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Foreword

Mr Veli-Matti Virolainen was a participant of the Young Summer Scientists Program in 1990. His work has been related to the design of control systems for logistic performance.

This Collaborative Paper provides a description of the logistic performance problem. The methods and techniques which can be used to measure the performance of logistics are presented and the control structure for logistic performance is proposed.

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Abstract

This text is concerned with identifying and outlining the various aspects of logistics control and performance measurement process. The objective is to identify, based on available literature, methods and techniques which can be used to measure the performance of logistics.

Logistics management is essentially a task of balancing between minimizing cost and ensuring availability objectives. Availability can be seen as the output of logistics system. On the input side, management is concerned with minimization of costs caused by holding inventories, warehousing, transportation, production and administration of logistics activities.

Logistics control is normally directed toward two subjects: the control of logistics output or service level and the input of logistics system. Key objects of logistics control are: service level, inventory turnover, warehousing costs, transportation costs and administrative costs.

The logistics control systems involves setting goals and standards for performance, measuring performance, and taking corrective actions.

Various methods such as productivity ratios, flexible budgets, standards, control charts, and audits, can be used to measure the performance of logistics activities.

The methods used to measure logistics activities usually provide a comparison to the past, not to the future. The nature of the problem in logistics is change. The focus must be to respond to change by projecting possible future system states. Control systems should assume possible future conditions in order to plan for response and to guide future decisions.

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Control Systems for Logistics Performance

Veli-Matti Virolainen *

1 Introduction

1.1 Definition of logistics

There are various definitions for the concept of logistics, but expressed very simply it is:

> The process of strategically managing the movement and storage of materials, parts, and finished inventory from suppliers, through the firm and on to customers (Christopher, 1985 p 1).

Logistics refers to the art of managing the flow of materials and products from the source to the user. The logistics system includes the total flow of materials, from the acquisition of raw materials, to the delivery of the finished product, to the ultimate users, and the related counter-flows of information that both control and record material movement (Magee, 1968).

As Shapiro and Heskett have stated (1985, p 2) that logistics encompass two elements: materials management and physical distribution. Materials management is concerned with the procurement, transportation, and storage of raw materials, purchased components and sub-assemblies entering the manufacturing process and the flow of goods within and throughout the manufacturing process. The main objectives are to ensure (1) that the production function has the necessary input at the right time and place, and (2) that the flow within the production system takes place in a timely and efficient manner. Physical distribution is concerned with (1) the transportation of finished products from the point of manufacture to their destination and (2) the storage of finished goods at intermediate points along the way.

Managing the entire logistics pipeline as a single system affords benefits that exceed the sum of the parts.

1.2 Logistics management

As mentioned previously, logistics management is the art of managing the flow of materials and products from the source to the user. The objective of logistics is to ensure that the materials and products are available at the right places at the right times and in adequate quantities to satisfy the demand. Availability can be seen as the output of logistics system. On the input side management is concerned with minimizing costs incurred by conducting inventories, warehousing, transportation, production and the administration of logistics activities.

Logistics management is essentially a task of balancing between minimizing costs and ensuring the availability of objectives. Appropriate trade-offs have to be made between key elements such as service levels, inventory turnover (inventory carrying costs), replenishment costs, transportation costs, warehousing costs, and administrative costs (see e.g. La Londe and Lambert, 1976).

This is not an easy task, because there is complex interaction between the various components of the logistics system. A cost decrease in one area can influence a variety of other logistics costs.

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This entire set of complex interactions must, therefore, be examined together in a systematic way (see Copacino and Rosenfield, 1985).

At the operational level those logistics decisions that are made by the management must be reached at the level of an individual item or product. Decision making in logistics management is therefore, as stated by Silver and Peterson (1989, p 56), basically a problem of coping with large numbers of units of a diverse nature and with a diversity of factors, both external and internal to organizations. Moreover, the detailed decisions must, in general, be consistent with the overall objectives of the management.

Furthermore, there are organizational conflicts that make logistics planning difficult. First of all, the responsibilities for many logistics activities are spread throughout the organization. There is often no clear single organizational authority that would span all the logistics activities. Second, different organizational functions have different interests and these create conflicting objectives and requirements for a logistics system (see e.g. Copacino and Rosenfield, 1985; Tersine, 1988, pp 16-19; and McKinnon, 1989, pp 4-6).

A simple framework for logistics decision making and management is presented in Figure 1.

Logistics activities are performed in order to support production and marketing, and therefore logistics management is closely linked with marketing and production strategies. It could be expected that senior management has the responsibility for broadly defining an outline of service level objectives and available resources for logistics activities.

Besides the top managers' guidelines, logistics decision making needs external input information from sales and supply markets, and from the transport sector (demand forecasts, delivery time information from suppliers, available transport service etc).

Management also needs feedback from the logistics system. Service levels, inventory turnover ratios, and costs of logistics activities should be viewed regularly and this control information should be used as basis for rational decision making. Summary and exception reports are also generated by the control system in order to inform top level management.

The decision process phase itself may consist of the analysis of input data, planning activities, actual decision making and goal setting for key variables. Managers may use models as tools in analysing input information and in planning logistics activities. In simple situations a model can be programmed to make decisions without managerial or any human other intervention.

The execution of decisions and policies are carried out by the day-to-day operational control. This execution may include both short-term corrective actions and more far-reaching development projects of the logistics system.

1.3 The purpose of the study

The aim of this study is to make a survey of the methods which can be used to control and key elements of logistics. The key elements of logistics control are plainly presented in Figure 2.

Control is directed to two subjects: control of logistics output or service level and input of the logistics system. Key elements of logistics control are:

- service level
- inventory turnover
- warehousing costs
- transportation costs
- administrative costs

Control information gained from the key elements is compared to objectives and possible corrective actions are taken. Corrective actions are directed to both the structure of the logistics system and operation, and the quantity and quality of used inputs. The influence of the external

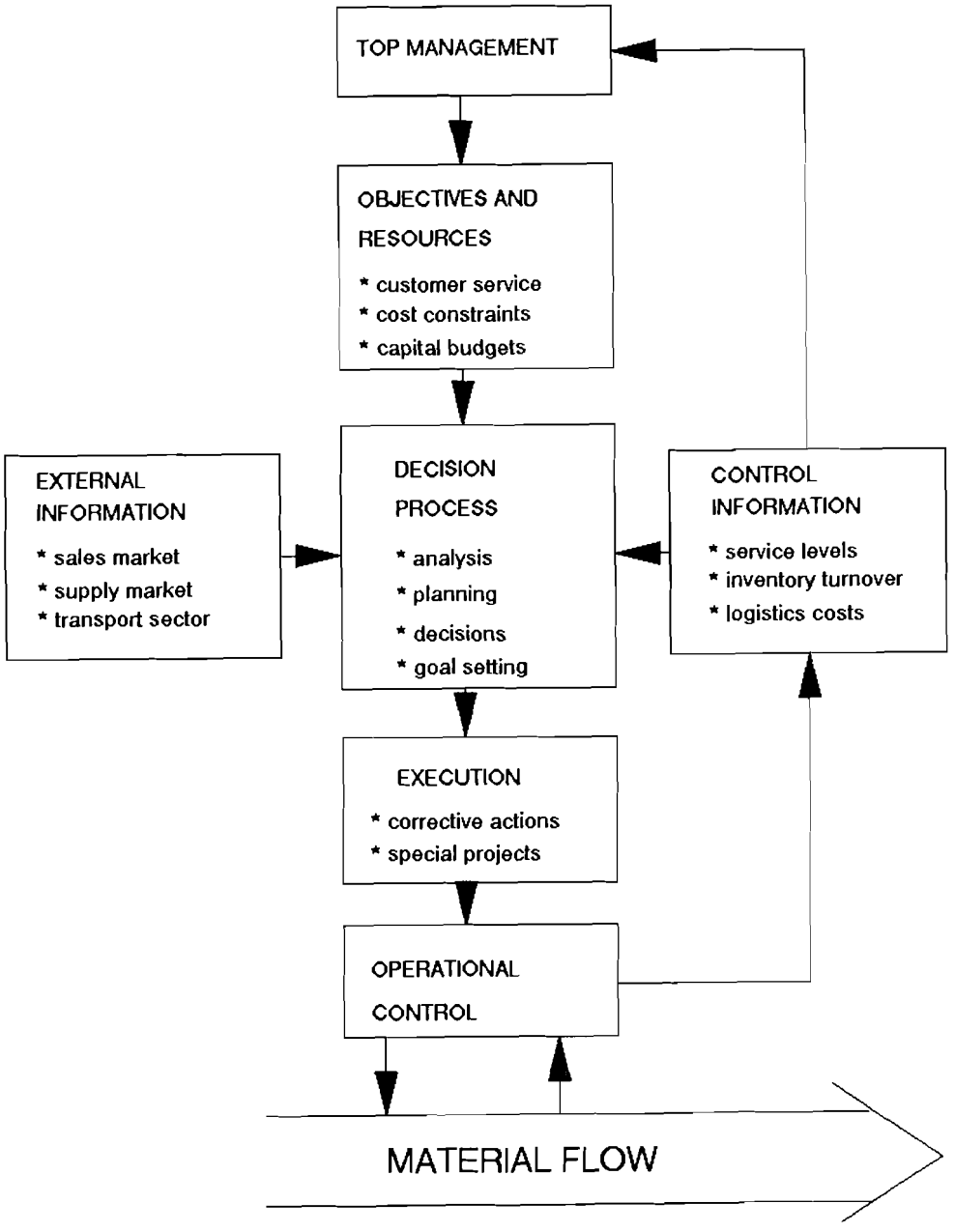

Figure 1: A framework for logistics management process.

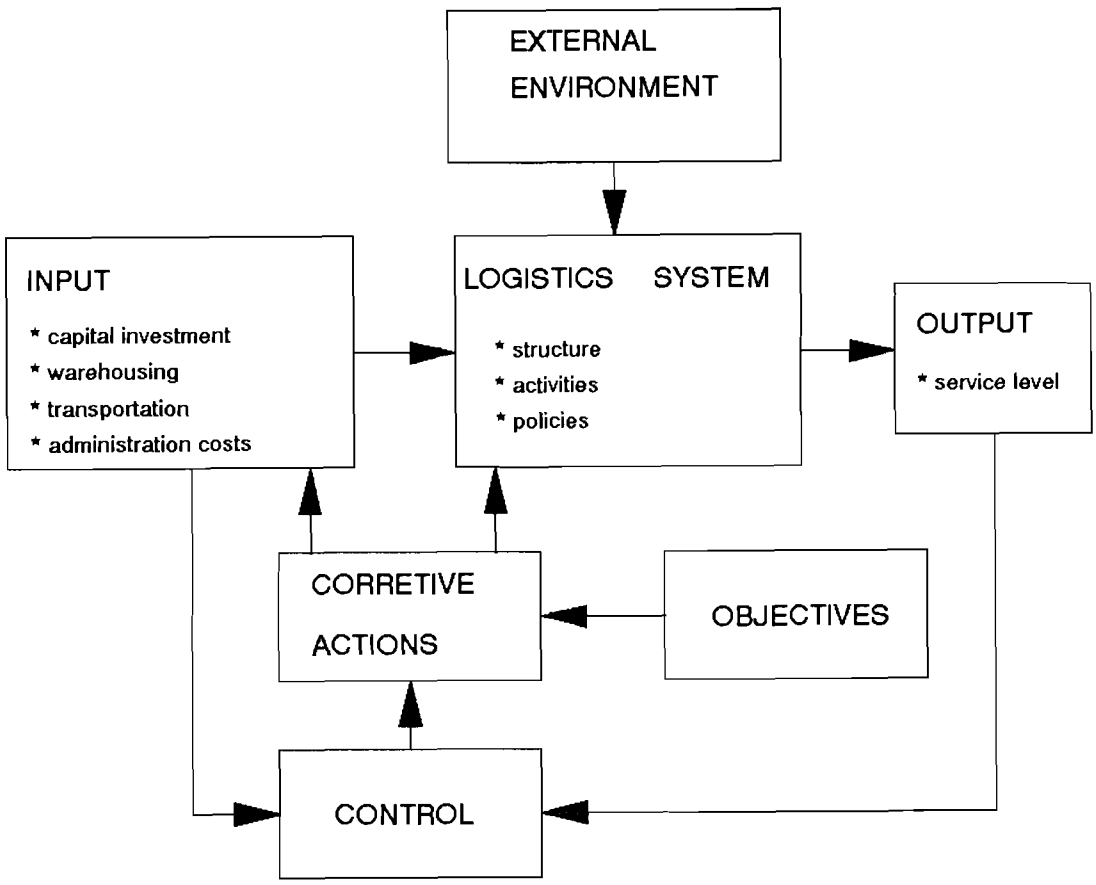

Figure 2: The key elements of logistics control.

environment is composed of factors to which enterprise must adapt its logistics management control. The most important of these external factors are the customers' demands, competitors' actions, subcontractors' and material suppliers' service levels, and the conditions of the trasport market.

2 Definition of logistics key elements

In this chapter each of the previously mentioned key elements, excluding administration costs, are discussed closely.

Administration costs are concerned with the definitions of other key elements. Usually administration costs include such costs as order processing/order entry, customer service, sales forecasting, production planning, sourcing/purchasing, inventory management, transportation management, logistics systems planning, logistics engineering, logistics control, and logistics general management (Kearney, 1984, pp 20-21).

2.1 Service level

It is often suggested that the role of logistics is to provide "time and place utility" in the transfer of goods and services between buyer and seller. In other words, there is no value in the product or the service until it is in the hands of the customer. It follows that making the product or service "available" is what the logistics function of the business is all about. "Availability" is a complex concept, influenced by a galaxy of factors which together constitute customer service (Christopher, 1985, pp 34-35).

Logistics customer service may also be seen as the quality with which the flow of goods and services are managed. It is the net result of all of the logistical efforts of the firm (Ballou, 1978, p 62).

It is not uncommon to find different forms of customer service actually practiced by companies. To some companies it is the time it takes for a delivery of a customer order and to other companies it could be stock availability.

Many authors have defined elements of customer service (e.g. Christopher, 1985; McKinnon 1989; Perreault and Russ, 1976), but the most common are as follows:

- order-cycle time
- consistency and reliability of delivery
- inventory availability
- order-size constrains
- ordering convenience
- delivery times and flexibility
- invoicing procedures and accuracy
- claims procedure
- condition of goods on arrival
- policy on returned goods
- order status information

2.2 Transportation costs

Transportation is an important element of a logistics system, as it provides the links among suppliers, producers, and consumers. A reliable and efficient transportation system contributes to efficient production and allows a firm to reach broader geographic markets. Transportation costs are, in fact, the most important elements of logistics costs. Transportation costs can vary greatly among industries, but across all industries they account for almost half of the total costs of physical supply and distribution (Magee et al., 1985, p 113).

Transportation activities incur a number of costs, such as labor, fuel, maintenance, terminal and roadway administration, and others. This cost mix can be divided into those costs which vary with services or volume (variable costs) and those that do not (fixed costs). However, it is very important to consider as fixed, the costs that are constant over the "normal" operating volume of the carrier. All other costs are treated as variables. More specifically, fixed costs are roadway acquisition and maintenance, costs of terminal facilities, transport equipment costs, and carrier administration. Variable costs usually include line-haul costs, such as fuel and labor, equipment maintenance, handling, pickup and delivery. This may not be a precise allocation between transportation costs, because there is a significant difference between fixed and variable modes, and there are different allocations depending on the dimension being examined. The reason for this is that all costs are partly fixed and partly variable, and that the allocation of cost elements into one class or another is a matter of individual perspective (Ballou, 1978, p 158).

According to Bowersox et al. (1986, p 23), the cost of transport is determined by the actual payment for transportation between two points, plus the expenses related to owning an in-transit inventory. A logistical system should be designed to minimize the transport cost in relation to the total system cost.

2.3 Warehousing costs

Warehousing, and products and materials handling are essential ingredients in the logistics mix of activities. In contrast with transportation which takes place over distance and time, warehousing and materials handling are, for most part, bound to given locations. Therefore, the cost of these activities are closely related to the selection of sites (Ballou, 1978, p 196).

If the demand for a firm's products were known precisely and products could be supplied continuosly to meet demand, theoretically no storage space would be required. However, it is neither practical nor economical to operate a firm in this manner, because demand usually cannot be predicted exactly.

The costs of warehousing and materials handling are justified because they can be traded with transportation and production cost. These costs are usually labor, facilities, equipment, energy, and financial investment costs.

2.4 Inventory cost

The control and maintenance of inventory is a problem common to all organizations in any sector of the economy and in logistical management it is one of the riskiest areas of decision.

Inventory may be viewed in several ways by a company. It can be seen not only as a physical stock of materials and products in the logistics chain, but also as an asset and as such, it may represent an investment competing for scarce resource-capital. For this reason, the measurement and control of inventory investment is an important consideration for logistics management.

There are three different cost categories in managing inventories (Ballou, 1978, p 266). These are (1) carrying costs, (2) procurement costs, and (3) out-of-stock costs.

The inventory carrying cost includes such items as capital cost, taxes, insurance, handling, storage, shrinkage, obsolescence, and deterioration. Capital cost reflects lost earning power or opportunity cost (Tersine, 1988, p 17).

Procurement costs are associated with acquiring the needed quantities for stock replenishment. These are, the cost of processing an order through the order-processing, accounting, and/or purchasing departments; the cost of transmitting the order to the supplier, usually by mail or electronic means; the cost of setting up production to produce or setting up handling procedures to fill the order quantity; the cost of any materials handling or processing of the order at the receiving dock, and the price of the goods (Ballou, 1978, p 263).

The stockout cost results from external and internal shortages. The external shortage occurs when a customer does not have his order filled; an internal shortage occurs when a group or department within the organization does not have its order filled. External shortages result in backorder costs, present profile loss, and future profit loss. Internal shortages can result in lost production and a delay in a completion date (Tersine, 1988, p 17).

3 Needs for logistics control

Control systems are the key to ensuring that performance is consistent with the management's operational plans. Logistical control activity serves several functions as Bowersox et al., (1986, p 477) has stated. First it measures performance through reports, audits, and observations. Secondly, it makes a comparison of the actual to planned performance. And finally, it identifies corrective actions. The control objective is to provide a prototype system for measuring the productivity, utilization and performance of the overall logistics system, functional areas, and individual managers.

Even the best organized systems will require some control to ensure that the desired outputs are achieved and that its use of inputs (resources) is within the planned levels. Products and service volumes, costs customer service requirements, and legal requirements all may change over time. If logistics objectives for cost and service are to be met over time, then the logistical performance must be kept in line with the planned performance. This is the responsibility of the managerial control (Ballou, 1978, p 415). Variations from planned levels will occur at both the input and output levels due to a variety reasons. It is convenient to categorize these variations into internal and external environments. The internal environment relates to those variables within the control of company, e.g. product mix, system configuration, procedures etc. The external environment concerns those elements generally beyond the control of the company, e.g. customer requirements, competitors' service policy, government legislation etc. Thus, to improve the control of the logistics system, both the internal and external environments must be monitored, along with the measurement of resource inputs and performance outputs.

The second reason for establishing a logistics control procedure is to assist in the search for productivity improvements. Productivity can be defined simply as the ratio of the outputs of a system to the inputs. In the logistics context we can think of customer service performance as the output and the logistics mix elements (e.g. inventory, warehousing, transportation, order processing etc.) as the inputs (Christopher, 1985, p 79).

4 Control levels

Schary (1985, p 44), has stated that logistics control operates at three levels: Level I, the functional activity center; Level II, logistics system management; and Level III, general management. Levels II and III deal with strategy, Level I with operations.

It is very clear that information requirements vary substantially among these three levels. Level I managers are concerned with controlling specific operations and the completion of routine schedules. Input data are oriented toward workload management and the aggregate volume of activity such as the numbers of orders received and completed, and identifiable costs and the elements influencing these costs, such as order size. Control may be exerted through models which posit "standards" orders based on specific order input conditions.

Management at Level II is concerned with planning, directing and controlling the logistics system as an integral unit. The output of each activity center must be controlled and coordinated to produce a system output. This requires two types of control: (1) specific results from each center and (2) balanced output from these centers to achieve results from the system as a whole, such as the performance of service at specified levels and cost minimization.

Each customer group also has specific requirements and characteristics such as service levels or order sizes which may differ according to group. Control must then deal with each customer group both at the level of activity centers and that of the system as a whole. Control then involves the use of selected aggregate indicators to determine whether the conditions under which the original trade-offs still hold and that the intended activity and resource balance is being maintained.

The impact of the market is felt directly at Level III. The strategic focus is on selecting and serving individual market targets and evaluating their contribution to corporate profit. The basic control at this level is, according Schary (1985, p 46), the contribution margin which measures the difference between revenues and direct expenses. The contribution margin alone, however, may not be sufficient to signal change. Further details must be provided from operations, calling on physical activity measures from Levels I and II. The combination then provides a clearer image of change.

5 Control process for logistical performance

In this chapter goal setting, performance measurement, corrective action, and some aspects of logistical information systems are discussed.

Controlling the logistics effort is constant concern of management, because a constantly changing environment and a contingency of events act to detour logistics activities from their planned performance levels (Ballou, 1978, p 424).

In principle, the logistics control is a straightforward exercise involving the identification of the important cost to monitor, the measurement of these costs, the comparison of these costs to targets, and the analysis of any resulting variances from the targeted costs. According Ballou (1978, p 424), managerial control involves (1) setting goals and standards for performance, (2) measuring performance, and (3) taking corrective action. The basic tools of control are various reports and audits that measure performance.

In practice, the control process is one of the most complex aspects of logistics management, because the costs related to logistics activities are often less visible and, therefore are often difficult to identify and measure. Sometimes, it is also difficult to develop targets for service level and especially for costs that vary with activity levels. Nonetheless, the application of a more formal and sophisticated management control system to logistics operations is rapidly expanding.

5.1 Set performance objectives and goals

Setting the performance objectives and standards requires the establishment of specific goals and measures for directing customer service and logistics costs. This requires the selection of specific measures as well as the establishing of quantitative goals for meeting those measures.

The identification of performance objectives require that the management consider the trade-offs between the benefits of a specific customer service level and its associated cost. There are two considerations in making this trade-off (Bowersox et al., 1986 p 101). First the enterprise must establish its service position relative to customer requirements and the competition. This consideration is the desires of the customer balanced against what an enterprise can provide while remaining competitive.

The second trade-off concerns the cost and benefit of specific performance objectives. Management must determine the expected benefits that can be obtained from a specific service level.

The benefit would typically come in the form of increased revenue, profitability, or competitive position. The costs that must be evaluated include the cost of increased inventory, premium transportation, or faster communication.

The evaluation of both considerations should be completed by a market segment since it may be desirable to define specific segmental strategies. There may be one segment that requires high product availability, while another segment may place more emphasis on low cost. The final outcomes of this task are specific objectives and strategies for each segment, along with the supporting material to defend them in light of other possible resource allocations.

5.2 Performance measurement

The measurement system should ensure that resources are assigned and monitored to achieve managerial objectives. Logistical performance should always be measured relative to the operational plan. Without an operational plan, measuring performance is very difficult, if not impossible.

Logistical measurement is management by exception. The comprehensive and detailed nature of logistics requires that management review be limited to the deviations from anticipated results.

There are several kinds of methods; productivity ratios, flexible budgets, standards, control charts, and audits, which can be used to measure performance and control logistics costs. Each method is discussed below.

5.2.1 Productivity ratios

Productivity ratios are the most simple form of management controls and involve the comparison of different physical and/or financial measures. These ratios can be used to monitor the performance of overall logistics operations, various functions or individual work activities (Magee et al., 1985, p 236).

These ratios are easily developed, readily understood and can uncover problem areas or indicate opportunities to investigate for potential improvement. However, productivity ratios are limited in their usefulness (Magee et al., 1985, p 237). First, they compare current performance against the past performance or the performance of similar operations - not against some objective standard of performance. Second, the productivity ratios generally do not distinguish between variable and fixed cost components, and therefore different operating levels of activity may greatly influence the productivity ratio. Third, the operating characteristics often differ for different facilities and companies, and therefore a simple comparison of productivity ratios may not be an appropriate measure of relative efficiency.

5.2.2 Flexible budgets

Flexible budgets are a common and useful method of logistical management control. Flexible budgets can vary with the level of activity. The fixed and variable cost components are separately identified, and a planned level of expenditure is computed for an actual operating level. Actual expenditures are compared against this budget, and the resulting difference or variance is analysed to determine if the difference in planned and actual performance was due to product mix changes, activity efficiencies or inefficiencies, or cost/price differences (Magee et al., 1985, p 238).

5.2.3 Standards

Standards, used as part of a flexible budgeting system, could provide the most effective management controls. Standard costs are based on predetermined costs, not historical costs. Standard costs are generally determined from industrial engineering studies, where operations and work activities have been analysed to determine efficient and reasonable operating rates for a given task.

Standards for distribution activities are at times difficult to determine because of the complex and causal relationship of many distribution activities. However, the costs of limitations standards may be developed for all logistics functions (transportation, warehousing, inventory, etc.) and for any logistics level or component (logistics subfunctions and individual work activities).

5.2.4 Adaptive control

Schary (1985, pp 43-44) has suggested that the focus of logistical control should be to respond to change by projecting possible future system states. This can be accomplished to some extent through flexible budgeting, and projecting fixed and variable costs separately. However, in some cases the response of flexible budgeting may be inadequate.

The focus should, therefore, be on adaptive control; management seeks comparison with a planned future, not the past. Adaptive control should not assume a continuation of the past, but possible future conditions, in order to plan for response and guide decisions. The control problem both precedes, includes, and follows the decision problem. The first objective in control is to detect change; second, to determine the significance for action, leading toward decision making and then to evaluate performance.

Adaptation requires the ability first to foresee future conditions and then to respond, comparing performance to the standards which have been projected. In general, an adaptive control system operates with both a feed-forward (projective) system and a feed-back (analytical) system.

5.2.5 Other methods

Not all performance data is best presented in a numerical form. Trends and activity performance that is out of control can be easily detected when performance levels are graphically presented. A popular type of control chart in industrial quality control applications is applied to the control of customer service. The upper and lower limits for service are based on standard statistical procedures. When either the trend becomes suspect or the service level falls outside the limits, the manager may wish to take action at that time bringing service back within its limits. This type of chart may be developed for logistics activity costs as well (Ballou, 1978, p 419).

Performance measurement on a regular basis is not always accurate. Reports may indicate that activity performance is within acceptable limits when, in fact, it is not. Because there can be reporting errors and because regular reporting does not have total coverage of the logistics system activities, it is necessary to take stock of the situation from time to time. (Ballou, 1978, p 420)

Several types of audits are popular in logistics control. Inventory audits are conducted at least on an annual basis by firm that maintains raw materials, in-process goods, and finished goods stocks. Stock counting is generally necessary for tax purposes, but a logistician can use the audit to correct any discrepancies in the accounting records. Such audits are periodically necessary, because errors occur in records due to common causes such as inadequate reporting of stock depletions and returns, and theft of stock.

The total function of an audit is becoming increasingly popular. An audit examines the logistical activities as a whole to assess the overall status of logistical costs and performance. The market, financial, legal, supply, and governmental regulation environment, can change at apace that can go undetected by management over long periods of time.

Different kinds of audits may be conducted for specific purposes. These might focus for example, on customer service, materials handling efficiency, transport fleet utilization, or vendor performance.

5.2.6 Performance measurement of logistics key elements

According to Kearney (1984, pp 46-47), there four separate stages for measuring the productivity and performance of transportation, warehousing and inventories.

Service level. Customer service performance may be measured with respect to availability, capability, and quality (Bowersox et al., 1986, pp 27 and 97).

Product availability measures the ability to provide a product when it is desired by the customer. This may be measured in term of the per cent of orders, units, or lines that can be filled from existing stock. Other measures may be lines shipped complete or orders shipped complete. The shipped complete measures record the percentage of instances that orders or lines can be completely filled from existing stock.

Customer service capability measures are order cycle time, distribution system flexibility, and malfunction handling capability. The order cycle time is the customer's perception of the elapsed time from when the order is placed until the shipment is received. The cycle time measures include average time and time variances associated with order communication, order processing, order consolidation, backorder delay, and delivery time.

The flexibility measure evaluates the capability of providing special services for orders such as processing back-orders, providing substitute products, expediting orders, and providing faster transportation. The flexibility measure must record the relative effort involved in the changes and the enterprise's ability to respond.

The malnufunction correction capability measures the ability to respond to problems such as errors or damage. The errors may involve order entry, processing, picking, or shipping errors when an incorrect product or incorrect amount is sent to customer. Damage may be incurred in the manufacturing process, warehouse handling, or transportation. The measures that are appropriate to the malfunction include the number and percentage of orders that are incurred in a malfunction, the corrective responses taken, and the cost of correcting such malfunctions.

The service measures that are quality related are information and product support. These measures evaluate the ability to provide pre- and post-transaction support for the customer in terms of both information and service. The information measure records an enterprise's ability to respond to customer inquiry for order and inventory status. The second quality measure concerns product support at all points in the transaction. An enterprise demonstrates product support ability by providing technical advice as well as maintenance and repair services. These measures can be reported in terms of availability, accuracy, and completeness of technical product information.

Transportation. At Stage I, transportation costs are often compared to some type of macro output such as sales in money. Thus a common Stage I measure could be total transportation costs as a percent of sales.

In Stage II, physical measures and activity budgets are introduced for transportation activities. Units such as weight stops, orders, kilometers, etc. are tracked within the transportation activities over shorter time intervals such as days or weeks. At this point, these physical units can be measured against transportation labor or non labor costs to track the cost per ton, per km, per stop, or per ton- km.

Stage III requires the establishment of goals for the overall transportation operation. These goals could be in the form of physical units or period operational costs, but in either case could lead to the measurement of performance (actual versus standard). Transportation requirements can be converted to standard hours of work, vehicle loads, or money of cost, for instance. Included here would be the actual cost versus the budgeted cost analyses as well as variance analyses highlighting the reasons for budgetary variance.

In Stage IV, physical performance data are merged with financial data to provide the management with an overall view of the transportation operation. Armed with this type of measurement system, the management is in a position to control ongoing operations as well also test alternatives and seek trade-offs to present operation.

Warehousing. Stage I pertains the development and use of raw data in terms of money. At this stage, these costs are often compared to some type of macro output as money sales.

At Stage II, physical measures and activity budgets are introduced for warehouse activities. Units such as weight, lines, orders, etc., are tracked within the warehousing activities over shorter time intervals. At this point, these physical units can be measured against warehouse labor hours, and warehouse labor and non-labor cost. The introduction of time phased activity budgets is now possible with this data.

Stage III requires the establishment of goals for overall warehouse and warehouse activities. These goals may be in the form of physical units or operating costs, but can lead to the measurement of performance. The productivity trade-offs among warehousing activities can be quantitatively gauged at this level.

Stage IV incorporates the use of physical performance and budget performance measures to evaluate trade-offs across logistics activities.

Inventory. In Stage I, the data are generally reported in values of money (e.g. total inventory money value). These macro measures may also be compared with some overall measures during Stage I such as total money sales.

A refinement of the performance measurement system occurs in Stage II when the measures of inventory are instituted by product category. This stage also includes the development of planning and control procedures of these functions including a time phased procurement plan by product group, an inventory stock status reporting system, and monitoring of shop-floor compliance with production schedules.

Stage III introduces the use of standards, budgets and goals in the form of inventory levels. This stage includes the comparison of actual performance to goals and the determination of variances.

The formal integration of inventory with other company objectives indicates the Stage IV measurement. Customer service goals and sales forecasting have been considered in inventory function to this point, but more in the manner of dictating requirements. Stage IV sees the merging of company objectives, with a constant updating of functional objectives and needs.

5.2.7 Corrective action

The managerial control process is not complete until a comparison of performance with goals or standards has been made and corrective action is taken if performance levels are outside of the normal acceptable limits. There are basic ways in which the comparison is made (Ballou, 1978, p 422). First, it may be made by the manager, who simply applies his judgement and experience to the reports received to decide whether some action should be initiated to adjust logistical activities in order to bring them back in line with planned performance.

Second, the versatility of digital computers has encouraged the automation of the control process. Computer systems may be designed so that the manager is not directly involved in routine control. In this sense, it is automated control.

Corrective action often depends on the degree to which the logistical activities are out of control. In practice there will always be a variation in logistical activities due to a constantly changing environment for these activities. The transport service cost might be vary due to weather, fuel costs, economic conditions, and routes that must be used.

The inventory carrying cost might change due to the interest rate on capital, customer requirements for stock availability, and variations in demand and lead time.

When minor adjustments do not bring cost and performance into line, major replanning may be necessary. Existing facilities, locations, inventory stocking policies, transport services, and warehouse and materials handling methods may have become obsolete over time. Practically the only option for a logistician is to conduct a careful examination of the logistics systems or its subactivities.

5.2.8 Information systems

It has long been recognized that managerial control performance is closely linked to the quantity, form, and accuracy of the information available on the subject (Ballou, 1978 p 330).

In this chapter, the management information system, as it aids in controlling the logistics system is discussed. The logistics information system (LIS) is a subsystem to the management information system (MIS). It provides the information that is needed specifically for logistical management. According Ballou (1978, p 331) and Bowersox et al., (1986, pp 332-334) logistical needs can separated into four levels.

The lowest level refers to transaction and inquires. At this level information flow is concerned with the execution of the operational plan. A stream of transaction documents signals a need, and the action document identifies the appropriate steps necessary to meet objectives.

There are two important features concerning the flow of information at this level. First, information deals with the day-to-day activities of the business on a transaction basis and then with the execution of predetermined programs. The second feature of the information flow at the this level is the accumulation of records to formulate a data bank for all other levels of control.

The next level of the information system involves first line-line supervision. This level is concerned with the accumulation of information regarding deviations from the initial plan. It is important to realize that the scope of the information reviewed at the this level is reduced considerably in comparison to the direction level.

Tactical planning and control is an extension of the management at the supervisory level. The assortment of information presented at this level will be very selective. Evaluation of inventory-control limits, supplier evaluation, carrier selection, planning warehouse layout, and transportation needs are examples of tactical control problems.

Finally, strategic planning involves setting the goals, policies, and objectives, deciding on the overall logistics structure, and determining the resources needed for the supply-distribution task. The speed of information is rarely critical, and the information system is interrogated only infrequently.

As noted earlier, each level is concerned with system monitoring as well as reporting exceptions. However, as information flows from the lowest level to the highest level, the subject matter decreases in quantity and increases in importance to the welfare of the enterprise.

6 Summary

The control process is one of the most complex aspects of logistics management and the problems of controlling logistics activities are nowadays common to most organizations. These problems usually stem from differences in orientation between logistics and other functions of organization such as marketing, production, purchasing, etc. and between the logistics mission and the central logistics concept of integrated product flow.

Therefore it is necessary to design a control system for the different management levels. Level I is the functional activity center. Level II is the logistics system management. And Level III is the general management. Information requirements vary substantially among these levels. Level I managers are concerned with controlling operations. The management at Level II is

concerned with planning, directing and controlling the logistics system as an integral unit. The impact of the market and strategy is directly felt at general management level.

The logistics control system involves (1) setting goals and standards for performance, (2) measuring performance, and (3) taking corrective actions.

Various methods such as productivity ratios, flexible budgets, standards, control charts, and audits, can be used to measure the performance of logistics activities.

The performance measurement system can be classified into four different stages. Stage I measures depend heavily upon gross financial measures such as logistics cost as a percent of sales to track logistics productivity.

At Stage II the control system takes a finer cut at financial measures and will also track some physical productivity measures.

At Stage III systems compare actual productivity against engineering or other standards. A Stage IV system integrates the Stage III performance measures with a formal budgeting system across the activities within logistics.

The methods described above provide a comparison to past operations, preserving in effect a steady-state system through feedback data. The nature of the problem in logistics is change: in products, customers requirements and competition, as well as new elements within the logistics system. The focus must be, therefore, to respond to change by projecting possible future system states. The focus should be on adaptive control; management seeks comparison with a planned future, not past. Adaptive control should assume possible future conditions in order to plan for response and guide future decisions.

The availability of information has often been a problem when controlling logistics activities. The challenge in logistical controllership is format required data in a manner that results in consistent performance information and measurement. All levels of management control require timely and accurate data. It has been suggested that from logistical viewpoint, the ideal management information system includes four different levels; the operative or transaction level, the supervisory level, the middle management level, and the top management level.

It has been claimed that a logistical control system can be only as effective and as efficient as the management information system that guides its destinity.

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