time optimization to capture the current inefficiencies and obtain new managerial insights. Li and Zhang [6] study the pre-order strategy that this study has assumed as the items are transportedto franchises that demand it.Generally, two types of wastages are observed for refrigerated products, quantity loss, and quality loss. While most of the available literature deals with either one kind of loss, this paper attempts to discuss wastages interchangeably as a quality loss for a refrigerated product is synonymous with quantity lost too. For instance, Cai et al. [7] adopt a stochastic model to study a supply chain for fresh products. The study showed success in terms of freshness preservation by adopting certain ambient controlled transportation arrangements. Few extended works [8];[9];[10] further include a third-party outsourced transport provider in the supply chain, which we have used in our

study as well.The second set of relevant literature is that of transportation. It is common knowledge that the studies on vehicle routing have been widespread.Bruns and Knust[11] study the problem of load planning for trains in intermodal transportation, where it assigns load units to wagons of a train to maximize utilization of the train and minimize transportation costs in the terminal. Chang[12] adopt a new hybrid approach by combining OR techniques with AI search methods in order to obtain good quality solutions for finding the best routes in international intermodal networks. Other studies [13] also talk about a lead-time-based approach for planning the transportation of goods. This study attempts to integrate the above-mentioned batch of literature in terms of time study for perishable goods in the dispatch and delivery process in the processed food sector.

III. DATA AND METHODOLOGY

The goal of this study was to analyze the performance of warehouse dispatch operations. By gathering information from the report of warehouse documents, meetings with the various warehouse departments, observational analysis of the processes, and time-data collection of these operations, and identify the weaknesses and wastes within these. A total of 62 (coded as S) samples from the long route were taken, plying through 15 long routes. A total of 52 samples were considered for studying across 15 short route vehicles. For the limited scope of this paper, the entire network of logistics could not be presented in this paper. Results and insights were drawn through the analysis of outgoing shipment timed data. Individual vehicles were coded along with routes (VL-0114 stands for vehicle no. 14 of long route stands 01; VS-0566 stands for Vehicle number 66 of short route 05). Individual shipments were also coded in order to maintain the confidentiality of data. For example, S1 stands for bread dough, etc.

A detailed description of the dispatch and delivery process is done at first. Then an exploratory study is done to identify the routes incurring wastages. Subsequently, time is being analyzed as per the items in indent as the quantity of the item is directly proportional to the number of traysloaded in the vehicle in terms of control charts. The vehicle utilization depends on the number of materials and the volume of the trays of the delivering goods.

IV. ANALYSIS AND DISCUSSION

Average times for all steps are mapped to identify the idletime of the dispatch and delivery process. Quality control charts reveal time lag in long-distance shipments is significantly higher than that of shorter distances. Results also reveal issues with specific routes of shipments that do not meet the control expectations frequently. Dispatch and delivery process to transport semi-processed food material exceeds the allocated time capacity in specific routes of long-distance shipments. Therefore, while dry and chiller items do not face manywastages, wastages are observed more in the case of frozen materials which require to be transported below -18 degrees.

A. Dispatch and Delivery:

The following figure (Fig. 1) gives a detailed description of the idle-time calculation process of dispatch, delivery, and reception of reception. Fig: 1 Time-Oriented data collection model for deliveringchilled and ambient food items *Bulk picking* is done by merging the shipment merging the shipment id into parent shipment along with all packaging material. *Segregation* of material is done according to the route. Materials are segregated separately for dry and chilled items. *Loading & Dispatch* is done as per the schedule of the routes. The loading of the vehicle usually occurs through docks.

Activity	Description	Remark
A	Request to open door idle time:1080 sec	•Vehicle report at securities •Documentation at gate
B	Take photo of seal idle time :180 sec	•Vehicle checklist •Photo send to higher Authority
C	Open seal idle time:90 sec	•3 layer seal being open
D	Open container idle time:36 sec	•Opening the container in presence of a) Quality officer b)Driver c) TPL representer
E	Take Photo of container idle time:180 sec	•Picture of loaded truck •Quality checking of material
F	Dismount Box idle time:1500 sec	•Box received by Warehouse •System entry of all material
G	Take photo of container idle time:36 sec	•Photo send to higher Authority
H	Storage of recption idle time:120 sec	•Material warehouse assigned locatior

Fig. 1 Idle-Time Calculation Process of Dispatch

Outstation vehicles are loaded first, followed by the local vehicles. The time taken for vehicle loading is directly proportional to the number of trays. *Return & Trip closing* happens when thereturned vehicles report at tray unloading docks, after which proper cleaning of vehicle is done. Empty trays are carried back by vehicle. After which wastages are recorded using Software.

B. Descriptive

After recording the different steps of the model mentioned above, the compiled data was plotted to find the vehicle-wise wastages and the value of items that fell short. This helps provide insight with respect to the collected data and create key figures for decision-making. The following and subsequent figures and tables (Fig 2, 3, and 4; Table 2 and 3) describe the vehicle-wise wastages. Due to the confidentiality of data, the vehicles are not mentioned in the plot below.

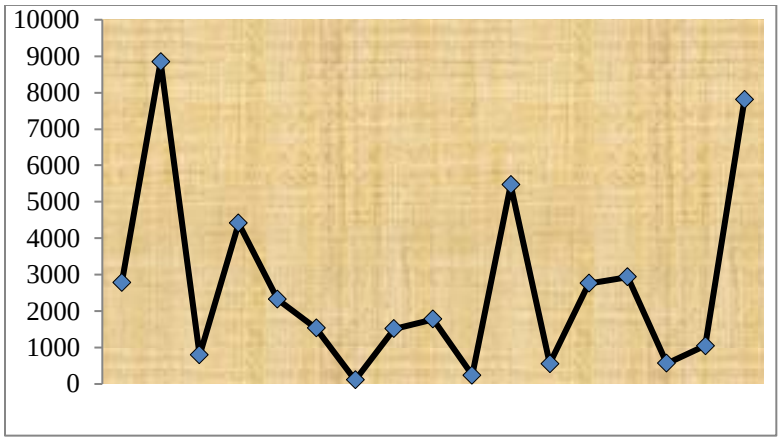

Fig. 2 Vehicle wise wastages

Maximum wastage was received at VL0514. Wastage was received for high-value S4 items.VL0766also received wastage received at route 07. Maximum wastage was found on local route VS09.Minimum wastage was observed at VS6062.

Table 1. The routes reporting most wastage

VL	*VS*	*Remarks*
05,09,10, 12, 14, 15, 18, 20,21	07, 09,10	Restaurants in longer routes show higher wastages than shorter routes

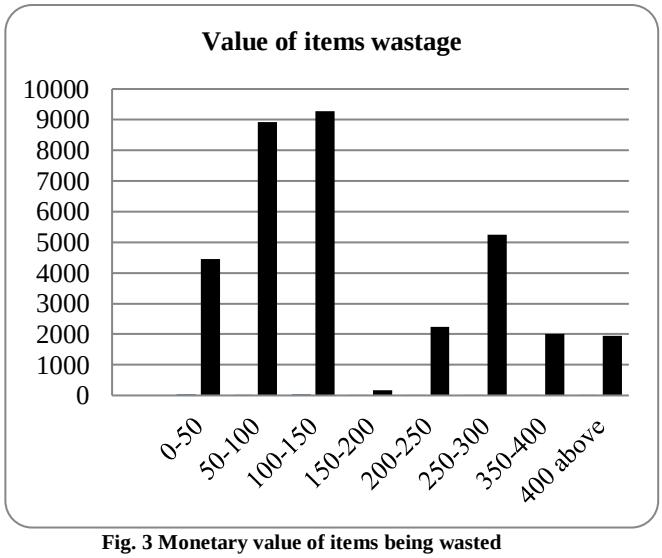

Fig. 3 Monetary value of items being wasted

Table 2. Maximum wattage range

Range	*Count*	*Total Amount*
50-100	34	8918
100-150	38	9285

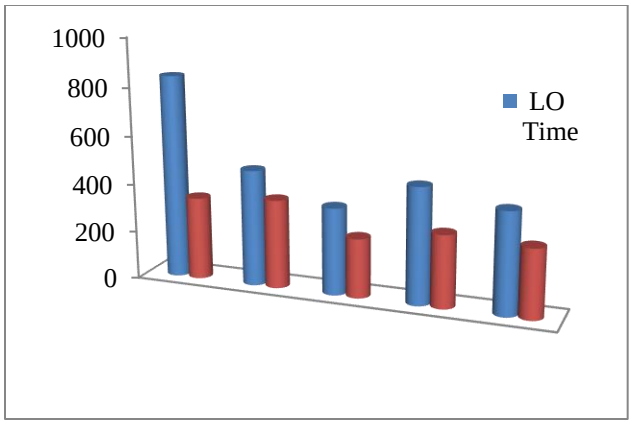

Fig. 4 Time taken to complete the activity

On the basis of daily records of segregation and vehicle loading of VL 01, the following observations were made: Firstly, the loading of the vehicle is directly proportional to the number of trays, the delay in which resulted in two wastages of chiller items (S04, S06) was received at restaurant number CC06.Secondly, segregation timing is dependent on the indent of the restaurant. Thereafter, equipment used during the loading BOPT used 3 man powers. It is also important to note that the loading of vehicles shows direct dependence on the numbers of manpower. If trays are manually taken by trolley near a vehicle, they take more time. Beverages consume more time for loading as they are not segregated.

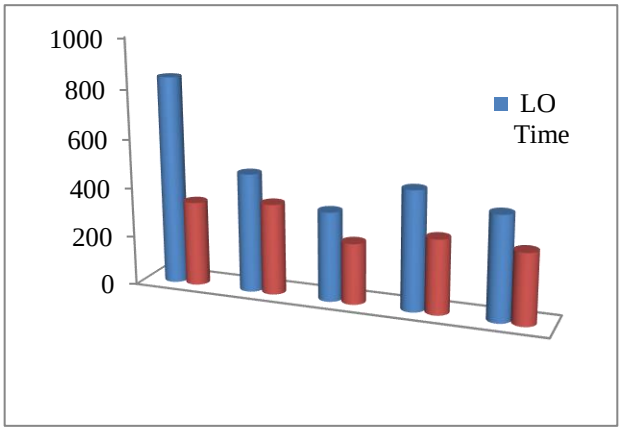

Fig. 5 Time is taken for loading of long-distance vehicles

On the basis of daily records of segregation and vehicle loading of VL 01, the following observations were made: Firstly, the loading of the vehicle is directly proportional to the number of trays, the delay in which resulted in two wastages of chiller items (S04, S06) was received at restaurant number CC06.Secondly, segregation timing is dependent on the indent of the restaurant. Thereafter, equipment used during the loading BOPT used 3 man powers. It is also important to note that the loading of vehicles shows direct dependence on the numbers of manpower. If trays are manually taken by trolley near a vehicle, they take more time. Beverages consume more time for loading as they are not segregated.

C. Analysing Timed Activities

After the above descriptive statistics were calculated, the different samples were compared to one another in order to identify which samples showed out-of-range wastage behavior.For instance,a number of sensitive chiller and ambient items used were plotted against dispatch times in order to understand how the allocation of resources affected the activity's cycle times. These results were driven through the quality control analysis tool of control charts and led to the evaluation of potential performance, involvinga decrease in wastes and an increase in timesensitivity. Note that idle times were only used for samples that included ambient and chilled items in the statistical analysis if they were greater than 5 minutes.

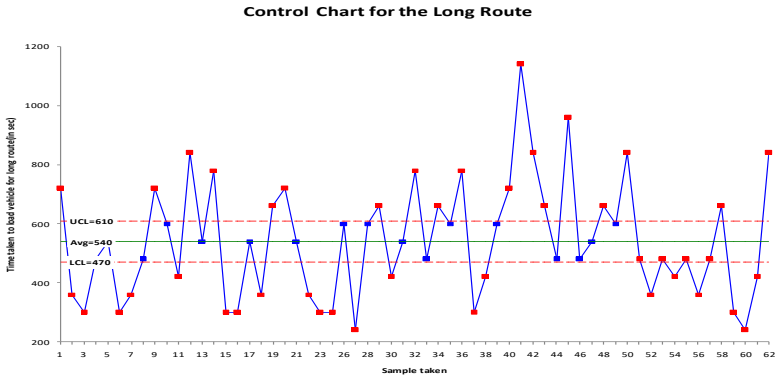

Fig. 5 Control chart of chilled and ambient items in the long route

As per the graph, the maximum time is 620 seconds to load the long route items.The average time for that is 537 seconds. The minimum time for the same is 220 seconds. As per the SCC norms, the idle time of the work isUCL = 660 sec, i.e., 11 min to load a store of long-distance. The average time taken is 540 seconds, i.e., 9 minutes.The time taken to load the material of the long route of the vehicle is generally 9 minutes as for one outlet. The material loading speed also depends on the efficiency of the worker working at the Supply Chain center. There are some of the stores which take a lot more time to load the vehicle,like the VS 42 takes 1160seconds to load the vehicle, and this may be due to an additional defect in the operation. And some of the stores are getting loaded in shot time. The various factors on which the loading of the vehicle is dependent on the quantity of material being loaded, the skill set of the worker, the use of an electronic vehicle to move material from one place to other and space allocation inside the vehicle

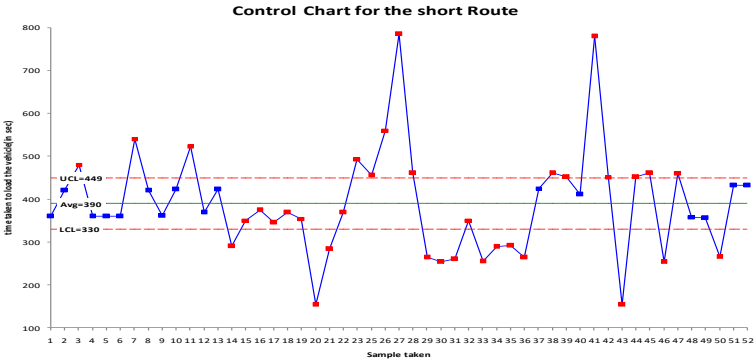

Fig. 6 Control chart of chilled and ambient items in the short route

As per the above graph, the short distance means time is 390 seconds. The maximum acceptable time to load the vehicle is 751 seconds, and generally, the minimum time taken is 150 seconds.But the idle time derived for the loading of a short distance store is 390 seconds. The maximum time required is 510 seconds.

V. RECOMMENDATION AND MANAGERIAL IMPLICATIONS

The paper has aimed to present empirical evidence of the impact of inefficiencies in the dispatch and delivery of time-sensitive operations. The following recommendations were drawn from the above analysis: The vehicle utilization by the chilled and ambient products is extremely time-sensitive.Therefore, bulk packing materials need to be placed in such a way that it avoids the unnecessary movement of BOPT. Picking and segregation can start nearly at the same time. Loading of material inside the vehicle needs to be done with optimized space allocation. For reducing wastage, a double checklist of the highest wasted items can be maintained containing items name and quantity by SCC as well as the third party transporter.Significant idle times and inappropriate allocation of resources are causing a pool of chilled item wastages in this procedure. The growing emphasis on research oftime study is due to the important role logistics costs have in the overall cost of production. In fact, the efficiency and effectiveness of these distribution networks, in turn,are largely determined by the advancement

in network studies[14].One of the limitations of this study is that it does not express the inefficiencies in financial terms. The repercussion of idle-time inefficiencies can further be translated into detailed financial losses.Further, it opens a detailed scope for study in the semi-processed (dry, chiller, and) frozen food sector, which is a rapidly growing industry in India.

Marketpressures and rival competition of cost-cutting have driven companies to find third-party outsourcing in transportationas a way-out for up-scaling cost advantage and expand their market share [15]. Reducing idle-time management has been a key area for this restructuring process.Apart from a financial incentive to enhance these, logistics & distribution are key processes connected with reduced overhead liability – which is the new high-value corporate objective.As Indian customers continue to demand greater value from the supply chain – third-party logistics providers – are becoming increasingly prevalent around the country [16]. They have been a rational alternative to both foreign and Indian enterprises as they deliver the complex services to interior locations required by large franchises. They aid companies to enter India's domestic markets throughon-time distribution networks that, if handled by the enterprises themselves, could display lower credibility. However, the Indian logistics providers are yet to be equipped with the latest modes of temperature-controlled refrigerated deliveries of non-Indian processed food items and need to improve upon theirwastage-reducing abilities.

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