

Distribution Channel Performance Measurement: Valid Measures From Customers' Perspective

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Abstract : This paper is structured into three main parts and a conclusion. The main section provide definitions of efficiency, effectiveness and performance in terms of the distribution channel, followed by a review of related performance measurement, before discussing difficulties of measurement. According to the theoretical approach, it appears that key theoretical issues are centered around customer service, logistics excellence, time compression, the use of IT, and a move towards integrated logistics. The empirical approach shows that in the past, various financial performance indicators were regarded as relevant management information. However, today, management needs additional performance indicators. Therefore, external assessments of effectiveness must be performed to measure customers'satisfaction with the physical flow of product through the distribution channel network. So, what is needed is to take previous normative and explorative research and progress through a framework by developing valid measures of distribution channel's effectiveness and efficiency, and identifying research methodologies suited to the data collection requirements.

Key words : Distribution channel, Performance measurement, Time compression, Integration, Lean & Agile

1. Introduction

Since the 1970s, companies have become more global, resulting in complex production and distribution networks, and in flows of goods across oceans and borders. The management of these complex distribution systems has become a real challenge to logisticians.

In the 1960s the business world first introduced logistics concepts to the management of material flows after Converse (1954) identified the need for academicians and practitioners to examine the distribution side of marketing. At the time it was a major rethink of the way firms, especially manufacturing firms, organised and managed their distribution activities. Since that time, managerial attitudes to distribution have been transformed. Today, distribution is generally considered to be a major cost centre, an important marketing tool, and a critical determinant of profitability.

However, the choice of an distribution channel is often made with limited information. Managers know that distribution channel can be more effective in certain situations, but the criteria used to evaluate a distribution channels' performance have not been clearly defined. Because the criteria are not clearly defined, determining when to change the distribution structure or even the distributor is difficult. Whenever a firm is involved in business, being able to measure what is happening is crucial to the ability to

make constructive changes. Also, evaluation criteria will provide information for rationally selecting an alternative distribution channel structure. The ability to evaluate a distribution channel's performance precisely can lead to increased distribution channel efficiency, along with increased satisfaction of all parties concerned.

This study presents a review of the literature which provides the premise for distribution channel performance measurement. After the introduction, the second section commences with a definition of efficiency, effectiveness and performance in terms of the distribution channel. The third section consists of two sub-sections. The first sub-section reviews the theory of distribution channel efficiency and effectiveness, which provides the theoretical framework for this study. The primary objective of this section is to provide an understanding of previous studies on distribution channel excellence and performance. The second sub-section examines the empirical literature on distribution channel performance measurement. The fourth section outlines difficulties in measuring distribution channel performance and the final section provides a conclusion of this study.

2. Definition of distribution channel efficiency, effectiveness and performance

Distribution channel is companies or individuals that participate in the flow of goods from the manufacturer to

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the customer. In distribution channel, effectiveness is generally defined as the extent to which an objective has been achieved and efficiency refers to the degree to which resources are used economically (Gleason & Barnum, 1986). Within the current context, effectiveness involves identifying appropriate service elements and efficiency means achieving adequate performance of those elements without wasting resources (Ellinger et al., 1997).

The efficiency component contains an actual measurement contrasted with a standard measurement. The actual measurement refers to the actual use of some company resources, such as time (e.g., man-hours or equipment-hours), dollar value, space, or unit of energy. The standard resources are usually expressed as the amount budgeted, planned, or standard amount used. The effectiveness component contains the dual goal criteria of cost and customer-service levels and should be part of the standard output value.

Performance measurement needs to be transferred to efficient and effective performance management (Amaratunga et al., 2002). The rationale behind this is that measurement, of itself, cannot contribute the firm's overall performance, but by facilitating the outcomes of measurement a company is able to control its entire operations.

Therefore, it can be said that a good performance management provides organizations with opportunities to improve their activities and methods to cope with necessary changes for the organizations' future, based on the performance measurement which diagnoses the current situation (finances, customer satisfaction and business process results) towards specific objectives and identifies the critical or uncritical elements.

3. A review of distribution channel performance measurement

3.1 The Theoretical Approach

1) Customer Service

In the late 1970's the customer service concept first introduced. At that time customer service has been defined as activity driven, as a performance level, and as a management philosophy. One of the most dramatic and important changes in customer service has occurred as a result of the deregulation of the transport industry. Transportation firms were forced to fight for customers, competing on the basis of service as well as cost. There are three basic ways that distribution channel creates customer value for its customer: effectiveness, efficiency,

and differentiation. Many of today's most progressive and successful firms emphasise distribution channel as a competitive differentiator. These firms focus on creating or adding value for the customer

In A.T.Kearney's research (1991), effectiveness was measured by the percentage of all orders that were delivered on or before the date the customer requested delivery. They said that the most arduous measure criterion would be on time delivery to the customer of complete orders of first quality. Through stock holding, companies can increase customer service levels, however, the true cost of holding stock is often thirty per cent or more of its value per annum (Coyle et al., 1996), and increasing inventory may not necessarily increase customer service as the lines in stock may not match with actual customer requirements.

Collins et al. (2001) indicated that factors for measuring customer service and the importance attached to those factors are different from industries, markets, and customers, moreover, they have been changed over time. Therefore, it is necessary to evaluate the customer service periodically to gain competitive advantages. Although there are a variety of elements were used for evaluating customer service, it was revealed that the most repeatedly utilized element for customer service was the product availability (order completeness, order accuracy and stocking levels), followed by order cycle time (order transit times, time for assembly and shipping) for most manufacturing companies.

2) Logistics Excellence

In 1995, Stewart indicated three keys to supply chain excellence through his supply chain performance benchmarking study. The first key to supply chain excellence was delivery performance which generated customer satisfaction. Interviewed best-in-class performers discussed other approaches to improve order fulfillment lead time and delivery that did not require the same trade-offs which meant achieving a high level of customer service with a low level of inventory.

Flexibility and responsiveness is the second key to supply chain excellence and includes production flexibility, re-plan cycle, and cumulative source/make cycle time. These have been developed to capture cycle time across the entire supply chain. Managing the cycle times of the various supply chain processes is a crucial enabler of outstanding customer delivery performance.

Flexibility becomes more critical as production life cycles shorten. One measure of production flexibility is the speed with which production can achieve a sustainable unplanned

twenty per cent increase in output. This is because a company experiencing, say, a twenty per cent increase in demand can meet this by achieving flexibility in its sourcing and manufacturing.

Modern supply chains are expected to respond rapidly, effectively and efficiently to changes in the market place. Simultaneously there is the drive to achieve world-class customer service levels coupled with Minimum Reasonable Inventory (MRI). Through a literature review, Menzer & Kahn (1995), pointed out three areas of weakness for most companies, namely, a lack of external linkages with customers and suppliers in improving logistics service; insufficient integration of the logistics planning process with other departments within the company; and underdeveloped employee involvement and training.

These weak areas are directly related to efficiency. An effective logistics process is essential to satisfy customers and gain competitive advantage. Today, most leading companies satisfy customers through distribution channel excellence. This means that through distribution channel excellence companies can rise above the traditional conflicting objectives of low costs, time compression and high quality.

3) Time Compression & Information Technology & Integration

A variety of scholars have applied time-based management concepts across operations in the supply chain. According to Stalk & Hout (1990), time is a fundamental business performance variable. Response time, lead time, on time are important success factors. It has been suggested that most failures in performance and competitiveness are due to excessive cycle times in the manufacturing/marketing or design/development cycle (Thomas, 1990). The rationale for such a conclusion is that in a number of growing industries we have seen how companies that exhibit both the ability to introduce new products to the market quickly and to respond to customer requirements rapidly, outperform those companies that lag behind in these areas.

Recently, the concept of time compression has been gaining increased popularity in performance measurement. Eliminating non-value added time in the business process allows firms to improve customer service and minimize total costs simultaneously. In addition, time compression leads to increasing overall productivity, improving quality and shortening cycle times while promoting advanced goods to marketplace (Loi Teck Hui, 2004). The author recommended that the effort to integrate value chains and value systems results in business timeliness as a result of

empirical analysis applying the time-based process mapping technique to the resource-based firm. Finally, the research also presented the time compression triangle among people, strategy and technology to sustain business cycle timeliness.

According to Jones & Towill (1998), any business operating within a product delivery supply chain is faced with an Uncertainty Circle. This is a major problem area and has four aspects associated with the supply side, the manufacturing process, the control systems, and the demand side. Whereas uncertainty caused by the first two processes may be considerably reduced via the application of lean thinking principles because they are under the direct control of the business, the last two require an understanding of total systems behaviour. In particular, the availability of un-distorted market place data throughout the chain plus proven decision systems will shrink the Uncertainty Circle dramatically. Jones & Towill (1998) illustrated the methodology through simulation and observed improved business performance in a real-world supply chain. Therefore, by improving information flow in the distribution channel, a company can reduce uncertainty, damp down the Forrester effect, and consequently reduce inventory.

Information technology (IT) is one of the few productivity tools that is both increasing in capability and decreasing in cost simultaneously. Many authors have promoted information technology as a means to enhance distribution competitiveness. There is no doubt that effective distribution channel management can provide a major source of competitive advantage. Consequently, the goal of a distribution channel manager must be to link the end customers, the channels of distribution, the production processes and the procurement activity, while ensuring that the total cost for customer service is lower than that of any competitor. One of the critical and enabling factors for the achievement of this goal is the effective use of information technology.

Integrated logistics management focuses on co-ordinating all logistics activities in a system that will simultaneously attempt to minimise total distribution costs and maintain desired customer service levels (Gopal & Cypress, 1993; Kenderdine & Larson, 1988). Through adopting the integrated logistics concept, firms can achieve more efficient logistics operations and tangible results. Previous research has shown a linkage between integrated logistics and increased efficiency and productivity (Gustin et al., 1995; Larson, 1994). Benefits in the form of inventory reductions, shorter lead times, customer service enhancements, and

improved forecasting and scheduling have been identified. It appears that key theoretical issues are centered around customer service, distribution channel excellence, time compression, the use of IT, and a move towards integrated distribution channel.

4) lean & agile (Leanness & Agility)

As the global market is becoming more turbulent as well as the customers' demands are changing inconsistently, suppliers are required to adopt the concepts of 'leanness & agility' for their distribution channel to cope with unexpected variation. Those 'lean & agile' notions on distribution channel is not brand new, rather, it was derived from the previous theoretical issues of logistics. Namely, lean and agile management of distribution channel means more flexible, responsive and customer-oriented performance with better utilization of time and IT through the integrated distribution systems.

In 2002, Towill D. et al. defined the concepts of 'leanness' and 'agility' as follows:

"...Lean is about doing more with less, a reasonable business objective as long as customer satisfaction is maintained. The term is often used in connection with manufacturing to imply a 'zero inventory', just-in-time (JIT) approach... and agility is a business-wide capability that embraces organization structures, information systems, logistics processes and, in particular, mindsets..."

The authors stated that the lean concept is suitable for stable and predictable market-places in order to manage supply chain efficiently, therefore, it can be concluded that lean management focuses on the efficiency of supply. On the other hand, the agility retaining flexibility feature is desirable in the context of where demand is volatile and diverse. Agility is essential for running supply chain more effectively and flexibly to accommodate unique customer demands (Christopher, 2000).

In Bruce M. et al.'s research (2004), three different approaches to supply chain management were described within the textiles and clothing industry. First of all, lean retailers must be able to replenish and ship products by means of bar codes, EDI as well as shipment marking so that they can remove related waste of time and resources within the manufacturing firms. The agile supply chain has the characteristic of responsiveness to react adequately to actual real time changes in demand. The information technology plays a major role in the agile distribution channel management in order to share data between manufacturers and customers. The term 'leagile' mixes the leanness and agility at a decoupling point for optimal

distribution channel management. Consequently, leagile concept takes advantages of cost effectiveness and high level of customer service in both upstream and downstream distribution channel.

Collin J. & Lorenzin D. (2006) suggested that continuous customer-oriented demand planning is needed for increasing agility in supply chains after researching mobile infrastructure industry in the form of case study. It is largely because that the attempt to understand demand and market circumstances leads to better well-balanced management which ensures the agility for suppliers despite the difficulties of forecasting the demand exactly.

The distribution channel strategies are critical for its efficient and effective management, eventually, for the success of firms. From companies and industries the features of demand are varying, and the uncertainties and changes are also multifarious. Accordingly, understanding the relevant industries' distribution channel is a prerequisite for achieving lean and agile distribution channel performance.

3.2 The Empirical Approach

Since 1984, the concept of how to measure satisfaction has undergone a gradual metamorphosis. From the direct measures of "are you satisfied?", and gap analysis using performance and expectations, the measurement of satisfaction has moved towards the direct measurement of performance.

Gattorna, et al. (1991), identified critical variables that are measurable to monitor performance effectiveness and efficiency. First, for measuring customer service effectiveness, they identified the following eight variables: order cycle time, fill rate (percentage ordered versus delivery), order consistency (variance in delivery time), response capabilities to customer enquiries, ability to adjust order quantities, ability to change requested delivery dates, ability to interact with production schedules, ability to substitute or back-order line items. Second, for measuring efficiency related to each functional activity, they identified transportation, warehousing, inventory, management, production planning/scheduling, and order entry/processing. Third, inventory, primary production and warehousing, company-owned vehicles were identified for measuring utilization of assets. Fourth, the variables competitive practice and performance with respect to customer service and asset utilization were identified.

In 1995, Gustin et al. developed six hypotheses concerning the relationship between information and successful implementation of integrated logistics within a firm, and conducted a questionnaire survey to all firms listed in the

Council of Logistics Management (CLM) membership directory. Each survey participant was asked to provide information regarding their perceptions of the status of integrated logistics implementation efforts in their firm. According to the survey results, a strong relationship between high levels of information availability and successful implementation of the *integrated distribution concept* was found.

In 1997, Ellinger et al. studied the relationship between integrated logistics and customer service. They examined how well firms were doing in responding to customers' requests and whether a proposed linkage between integrated logistics and customer service could be documented. More specifically, the research sought to determine whether firms that had implemented the integrated logistics concept could more easily accommodate customer requests. The result provided an indication of the respondent firms' relative abilities in the eight customer service areas sales/marketing incentive programmes, product introduction, special customer service requests, returned goods, product phase out, product recall, product modification while in your possession, and customisation of service to specific markets/customers..

The researchers found a strong linkage between adoption of the internally integrated logistics concept and customer service capabilities. According to the research, logistics executives in integrated firms reported significantly greater ease in accommodating service requests than executives in non-integrated firms. However, the study employed a rather subjective measure of integration, i.e. the respondents' perceptions of their firms' integration levels. This limited the generalisability of the results. An additional research study is needed, utilising more quantifiable or 'hard' measures of integration. Also, further research is needed to explore the linkage between external integration and customer satisfaction.

Recently, Ward P. & Zhou H. (2006) highlighted the important correlation between IT integration and lean/JIT practices. More specifically, the authors conducted empirical research among 769 manufacturing firms for intensifying the lead time performance with interfirm IT integration, intrafirm IT integration, and lean/JIT practices. They found that successful implementation of lean/JIT practices totally adjust the effect of between-firm and within-firm IT integration and vice versa. In short, the result of this study implied that companies must facilitate IT integration such as resource planning systems adequately with lean/JIT practices when they want to lessen lead time.

Based on previous studies following distribution channel performance measurement model is established.

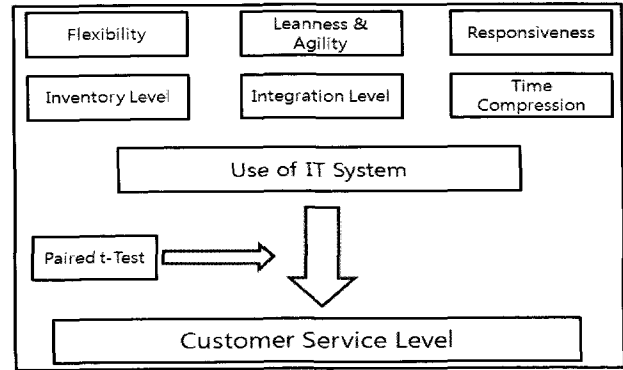


Fig. 1 Distribution channel performance measurement model

4. Difficulties in measuring distribution channel performance

In recent years companies have focused more and more on distribution as competitiveness parameters. However, one of the most critical aspects of distribution channel management, and yet what seems to be the least managed, is measurement and evaluation of distribution channel performance. Evaluating a company's distribution performance is extremely difficult, because of the variable characteristics of products in the supply chain and, further, company data relating to logistics performance are not standardised between companies.

In addition, quantifying all aspects of distribution channel performance is also very difficult, and makes inter-company comparisons difficult if not impossible. Products are often subject to value-added processes in manufacture or transport that result in an expansion of volume or different handling requirements. Unless an extensive audit is undertaken of the distribution channel for each company, it is difficult to make a detailed assessment of distribution channel performance in relation to the price paid for distribution channel services.

Most known performance measurement ratios reflect an accounting or management-science orientation to identify inputs (analogous to direct costs) with outputs in some measurable form (such as miles driven, gallons of fuel used, or total pieces unloaded). However, one major problem with the selection of the variables used is that the measures typically chosen do not entirely measure all aspects of the actual inputs and outputs. The measures, by necessity, are fragmented and include only a partial accounting of the full picture. The underdetermination problem gives an inherently flawed measure which, unfortunately, may be used for decision-making, consequently carrying the defective information through to the managerial level. Thus, it is important to select performance measurement criteria and to establish performance measures carefully.

The effectiveness measurement is much more difficult than measuring the efficiency dimension of distribution performance. Distribution activities favourably impact on future demand to the extent that customers are satisfied with the distribution services provided in the distribution channel. Therefore, external assessments of effectiveness must be performed to measure customers' satisfaction with the physical flow of product through the distribution channel network. As Rhea & Shrock (1987) pointed out two decades ago, this control task poses two research problems: developing valid measures of distribution effectiveness and identifying research methodologies suited to the data collection requirements

In the past, various financial performance indicators were regarded as relevant management information, however, today, management needs additional performance indicators. Many dimensions of distribution channel performance lend themselves well to hard performance measures. Hard performance measures such as net income or order fill rate are typically impersonal, accurate, and easy and inexpensive to collect. Measures such as net income, and accounting ratios such as Return On Investment (ROI) are useful ways of capturing profitability, and are often easy and inexpensive to collect too, particularly where distribution channel is treated as a profit centre. Profitability is an especially useful goal because it directly reflects the goals of all of the organisation's internal constituent groups to one extent or another, although it may not be a good indicator of the viability of the firm in the long run. Cost accounting measures may also be useful particularly in evaluating several dimensions of efficiency. The data are often highly accurate and, in many cases, available over long periods of time.

Also, these measures are not always comparable between one organisation and another. Changes in accounting practices may even inhibit valid comparisons with the same organisation over time and international comparisons are notoriously difficult to make. Furthermore, financial measures and cost accounting data are often considered confidential, and many firms are reluctant to release information to outsiders. In making comparisons between organisations or time periods, variations in standards or accounting methods are a frequent threat.

For service measures such as order cycle time or lead time variability, the advantages and disadvantages are essentially the same as those of performance indicators. One limitation common to both is that there are many dimensions of performance which they cannot capture, particularly the extent to which customers are satisfied.

The difficulty in capturing customer satisfaction is the underlying reason that hard measures should be supplemented with "soft" perceptual ones.

Moreover, customer satisfaction cannot be captured by hard measures. A set of soft measures, collected using techniques such as the mail survey, telephone interview, or similar method are needed. Besides their usefulness in identifying problems, soft measures may also be called for where available hard measures are not comparable between one organisation and another because of differences in accounting standards or similar problems. These measures are subject to the limitations inherent in any self-report, such as consistency bias, and the social desirability problem.

However there is no single test or measure of distribution channel performance. Absolute service levels measure only what has been achieved, not what is required. Cost or productivity levels are hard to compare across firms because of difference in operations and product price when using cost as a percentage of sales as a measure.

Table 1 Strength & Weakness of "hard" & "soft" measures

Measures	Strength	Weakness
Hard measures (net income, order fill rate, accounting ratios)	Impersonal Accurate Easy and inexpensive to collect Easy to quantifiable	Difficult to make comparisons Financial measures and cost accounting data are often considered to confidential Variations in standards Difficulties lies in quantifying all aspects
Soft measures (customer satisfaction ratings)	Useful to identify problems Easy to make comparisons	Hard to generalize the results Difficult to make a detailed assesment Personal Difficult to select variables which measure all aspect Collected using techniques are needed (mail survey or inter-views)

5. Conclusion

In summary, the definition of performance is a challenge for researchers in any field of management. Some define goals in terms of profits. Others may choose goals such as customer service or sales maximisation. Furthermore, difficulties exist in the tasks of selecting and developing adequate measures for the chosen definition. "Hard" measures (such as net income or accounting figures) and "soft" measures (such as customer satisfaction ratings) each have associated strengths and weaknesses.

This article began with the definition of distribution channel efficiency, effectiveness, and performance, and then

reviewed difficulties in measuring distribution channel performance from the existing literature related to performance measurement. Only a few research studies have been undertaken in this field of study. Furthermore, during the last decade, most studies about logistics were normative, exploratory and descriptive. This indicates that most studies related to logistics examined what ought to be and what organisations and individuals ought to do. The second largest publication category was exploratory studies, i.e. research that makes observations of distribution channel for the purpose of developing theories, but leaves the testing of the theories to other studies. These findings suggest that present logistics research has a large degree of substantive justification, but little subsequent theory development and testing. In the international distribution channel sector, it is important to have a good performance in operations.

In order to achieve high performance levels, it is critical to know which operational factors are important for success and which are less important. In this research, distribution channel effectiveness is defined as "the extent to which distribution channels satisfy customers" and therefore efficiency can be measured by the cost of delivering that level of customer service. Consequently, an excellent distribution channel can be defined as the distribution channel which achieves a high level of customer service with low level of inventory which is in the trade-off relations. To achieve both at the same time, there are only two ways which are shortened lead time and ability to forecast more accurately. For this, Information technology and integration are necessary. Therefore, what is needed is to take these normative and explorative research and progress through a framework by developing valid measures of distribution channel's effectiveness and efficiency, and identifying research methodologies suited to the data collection requirements.

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References

- [1] Amaratunga, D. and Baldry, D. (2002), "Moving from performance measurement to performance management", *Facilities*, VOL20 NO 5/6, pp.217-223
- [2] Anthony, R. N., Dearden, J., and Govindarajan, V. (1992), "Management Control Systems", Irwin, Boston.
- [3] Christopher, M. (2000), "The agile supply chain: competing in volatile markets", *Industrial Marketing Management*, VOL 29 NO 1, pp.37-44
- [4] Collins, A., Henchion, M., and O'Reilly, P. (2001), "Logistics customer service: performance of Irish food exporters", *International Journal of Retail & Distribution management*, VOL 29 NO 1, pp.6-15
- [5] Collin, J. and Lorenzin, D. (2006), "Plan for supply chain agility at Nokia-lessons from the mobile infrastructure industry", *International Journal of Physical Distribution & Logistics Management*, VOL 36 NO 6, pp.418-430.
- [6] Coyle, J. J., Bardi, E. J. and Langley, C. J. (1996), "The Management of Business Logistics", West Publishing Company, New York
- [7] Ellinger, A. E., Daugherty, P. J. and Gustin, C. M. (1997), "The Relationship Between Integrated Logistics And Customer Service", *Logistics and Transportation Review*, VOL 33 NO 2, pp.129-138.
- [8] Gattorna, J., Day, A., and Hargreaves, J. (1991), "Effective Logistics Management", *International journal of physical distribution and logistics management*, VOL 4 NO 2, pp.3-82.
- [9] Gleason, J. M. and Barnum, D. T. (1986), "Toward Valid Measures of Public Sector Productivity : Performance Measures in Urban Transit", *Management Science*, VOL 28 NO 4, pp.379-386.
- [10] Gopal, C. and Cypress, H. (1993), "Integrated Distribution Management : Competing on Customer Service", *Time and Cost*, Richard D. Irwin Inc, Burr Ridge
- [11] Gustin, C. M., Daugherty, P. J., and Stank, T. P. (1995), "The Effects of Information Availability on Logistics Integration", *Journal of Business Logistics*, VOL 16 NO 1, pp.1-21.
- [12] Hui, L. T. (2004), "Business timeliness: the intersections of strategy and operations management", *International Journal of Operations & Production Management*, VOL 24 NO 6, pp.605-624
- [13] Jones, R. M. and Towill, D. R. (1998), "Total Cycle Time Compression and The Agile Supply Chain", *International Journal of Economics*, 62, pp.61-73.
- [14] Kearney, A. T. (1991), *Leaders & Laggards in Logistics '91*, The Institute of Materials Management, London
- [15] Kenderdine, J. M. and Larson, P. D. (1988), "Quality and Logistics : A Framework for strategic integration", *International journal of physical distribution and Materials management*, VOL 18 NO 7, pp.5-10.
- [16] Menzer, J. T. and Kahn, K. B. (1995), "A Framework of Logistics Research", *International journal of physical distribution and logistics management*, VOL 16 NO 1,

pp.231-249.

- [17] Stalk, G. Jr. and Hout, T. M. (1990), "Competing Against Time - How Time-based Competition is Reshaping Global Markets," Collier Macmillian Publishers, London
- [18] Thomas, P.R. (1990), "Competitiveness Through Total Cycle Time," McGraw Hill, London
- [19] Towill, D. and Christopher, M. (2002), "The Supply Chain Strategy Conundrum: To be Lean Or Agile or To be Lean And Agile?" International Journal of Logistics Research and Applications, VOL 5 NO 3, pp.299-309.
- [20] Tunc, E. A. and Gupta, N. D. (1993), "Is Time a Competitive Weapon among Manufacturing Firms?", International Journal of Operations & Production Management, VOL 13 NO 3, pp.4-12.

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