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Research Article

Logistics across the Functional Areas & Logistics Considerations in System Life Cycle

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Abstract

The manufacturing sector/industry, faced with the challenges of producing quality products and distributing the same to customers in rapid response to their needs, in order to retain and add up its customer base/target market, has to bear additional responsibilities in the current scenario that extend to continuously and effectively provide maintenance & support to the product after the transfer of ownership. These challenges entail additional resources and infrastructure at a time when almost all manufacturing units are going through a resource constrained environment. Logistics, in such a delicate situation, has gained importance as a support function providing effective and economical support for the manufacturing system in all phases of its life cycle. The objective of this paper is to manifest and elucidate the role and activities of logistics in proper perspective i.e. as a support function having interfaces with other functional areas as well as the environment (markets/suppliers). Towards the end of furnishing support to the firm in an effective and efficient manner, there is a need for a systematic approach for planning, development, implementation and evaluation of a Logistic Function together with its integration with other functional areas. A generalized approach to incorporate logistic considerations right from the concept exploration/conceptual design phase to the system's retirement with the objective of minimizing the life cycle cost of the system is discussed.

Keywords: *Benchmarking, Logistics, Optimization, Evaluation Tools/Techniques*

1. Introduction

All the facts, the depth and geographical spread of logistics are encompassed in a much broader term Industrial logistics. As proposed by Barros, Industrial Logistics is concerned with the physical inflow and outflow of goods and associated services which link the firm to the external world, before and after production.This definition provides global view of logistics. Banos, Riley & Brown identified the following subsets of logistics as

1. *Product support logistics:* It is also known as engineering logistics or systems logistics. The salient feature of this class of logistics is the incorporation of logistic supportability measures such as reliability, maintainability at the design/acquisition stage of sophisticated / complex systems. The aim is to strike an economic balance between the high costs incurred in enhancing logistic supportability measures during system/product design and the expected feature maintenance and support cost of the system likely to be incurred during operational/utilization phase and the post sales customer support. Tradeoffs between these costs are considered on the basis of life cycle costs of various alternatives. This analysis works on the premise that decisions made on supportability measures at the design stage have the maximum impact on the future maintenance cost and the shape and configuration of the maintenance/support resources (spares, personnel, facility etc.), required by the system and the product. The attainment of high degree of the system and the product availability (Operational Readiness) at the lowest possible resource expenditure is the major thrust area in this type of logistics.

2. *Production support logistics:* Also referred to as operations logistics, it includes the activities pertaining to procurement, acquisition, movement, flow, storage and control of materials into through and out of the enterprise. Tasks related to distribution channel warehousing, locations and inventory control are the primary areas of concern.

The supply chain management concept has proved to be the most attractive choice in carrying out these tasks that can be summarized as making the right material available in right quantity, at the right place, at the right time. Cost effective material availability is the performance parameter for this kind of logistics.

3. *Industry support logistics***:** It comprises of the global issues that have a bearing on the whole of the industry. The realm of industry support logistics comprises issues

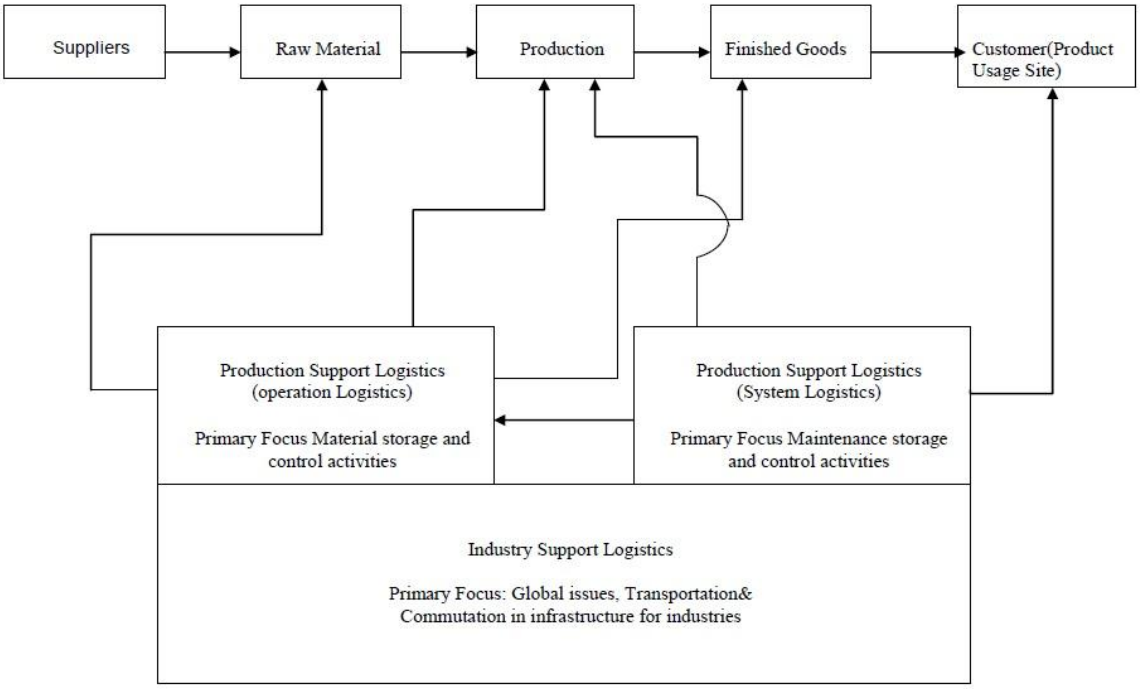

Figure1 Inter Relation of the three types of Logistics

pertaining to transportation policy, tariffs, import / export policies, and other issues of global concern such as globalization, environmental / ecological issues, monetary policies that impact the economics of the industry sector worldwide. This type of logistics provides the infrastructure (transportation modes, communication links) to the production systems. A diagrammatic representation showing interrelation of these three types of logistics is shown in figure 1.

Previous attempts to define the logistics function focused on the material transportation, inventory management, storage and warehousing by Christopher and Magee that are business oriented in nature. The U.S. Department of Defense on the other hand concentrated upon the maintenance / support activities along with the inclusion of logistics supportability considerations during the design and development phase.

In the context of manufacturing industry both the activities, material movement, storage and control as well as maintenance & support are of equal importance, from the author's perspective logistics is more precisely defined as

Making the right material and service available in right quantity at the right place and at the right time and simultaneously sustain prime mission related components of the manufacturing system, the product and the logistics support infrastructure at the desired level of operational readiness at the least possible resource expenditure.

The above framework reflects the extent of diffusion of operations logistics (production support logistics) and systems logistics (product support) in the manufacturing sector. The Integrated logistics support concept (Huchinson, Norman E., 1987) encompassing all the activities related to material availability and the operational readiness parameters is more suited to the manufacturing sector in the attainment of the logistics objectives of the firm.

2. Integrated logistic support and logistic elements

Logistics, science its inception, remains one of the hazy areas because of its interfaces with the other functional areas of the firm as well as the environment wherein it operates (Suppliers/customers). The emphasis has always been on sustaining manufacturing operations through effective and timely movement and storage of material and when it flows from suppliers as raw material to the markets in the form of finished goods, with the transformation process in between.

The concept of Integrated Logistic Support (ILS) evolved as the conversion process became more sophisticated and with the increasing technological content of the product rendered the ultimate user incapable of its maintenance and repair, for sustaining the production and distribution related activities at the desired level of performance, the logistic function became critical to the success of the organization. It concerned itself with providing the materials and maintenance & support in a timely and effective manner. This resulted in emergence of ILS manager, vested with the tasks to control the logistic activities related to material movement and storage and providing maintenance and support.

The advent of integrated logistic support concept can be traced to the ever increasing necessity for specialization in design, engineering, production and marketing functions. Increased competition has driven these functions to focus on the areas of the respective competencies.

Such an approach has been adopted by a variety of firms over the years through the development of a Logistic Function suited to their own specific requirements. But the generalization of the process of putting in place a logistic function, has remained one of the least understood phenomena

A Typical logistic function comprises a set of resources commonly referred to as the elements of logistics. The following are the various elements of logistic that make the logistics function of a manufacturing system:

(i) Movement (Transportation) of raw materials, semi finished goods and finished products
(ii) Storage (Inventory) of raw materials, semi finished goods and finished products
(iii) Spare & repair parts for production system and product
(iv) Personnel and training providing support for production equipment and product.
(v) Test and support equipment for inspection, fault diagnosis Maintenance and repair
(vi) Technical data/publications (operations and maintenance instructions)
(vii) Facilities for transportation, storage, distribution and repair

The objective of ILS is to integrate these elements along with the production and operations components. This yields the package of logistic resources that provides economic and effective support throughout the life cycle of the system

The logistic function also plays a co-coordinating role amongst various functions of the firm towards realization of the organization's overall objectives. Advance anticipation of the potential impact of the environmental factor (market forces, competitions, technological advancements etc.) by the logistic function coupled with periodic review and adaptations of logistic activities and elements, enables the firm to adapt to the environmental fluctuations and changes.

3. Organization for Logistics, Logistics Function and Logistics Co-Ordination

The integration of all the elements of logistic in relations to each other and also to the production equipments and the final product that provides support to the manufacturing system throughout its life cycle is referred to as logistic function.

Integrated logistic support sustains the operations ensuring smooth flow of materials through the organization, the provisioning for its storage as well as furnishing maintenance to equipments and the product.

Usually there is a diffusion of elements of logistics and their control amongst various functional areas of the firm. For instance a transportation facility and raw material warehouse within the control of the production function and transportation and warehousing of finished goods within marketing function, the logistic function controls and coordinates the logistic activities pervading all over the firm's sub systems as shown in figure 2.

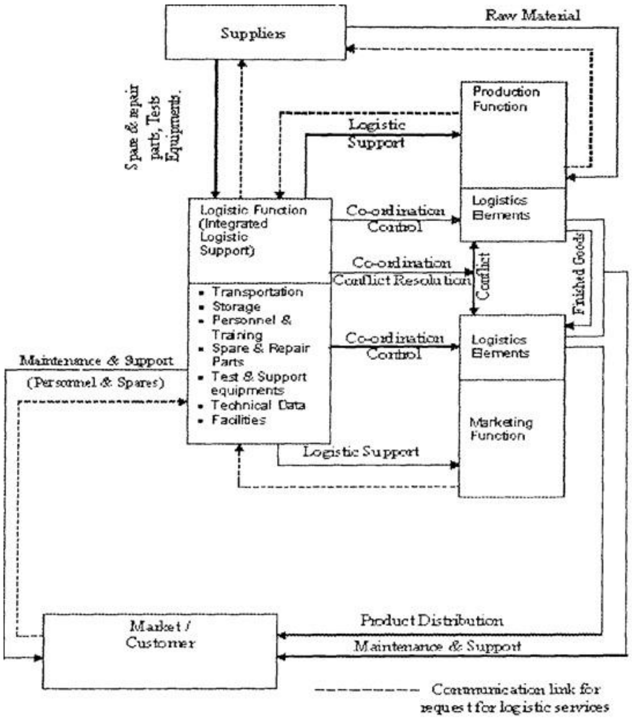

Figure 2 Logistic Function and its Interfaces with other Function and Environment

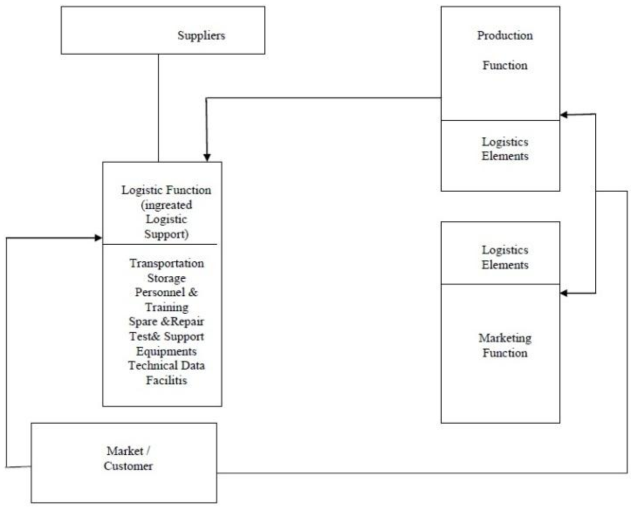

Figure 3 Reverse Logistics (Products Return For maintenance/Repairs)

This coordination leads to the resolution of conflicts amongst various functions arising out of their diverse subsystems goals. In order to preclude the possibility of various functional areas working at cross purposes in an effort to maximize their subsystem objectives. The logistic function has to step in and arrive at a compromise wherein one or more of the functions sub-optimize its goals in keeping with the attainment of the overall goal of the organization. Morash, Dorge & Vickery investigated the performance relationships of sub- functional process integration and scientific logistics capabilities, resulting in the competitive advantage to the firm from the inter-functional integration when individual functions sub-optimize their goals.

As illustrated in figure 2.2, the spread of the logistic activities and elements throughout the firm renders the logistic functions an amorphous entity as opposed to a physically identifiable function.

It is due to the fact that the objective of logistics function is to coordinate, harmonize and orchestrate the activities of other functions.

It results in their being in consonance to the overall objectives of the organization. This fact places the logistic function as an arbiter for resolution of conflicting objectives of other functions that work in relative isolation. Kahn & Mentzer propounded the interdepartmental integration and the collaboration by taking a composite view of the organization's sub-functional activities by proposing a model for interdepartmental integration & collaboration in different logistics situations and managerial implications in such situations.

The logistic function interacts and coordinates with other functional areas as well as customers and suppliers which constitute the environment, by furnishing logistic services in the form of material movement and storage and providing maintenance and support as shown in figure 2. Request for logistic service (shown as communication link by dotted lines) stimulates logistic activities. The reverse flow of the product, as shown in Figure 3, from the customer to the firm in the form of items returned for maintenance and repair (commonly referred to as reverse logistic) occurs in the direction opposite to the flow of maintenance and support activity from the firm and also from the firm to the suppliers. The objective of the logistic function is to convert all the elements of logistics into a harmonious logistic package orchestrated to meet the needs of logistics services.

4. Logistic Considerations in System Life Cycle

The following text focuses on the pervasiveness of logistics considerations in various phases of a manufacturing system's life cycles and a generalized approach towards the development of the logistic function and the logistic support system is discussed.

Phase 1 - System design

The conventional procedure that goes into system engineering process to arrive at the final systems configuration that satisfies a need or attains an objective, involves performance parameters such as measures of cost effectiveness, reliability, maintainability, availability and system utilization factors etc.

Of these reliability, maintainability and availability factors that indicate breakdown frequency, time to repair as well as costs of maintenance and operational readiness, determine the type and quantity of the logistic support infrastructure required from the operational phase of the system till its retirement

Logistic considerations in system engineering process involve the analysis of the system from the viewpoint of supportability, producibility and disposability. As the prime mission components of the system are designed/ selected and analyzed by the translation of the overall system operational requirements into requirement allocation for all its components, the logistics consideration such as reliability of individual component and that of the system lays the foundation of the logistic support for the manufacturing system (Figure 4).

Therefore, design, development and selection of the system from amongst various alternatives available must be done in conjugation with the development of the logistic needs of the firm and product.

The design process must involve reliability and maintainability engineers as the they strive to impart those attributes and characteristics to the system & the product that enhance their reliability and maintainability, thus controlling the increased future operating and maintenances costs and associated resources requirement, during system operational phases and providing supports the product delivered customers.

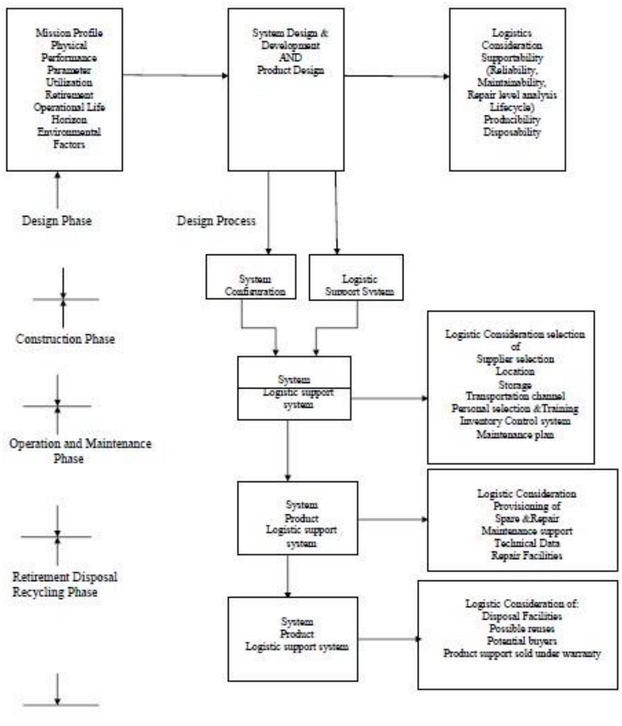

Figure 4 Logistics Considerations in Various Phase of System Life Cycle.

The challenges is to strike an optimal balance between high costs of designing reliable and maintainable systems & products as opposed to the large costs and resource allocation for providing logistic support in the future. Reliability Maintainability repair level analysis and life cycle costing are the major inputs in carryings out the supportability analysis of the alternate designs of the system, the selection of the final configuration of the system and associated package of logistic support resources that minimizes the life cycle cost of the system while performing its stated primary functions in an effective manner. Blanchard proposed that in developing a new system, the implementation of ILS concept is essential to satisfy customer requirements in a cost effective manner in terms of mission fulfillment and life cycle cost.

Phase 2 - System Construction

The selected configuration of the system and product obtained from earlier design related activities when physically constructed and realized, needs additional logistic considerations. It requires the development of the suppliers and logistic channel for physical movement and storage of raw material into the firm, a system for movement and storage of in-process inventory during transformation process and the distribution of finished goods to the customers.

The location of the firm and warehouse with respect to the suppliers and the markets becomes a critical issue along with the management & control system of inventory of materials. Jayraman, V. emphasized for the integrated model for distribution network that analyses the alternatives location and transportation on the basis of cost and transit time. These factors as well as repair parts for the system and the product , the location of product support facilities, the level and sophistication of the maintenance activities(Organizational, Intermediate & Depot), provide the basic input to the construction process of the system, the transportation/distribution network, storage, logistic support system for production equipments(Industrial Logistics) and the product (Customer Support).The construction process guided by supply chain management concept yields optimal results.

Phase 3 - System Operation and Maintenance

During operation and utilization phase of the system, the logistic function is vested with the additional responsibility of providing support to all of the firm's production and distribution components as well as the product that has been passed onto the customer. Sandberg & Stromberg described the continuous collection of operations data, in order to provide essential inputs to continuous improvement of production and support systems, concluding that keeping availability performance and life cycle cost help develop a system with high performance.

Demand of spare and a repair part is random in nature because of the random nature of breakdowns that stimulates their demand. Therefore associated inventory requirements of spares, test and support equipments and the number of maintenance personnel required etc. are determined through rigorous mathematical analysis based on statistical and probability theories. The establishment of management and control system of these elements of logistic becomes a formidable task when it comes to their timely delivery and allocation at various levels of maintenance (organizational, intermediate and depot). Appropriate models may be adopted to for such situations so also for evolving maintenance programmes regarding periodic inspections, servicing, repair versus replacement activities. These maintenance programmes (Preventive/corrective maintenance) are continually reviewed during this phase and adjusted to varying situations.

Phase 4 - System Retirement and Disposal

The ever interesting scarcity of the natural resources and mounting social and political concerns regarding environmental issues have extended the responsibilities of the enterprises beyond the point when the systems reaches its retirement and the production of goods ceases completely. Livingstone & Spark dealt with the impact of government legislation to encourage reuse and recycling of materials on the companies exporting products to Germany. During the initial design and development process additional logistic considerations must be factored into regarding incorporation of disposability, recycling and reuse characteristics into the system components. An advance planning for the disposability of the system during design stage yields a phase out programme, its probable point of initiation at a point of the system life cycle and a disposal Ire cycling capability within the system.

The additional costs for establishment of disposal capability, its operations and resource requirements must be balanced against the future penalties for failure to do so. Identification, selection and agreements with the parties willing to buy disposed of material must also be done in advance.

Even after system retirement, the elements of logistics, providing support to the items distributed to users under commitment for the same, must be in place for a certain duration of time. This entails the continuation of logistic support activities through maintenance and support to the customers using the firms products till all the commitments made to customers in this regard are met and their period expires

5. Summary

The modem industrial scenario poses a multitude of challenges on a manufacturing firm to competitive advantage. Quick and effective availability of product or service has become an important basis for competing. The technological sophistication of manufacturing technology and the product calls for the provisioning of an effective maintenance & support to ensure their operational readiness. It is in this context the logistic support infrastructure is needed that strives to achieve these objectives economically with the system life cycle perspective.

Logistic support system that is designed at the program inception phase of the manufacturing system considering all the future costs (Life cycle cost) yields an effective and efficient system configuration together with a well integrated logistic support system. The rapid advancement in technology, to an extent determines the life span of a manufacturing system. Finally selected system and its logistic support infrastructure owes its selection from amongst various alternatives to the comparison of their life cycle costs. Inclusion of logistic considerations at the design and development phase holds the maximum potential to minimize the life cycle cost of the system. Subsequently it sustains the operations/production related activities by providing needed materials (through transportation and storage) and maintenance & support to the production equipments and the product for better customer service.

The incorporation of logistics from the programmed inception phase throughout the system life cycle enables the development and selection of a system configuration along with logistic support system that provides effective and economical service throughout the life cycle of the firm. Thus this approach to incorporate logistics facilitates the selection of the optimum system configuration and the logistic support package.

Towards this end, the integration of logistics with other functions of the firm provides the sound foundation that sustains the prime mission related activities of the different functional areas. Apart from providing routine logistic activities of movements and storage, maintenance & support and conflict resolution amongst various functional areas, the logistic function permeates the interfaces of the firm with the environment (suppliers and customers).

The interface of logistic with the environment ensures anticipation of the potential future environment factors and their impact to the firm and in the process adapts the elements of logistics and the logistic support package.
The implementation of a generalized approach for development of integrated logistic support function of the firm through the incorporation of appropriate logistic considerations during various phases of the manufacturing systems life cycle will enable the manufacturing system to provide effective and economical products and services to the customers.

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