Available online: www.ijsrmes.com

International Journal for Scientific Research in Modern Engineering and Science

International Journal for Scientific Research in Modern Engineering and Science, 4(3): 55- 75 (2023)

A REVIEW ON METRICES OF PERFORMANCE EVALUATION OF VARIOUS SUPPLY CHAIN AND SERVICE SUPPLY CHAIN IN SERVICE SECTOR

Mehandra Pal Damle [1]*, Revendra Kumar Deshmukh [2]

[1]*M. Tech. Student, Department of Mechanical Engineering, CSIT Durg, (C.G.), India.*

[2]*Assistant Professor, Department of Mechanical Engineering, CSIT Durg (C.G.), India.*

Abstract

Performance evaluation is a key activity of supply chain in the dynamic global competitive scenario for the improvement of productivity and profitability. As there is enough scope for improvement in productivity and profitability, supply chain managers need to strive for collection, analysis, and interpretation of qualitative and quantitative information to measure and compare in order to give the right direction to enhance supply chain performance. Then a comprehensive performance evaluation system needs to be developed and redefined to monitor, control, and direct total supply chain operations on a continuous basis by incorporating the entire supply chain process as an integrated system.

Service sector is becoming as a lifeline for the social and economic growth of any country. It is well known that contribution of service sector to nation's progress is substantial. Services contribute twice the economic output compared with manufacturing. Evaluating service supply chains is essential to measure the growth. Very little attention has been paid to performance evaluation of service supply chains and hence there is a pressing need to direct research efforts in this direction. Since the output of service is intangible, heterogeneous and simultaneous, identifying suitable evaluation criteria is a crucial exercise. Factors like, the nature of the service industry the firms under evaluation belong to and the country and region where they are operating, can influence the list of evaluation criteria.

Various research paper have been studied and came to the conclusion that List of performance metrics applicable for evaluating performance and Multi criteria decision making approaches appropriate for carrying out performance evaluation of service supply chains need to be identified. Also the suitability, effectiveness and applicability of the approaches recommended for performance evaluation of service supply chains need to be demonstrated by carrying out service supply chain case studies in an emerging economy.

Keywords: SCM, DEA, MCDM, TOPSIS, VIKOR, KPI.

** Corresponding author*

1. INTRODUCTION

The transportation sector offers transportation via truck, rail, air, and water. warehousing and storage services are also available. Transportation services for pipeline, postal, courier, and messengers are also included. India's transport industry is largely reliant on the world economy. Manufacturing outputs, commodities trade, leisure trip activities, and consumer and corporate spending may all increase with a strong and stable economy. Some costs, like the price of fuel and labour, are constant. For the transportation industry to run smoothly, everyone must focus on the operations, which calls for a robust global economy.

1.1 Supply Chain Management (SCM)

Customers, retailers, wholesalers, manufacturers, suppliers, and service providers make up the network known as the supply chain. (Hugos 2003). The main goal of supply chain is to increase the total value created. According to Chopra & Meindl (2003), All phases involved in directly or indirectly completing a customer request are included in a supply chain. Along with the manufacturer and suppliers, the supply chain also consists of transporters, warehouses, retailers, and the actual customers. Although supply chains can be simple time- and frequency-distribution structures, they typically exhibit complexity due to the presence of numerous independent organisations, roles, and individuals operating in a fluid environment. (Van der Zee & Van der Vorst 2005).

The objective of SCM is to satisfy the end customer requirements (Childerhouse & Towill 2000) and the focus is on how organizations utilise the processes, technology, and capabilities to enhance their own competitive advantage. Christopher (1992) defined SCM as the control of supplier and customer connections upstream and downstream in order to provide better customer value at lower supply chain costs. Levy et al (2003) defined SCM is a collection of techniques used to effectively integrate suppliers, manufacturers, warehouses, and stores so that goods are produced and distributed in the appropriate quantities, at the appropriate times, and in the correct locations in order to reduce system costs and meet service level requirements. In the definition of Stadtler & Kilger (2008), SCM is “the process of connecting organisational units throughout a supply chain and coordinating material, information, and financial flows to meet (ultimate) consumer needs in an effort to increase the supply chain's overall competitiveness. SCM contributes in the value addition in the form of quality, costs, quick response, availability, and consistency of the system. In the supply chain process, each participant adds some value to the goods and services received from his preceding member before making delivery to the next party. The success or failure of each link in the supply chain network largely depends upon the real time contribution of its preceding link.

Information flow is as significant in the supply chain as blood is for human life (Colicchia & Strozzi 2012). The flow of information in the SCM network is in both directions for activation and improvement of the total supply chain system. The nature of backward information flow facilitates coordination activities consisting of quality feedback, customer order and specification, procurement quantity with specification and timing, strategic capacity, processing and dispatch planning, etc. The forward information flow refers to operational activities that

consist of availability of goods and services, order processing and management, order status, invoice, transportation and shipping systems, quality assurance, warranty card, operating manual etc. Any delay in the information flow costs to the firm, which ranges from higher transportation cost to lost sales and corporate image (Pereira 2009).

The role of supply chain management within an organization has changed considerably over the last few decades (Estampe et al 2013). It has evolved from an emphasis on integrating logistics and lowering of costs to provide better products and services to customers on real time basis in cost efficient manner. In the changing business dynamics, the challenge is to take supply chain management to a more strategic level within the firm. The foundations of overall business strategies of most of the proactive firms are moving around supply chain management. There is an alignment of SCM strategy with firm‟s overall business strategy (Roh et al 2014).
These changes in supply chain strategies are mainly aimed at achieving superior performance. Proactive firms are moving towards working more closely with their supply chain partners for the adaptation of rapidly changing market place scenario. This improved integration and collaboration is the essence of strategic supply chain management. Firms are reconsidering the linkages, not only between functions within their own enterprise, but also other firms up and down the supply chain (Kache & Seuring 2014).

In this process of transformation, there is significant thrust given to superior performance. The pursuit of functional excellence developed into a focus on business process excellence, with firms breaking down their systems and reorganizing around core supply chain related processes. This core of supply chain management philosophy is largely based on network excellence in the form of consumer response that links raw material providers, manufacturers, distributors, and retailers along a seamless supply chain (Gorane & Kant 2015). This strategic approach of supply chain emphasizes sharing of resources and information, eliminating duplication, enabling rapid information flows and, ultimately real time product and service flows.

In the era of global competition, the importance of superior customer service has been intensified significantly for driving growth (Agus & Shukri Hajinoor 2012). Growth once considered as a responsibility of product development, sales and marketing in many firms, emerged as a core objective of the strategic supply chain management. The continuing need to reduce costs and supply chain assets, the increased importance of superior customer service to gain sustainable competitive advantage and the emerging focus on driving growth in maturing markets are the key reasons behind strategic orientation of supply chain management. It focuses on effectiveness and efficiency of the whole SCM network structure and reengineering of processes across the network for strategic and operational excellence (Gligor & Holcomb 2012). Supply chain practices apply equally to service industries, as the practice of placing greater emphasis on supply chain members is not restricted to manufacturers.

1.2 Service Supply Chains

The size of service sector is increasing in virtually all countries around the world. Every industrialised country's economy has traditionally been driven by the service sector. (Giannakis 2011). It has been a persistent occurrence for industrialised economies to shift from a manufacturing foundation to a service focus. (Smith et al 2007). As a

national economy expands, the relative share between agriculture, industry and services undergoes changes in favour of services. In most of the more highly developed nations, services account for between two-thirds and three-fourths of the gross domestic product (GDP). Even in emerging economies, the service output is growing rapidly and represents at least half of the GDP. Government policies, social changes, industry trends, advances in information technology and globalization are among the major factors contributing to the rapid growth of the service sector (Lovelock et al 2011).

Services are important, yet defining and classifying services is problematic (Ellram et al 2004). Services can be defined as economic activities between two parties, implying an exchange of value between the seller and buyer in the market place (Lovelock et al 2011). Though services often include important tangible elements, such as, hotel beds, restaurant meals, and bank cards, it is the intangible elements that dominate the creation of value in services. One of the main challenges in classifying services is the fact that in service based industries, it can be very difficult to separate out generation and consumption from the operation management of final service. As such, services are often classified in numerous different ways. While some consider a service as an offering when it is complementary to goods or commodities, others regard services as a form of activity in itself.

Ellram et al (2004) defined SCM as "the management of information, processes, capacity, service performance and funds from the earliest supplier to the ultimate customer". According to Ellram et al (2004), there are seven theoretical processes of service supply chains including: Information flow, capacity and skills management, demand management, customer relationship management, supplier relationship management, service delivery management, and cash flow.

Baltacioglu et al (2007) defined the service supply chain as "the network of suppliers, service providers, consumers and other supporting units that performs the functions of transaction of resources required to produce services, transformation of these resources into supporting and core services, and the delivery of these services to customers". In their definition, the core service that provides a benefit to the customer is the ultimate benefit delivered to the customer. Supporting services are subsidiary ones required to deliver a core service.

Very few studies have investigated how service providers manage the service supply chains that extend their organizational boundaries (Cho et al 2012). The lack of research in service supply chain management may have been caused by the inherent challenges of service standardisation as well as the challenges of service design and delivery procedures. The complexity of the services industry makes it challenging to build a unified services framework, and services are challenging to see and quantify. (Ellram et al 2004).

1.3 Performance Evaluation of Service Supply Chains

Performance assessment has traditionally been described as the process of calculating the effectiveness and efficiency of activity. (Neely et al 1995). Performance measurement in modern corporate management encompasses much more than just quantification and accounting. It is anticipated that it would significantly boost corporate management and employee performance in the organisations. From a managerial standpoint, performance evaluation gives decision-makers and process managers the data they need for management feedback. It is essential for

tracking progress, fostering motivation and communication, and identifying issues. (Rolstands 1995; Waggoner et al 1999). Additionally, performance evaluation offers a method for determining the efficacy and potential of management strategies as well as for facilitating situational understanding. It aids in focusing management efforts, updating corporate objectives, and reengineering business procedures. (Van Hoek 1998; Bourne et al 2000; Kuwaiti & Kay 2000).

Performance evaluation is a key activity of supply chain in the dynamic global competitive scenario for the improvement of productivity and profitability. Taking into consideration the present global competitive scenario, improvement of productivity and profitability on a continuous basis are the order of the day for survival. That is why, proactive and progressive enterprises need to be always concerned about performance evaluation. It can help them not only to improve productivity and profitability but also to ensure efficiency and effectiveness in utilization of resources for maximization of customer value. As there is enough scope for improvement in productivity and profitability, supply chain managers need to strive for collection, analysis, and interpretation of qualitative information to measure and compare in order to give the right direction to supply chain performance. Then a comprehensive performance evaluation system needs to be developed and redefined to monitor, control, and direct total supply chain operations on a continuous basis by incorporating the entire supply chain process as an integrated system.

Due to global competition and explosion of choices, the expectations of customers and end users are significantly increasing (Laosirihongthong & Dangayach 2005). Hence, to survive in such a situation, it is essential to take into consideration the perception of customers regarding supply chain performance so that improvements can be made in it. The leading edge enterprises conduct customer perception and satisfaction surveys on a regular basis. They have customer monitoring cells so that monitoring can be made on a regular basis. To win in the new environment, supply chains need continuous improvement. To achieve this we need performance metrics which support global supply chain performance improvements rather than narrow company specific or function specific metrics which inhibit chain wide improvements.

Modern supply chains are highly complex and dynamic (Merschmann & Thonemann 2011). They are characterized by constantly changing relationships and configurations, they support a proliferation of stock keeping units, they use a mixture of operations to fulfill orders, and they involve multiple organizations. Additionally, as a new technology enabler, the internet has increased the quantity of customer interactions and product configurations, placing more demands on the management and effectiveness of the supply chain. The capacity to satisfy client requests for personalised goods and services quicker and more successfully than the competition is the ultimate aim and benchmark for success. Therefore, it is crucial to direct management attention towards the supply chain's performance as an integrated whole rather than as a collection of distinct processes or companies.

Although it is believed that services can benefit applying some best practices from manufacturing, the differences between service and manufacturing sectors create a need for specific constructs or scales reflecting service supply chain practices (Boonitt & Pongpanarat 2011). It is necessary to evaluate service supply chains' performance in order for them to develop into efficient and effective systems. However, there hasn't been much research on measuring the performance of the service supply chain. (Cho et al 2012).

Performance reviews of service supply chains can not only highlight areas for development, boost communication and motivation, and pinpoint issues, but they can also encourage cooperation and integration across chain participants. Overall levels of customer service, competitiveness, and profitability can all be raised as a consequence. Evaluation of the performance of the service supply chain is challenging due to the intangibility, inseparability, and heterogeneity of services. Therefore, it is necessary to identify and prioritise pertinent criteria as well as to develop appropriate and efficient methodologies for conducting a systematic evaluation of service supply chain performance.

2. LITERATURE REVIEW

In one of the earliest studies related to performance evaluation of supply chains, Lee & Billington (1992) observed that the discrete sites in a supply chain do not maximize efficiency if each pursues goals independently.

Perea et al (2000) developed a dynamic model based on the development of a dynamic framework to model supply chains, and on the application of ideas from process dynamics and control. They modeled the flow of information and material within the supply chain, and used them to capture the dynamic behavior of the supply chain. Moreover, the use of ideas from dynamics and control allowed the design of systematic decision making processes for the supply chain as if they were control laws for dynamic system.

Brewer & Speh (2000) described the relevance, importance and usefulness of the balanced score card (BSC), proposed by Kaplan & Norton (1992), with respect to supply chain performance measurement. The balanced score card approach reflects an intent to keep score of a set of items that maintain a balance between short term and long term objectives, between financial and non financial measures, between lagging and leading indicators, and between internal and external performance perspectives. Brewer & Speh (2000) highlighted that the balanced score card approach, with its multi dimensional view on organizational reality can be a versatile tool for practicing managers for measuring supply chain performance.

Shah & Singh (2001) described a benchmarking approach for internal supply chains and demonstrated how meaningful results can be derived from this exercise. Benchmarking can be defined as the search for industrial best practices that lead to superior performance (Camp 1989). Pioneered by Xerox, benchmarking has been widely adopted by companies as an improvement initiative (Port & Smith 1992). By following the framework proposed by Shah & Singh (2001), a firm can identify areas of opportunity for improvement in its

internal supply chain. Further, the framework can help to identify specific reasons behind the performance levels in the internal supply chain and stimulate performance improvement.

Bullinger et al (2002) described a supply chain analysis approach and proposed a measurement methodology integrating bottom up and top down performance measures as a hybrid balanced measurement approach. They kept the SCOR framework as the basis for their approach. Opportunities are to be derived from suboptimal, inner and cross organisational business processes and the related material, information and capital flows.

Kee-hung Lai et al (2002) based on the SCOR model and various established measures, proposed a measurement model and a measurement instrument for supply chain performance in transportation logistics.

Chan (2003) adopted the Analytic Hierarchy Process (AHP) for evaluating the performance of supply chains. The Analytic Hierarchy Process (AHP) proposed by Saaty (1980) is a systematic procedure for representing the elements of any problem, hierarchically. It organizes the basic rationality by breaking down a problem into its smaller and constituent parts and then guides decision makers through a series of pair-wise comparison judgments (which are documented and can be reexamined) to express the relative strength or intensity of impact of the elements in the hierarchy. Chan (2003) analysed the case of electronic industry as an example to demonstrate the suitability of AHP technique in performance measurement in a supply chain.

Chan & Qi (2003) proposed a channel spanning performance measurement approach from a system perspective and introduced fuzzy set theory to address the real situation in the judgment and evaluation processes of supply chains. They developed a fuzzy Analytic Hierarchy Process (AHP) for analyzing the performance of supply chains. They employed a geometric scale of triangular fuzzy numbers to quantify the comparison ratios of AHP.

2.1 Performance Evaluation of Supply Chains

Kleijnen & Smits (2003) suggested that multiple supply chain measures may be aggregated into the utility, which is the final performance measure of a system, through scoring methods. Using the simulation study they quantified the values of parameters like the bullwhip effect and the fill rate.Statistical analysis and sensitivity analysis were also carried out.

Otto & Kotzab (2003) proposed six perspectives for measuring supply chain performance such as: system dynamics, operations research, logistics, marketing, organization and strategy areas. These follow a particular set of goals, which lead to a particular set of metrics.

Lockamy & McCormack (2004) investigated the relationship between supply chain management planning practices and supply chain performance based on four main decision areas of SCOR model (plan, source, make and deliver) and highlighted the importance of planning function and the importance of collaboration, process measures, process collaboration, process credibility, process integration and information technology.

McCormack & Lockamy (2004) developed a process maturity model taking the business orientation view, defined five general levels of process maturity and used the survey instrument to analyse the relationship of process maturity with performance. Lohman et al (2004) suggested aggregating various performance measures into distinct groups by using the metric normalization method derived from Maskell (1991). They implemented their approach at the European operations department of a company producing and selling sportswear worldwide.

Perona & Miragliotta (2004) investigated how complexity could affect a manufacturing company‟s performances, and its supply chain. A model was suggested to control complexity so that the logistics systems could be regarded as a core competence in order to jointly improve efficiency and effectiveness of the supply chain.

Agarwal & Shankar (2005) provided an effective framework for analyzing different variables affecting supply chain performance. The core of their approach involves identifying a causal relationship among the different variables that are relevant.

Agarwal et al (2006) proposed a framework by using three types of metrics such as, lean, agile and leagile with the help of analytic network process (ANP), to support managers in making strategic decisions in supply chains.

Chen et al (2006) proposed that data envelopment analysis (DEA) is a useful method to evaluate the relative efficiencies of supply chain members.

They investigated the efficiency game between two supply chain members and showed that there existed numerous Nash equilibrium efficiency plans between the supply chain members with respect to their efficiency functions.

Liang et al (2006) highlighted that conventional data envelopment analysis (DEA) cannot be employed directly to measure the performances of supply chain and its members, because of the existence of the intermediate measures connecting the supply chain members. They developed DEA based approaches for characterizing and measuring supply chain efficiency when intermediate measures are incorporated into the performance evaluation. Non linear programming problems were developed to solve these new supply chain efficiency models. It was shown that these DEA based non linear programs can be treated as parametric linear programming problems and best solutions can be obtained via a heuristic technique.

Li et al (2006) developed five dimensions of supply chain practices and tested the relationships between supply chain practices, competitive advantage, and organizational performance. Data for the study were collected from 196 organizations and the relationships proposed in the framework were tested using structural equation modeling. The results indicated that higher levels of supply chain practices can lead to enhanced competitive advantage and improved supply chain and organizational performance.

Seth et al (2006) suggested using a novel methodology that integrates statistical analysis, quality loss function, and data envelopment analysis (DEA) to create a single performance indicator for the measurement of the quality of service in the supply chain context.

Yao & Liu (2006) suggested an integrated approach for measuring supply chain performance, combining economic value added, the balanced score card and activity based costing, clearly emphasising the need of overhead handling and a balanced approach.

Bhagwat & Sharma (2007) applied the balanced score card to analyse the performance of supply chains. They grouped the various supply chain metrics compiled by Gunasekaran et al (2001) into the four different perspectives of BSC. They recommended that the perspectives should be revised periodically and updated as necessary. The measures included in the given BSC should be tracked and traced over time and integrated explicitly into the strategic supply chain management process.

Ho (2007) focused on ERP based supply chain performance and proposed an integrated method, the total related cost measurement, to evaluate supply chain performance of a three echelon, ERP based supply chain system. The study used simulation based validation experiments.

Sharma & Bhagwat (2007) proposed an integrated Balanced Score Card - Analytic Hierarchy Process approach which aimed to analyse the performance of supply chain from the following four perspectives: finance, customer, internal business process, and learning and growth.

Bernardes & Zsidisin (2008) investigated the relation of strategic supply chain management with the concepts of network embeddedness and network scanning. Their work involved a survey based study made in US corporations supported by rigorous statistical analysis.

Bhagwat et al (2008) highlighted that performance measurement can facilitate understanding and integration among the supply chain partners. They proposed a new mathematical model to optimize the overall performance measurement of supply chains for small and medium sized enterprises, which is based on the prioritisation of the suggested performance measures and performance at different decision levels.

Gulledge & Chavusholu (2008) reported that unless data collection to support construction of key performance indicators (KPI) is automated, it is difficult to institutionalize the SCOR model as a measurement and benchmarking framework. They recommended automating the supply chain operations reference (SCOR) model as an enabler for process oriented supply chain business intelligence. To test their hypothesis, an alignment product that allows the SCOR model to be automated with information that is directly extracted from the Oracle E-Business Suite was also developed.

Hwang et al (2008) performed a case based study for the Taiwanese thin film transistor liquid crystal display manufacturing sector specifically focusing on the sourcing side of the SCOR model. Their work contains a comprehensive SCOR overview and stepwise regression analysis to analyse the dependancy of different performance measures.

Kamalabadi et al (2008) presented a supply chain performance evaluation approach by combining the fuzzy approach and the multi attribute decision making approach. The three step approach presented by them includes identifying and prioritizing the key factors in increasing competitiveness.

McCormack et al (2008) carried out a comparative analysis of the supply chain operations reference (SCOR) model and business process orientation maturity model. Their study provides a comparison on the traditional versus innovative performance measurement systems. A Brazilian survey was conducted in the study for analyzing the clustering performance of the companies surveyed. The study puts forward a clear support for the need of new performance measurement methodologies and maturity models.

Puigjaner & Liainez (2008) employed a multistage, multi period, stochastic mixed integer linear model to capture the supply chain dynamics and developed a strategic level model that used forecasting, optimisation and simulation in tandem to analyse results using sample scenarios. The model involved demand and price uncertainty, and financials (assets, liabilities, credit policies, capacity expansion, and shareholder value).

Wong & Wong (2008) reported that the supply chain benchmarking process differs from general benchmarking since performance measures differ field to field. Insights of supply chain benchmarking such as, problems, and tools used for benchmarking were discussed. The application of data envelopment analysis (DEA) in supply chain benchmarking was also analysed.

Bhagwat & Sharma (2009) developed a combination of analytical hierarchy process and preemptive goal programming model by considering qualitative and quantitative measures for optimizing supply chain performance.

Chae (2009) developed pragmatic guidelines and benchmarking issues for monitoring of supply chain performance as, they reveal the gap between planning and implementation and help companies to identify potential problems and areas for improvement.

Chia et al (2009) conducted a survey designed from the four perspectives of the BSC framework on senior personnel involved in the supply chain functions from the logistics service provider industry wherein they tested empirically the BSC framework in the supply chain by considering the 15 generic performance measures.

Heydari et al (2009) investigated the relationship between lead time variance, bullwhip effect, inventory position and performance measures of supply chain. A structural relationship model with three hypotheses about direct and indirect impact of lead time uncertainty on supply chain inventories was developed. Simulated data were used to test the proposed structural relations.

The results of the study show that by increasing the lead time variance, order variances can be increased while no impact on the bullwhip is observed. Furthermore, results show that the increase in the lead time variance will lead to inventory fluctuations.

Martin & Patterson (2009) identified cycle time and inventory as the key performance measures to analyze the company performance in a supply chain. However, continuous improvement of supply chain performance needs frequent monitoring of these key performance measures.

Tao (2009) combined improved entropy method and fuzzy matter element theory to establish a fuzzy matter model for evaluating supply chain performance. The weight of index was endowed by improved entropy method and this provided a new way for the evaluation of supply chain performance.

Thakkar et al (2009) proposed a framework combining the features of BSC and SCOR model to deliver a comprehensive performance measurement framework for small and medium scale industries. The framework includes both tangible and intangible measures. The framework includes metrics for various categories of BSC and users are advised to further classify them into strategic, tactical and operational level. This makes the purpose of a particular measure and associated necessary decisions more explicit for managers.

Xu et al (2009) studied the supply chain performance evaluation system of a furniture manufacture industry in the southwest of China. They identified the main uncertainty factors affecting the evaluation process, modeled and analyzed them using rough data envelopment analysis.

Wouters et al (2009) carried out a longitudinal case study and analysed the challenges of performance measurement, need of developmental approach in performance measurement and the importance of delegating the performance measurement at every level of hierarchy.

Akyuz & Erkan (2010) conducted a critical review in the domains of supply chain, information technology, business process management and performance management and brought forth the requirements of performance measurement metrics in present era, which can enable designing the metrics to encounter the issues related to supply chain measures.

Lin & Li (2010) proposed an integrated framework for supply chain performance measurement. The framework adopts the six sigma metrics and includes three components i.e. team structure management, supply chain process management and output measurement, to provide a more complete coverage of performance requisites.

Internal benchmarking for assessment of supply chain performance was proposed by Soni et al (2010). An extensive use of performance value analysis (PVA) and strengths, weaknesses, opportunities, and threats (SWOT) analysis provided for diagnosis of supply chains. Internal benchmarking can be useful in leveraging the drivers of various supply chains belonging to same focal organization and hence bring performance of all the supply chains at the same performance level.

Fabbe Costes et al (2011) discussed sustainability of supply chains with the help of a scanning framework which includes six levels such as, societal, network, chain, firm, function, and people levels.

Cuthbertson & Piotrowicz (2011) demonstrated an approach for analyzing existing supply chain performance evaluation systems across different supply chains and sectors. The authors created an opportunity to use a consistent data collection process across a variety of supply chain situations and thus generated data for further theory development.

Geethan et al (2011) developed a performance evaluation analytic for reverse logistics to facilitate decision making from the perspective of an enterprise engaged in reverse logistics. They also developed some key performance metrics and business strategies that can be implemented for successful operations of reverse supply chains.

Vanichchinchai & Igel (2011) investigated the relationships between supply chain management practices and firm‟s supply chain performance in the automotive industry in Thailand. The evaluation parameters were developed based on an extensive literature review and were verified by experts, pilot test and various statistical techniques to ensure reliability and validity in structural equation modeling constructs. The hypothesized model was tested through a path analysis. Qualitative case studies of two large first-tier automotive suppliers were conducted to obtain more in-depth information.

Olugu & Wong (2012) developed an expert fuzzy rule based system using Visual Basic.Net for performance evaluation of closed loop supply chains in the automotive industry and implemented the system in an automobile manufacturing company.

Cho et al (2012) carried out a literature review on performance measurement issues of service supply chains and implemented the fuzzy analytical hierarchy process for performance evaluation of the hotel supply chain.

Estampe et al (2013) analyzed various models used to assess supply chains by highlighting their specific characteristics and applicability in different contexts. They also presented an analytical grid that can help managers evolve towards a model that is more suitable for their needs, by breaking these models down into seven layers.

Chiu & Okudan (2014) investigated the supply chain performances of two module and three module design concepts in an effort to explore the impact of modularity level on supply chain performance and found that increased modularity is advantageous for the time based performance of a supply chain network, whereas decreased modularity yields superiority in terms of cost performance.

Shafiee et al (2014) proposed a hybrid method by combining the network data envelopment analysis with the balanced score card approach for performance evaluation of supply chains and applied the method in the Iranian food industry to evaluate the efficiency of supply chains.

Jakhar & Barua (2014) proposed a model that provides a salient notion of integrated supply chain performance evaluation approach for practicing managers by combining the structural equation modelling and the fuzzy analytic hierarchy process.

Irena Ali et al.'s (2021) main goal is to create a model for selecting the optimal business improvement plan for the transportation firm. The research is dependent on the harmonisation of methodologies and the validation of their findings since decision-making (DM) is not a simple series of actions. This methodology may be used in SMEs that make these kinds of judgements and others like it. Companies may use this model to improve their company outcomes by adapting their operational procedures to the model's findings. This study is the first to permit the use of such a model in strategic choice-making.

2.2 Metrics For Performance Evaluation of Supply Chains

The term "metric" refers to the definition of measure, how it will be calculated, who will be carrying out the calculation, and from where the data will be obtained (Neely et al 1995). The main challenge in performance evaluation of supply chains is to identify the key performance metrics and measures for value adding areas of an organization. Various researchers have proposed performance metrics considering the changes and enterprise environments. This section discusses articles that analysed and brought out metrics for performance evaluation of supply chains.

Chow et al (1994) were probably the first to attempt to analyse supply chain performance and they presented measures for measuring supply chain performance. They also reported that practitioners have assigned less importance and benefits to measures at strategic level compared to operations and individual processes.

Supply Chain Council, in 1996, developed the Supply Chain Operations Reference Model (SCOR) (1996). In SCOR it is important to quantify the operational performance of similar companies and establish internal targets based on „best in class" results, e.g. supply chain operation performance analysis. SCOR proposed two dimensions of analysis: Customer - facing and Internal - facing. In Customer - facing dimension, reliability, responsiveness and flexibility are measured. Performance metrics include delivery performance, fill rate, perfect order fulfillment, order fulfillment lead time, supply chain response time and production flexibility. In Internal - facing dimension, costs and assets are measured. Performance metrics include cost of goods sold, value added productivity, warranty cost or returns processing cost, cash to cash cycle time, inventory days of supply and returns on assets.

Beamon (1999) identified and evaluated various individual supply chain performance indicators and proposed that resource, output and flexibility are vital components to success of supply chain. The resource measures refer to such performance measures as total cost, distribution cost, inventory cost and return on investment. Output measures include customer responsiveness, the quality and quantity of final products. Flexibility measures refer to volume flexibility, delivery flexibility, mix flexibility and new product flexibility.

Gilmour (1999) described a group of benchmark measures for supply chain processes which are based on a set of capabilities which incorporate the extent of intention and use of technology in the logistics processes of an

organization and the degree to which logistics is used as a key element of overall strategy formation and implementation. He proposed an integrated supply chain model, in which 11 processes, technology and organization capabilities are identified. Five dimensions for each of 11 capabilities were established in order to determine the logistics sophistication by the area of managerial activities.These dimensions are organization strategy, planning, business process and

information, product flow and measurement.

Lapide (2000) focused importance on balanced score card, process measurement and limiting of total metrics in the supply chain. They reported that a major challenge for many companies that are developing a measurement process is limiting the number of measures.

Gunasekaran et al (2001), based on literature survey, developed a framework for measuring the strategic, tactical, and operational performance in a supply chain system. They categorized the performance evaluation metrics into strategic, tactical, and operational categories and also into financial and non financial categories.

Lambert & Pohlen (2001) provided a frame work which helps to develop the performance metrics in supply chains and identify those that translate into shareholder‟s value. In their view, the overall performance is determined by the increase in market capitalization for each firm in the supply chain. They also highlighted that more research is needed to develop supply chain metrics and to overcome the implementation barriers.

Chan (2003) brought about a listing of metrics for performance evaluation of supply chains. The listing comprised of seven performance criteria and forty sub criteria categorized into two separate groups.

Gunasekaran et al (2004) developed a framework for supply chain performance measurement. They carried out a detailed measurement and metrics classification and used a survey aimed at assessing importance within each metric group.

Shepherd & Gunter (2006) classified metrics into cost, quality, time, flexibility and qualitative versus quantitative with respect to the SCOR process stages. They also pointed out that a number of important issues with respect to supply chain performance evaluation had not received adequate attention, including the factors influencing the successful implementation of performance measurement systems for supply chains, the forces shaping their evolution over time and the problem of their ongoing maintenance.

Gunasekaran & Kobu (2007) offered a comprehensive review and classification for supply chain measurement and metrics. A trend of increasing attention on performance measurement and metrics, both in practice and literature, was emphasised in their work. They highlighted the confusion as to the classification of metrics in literature, and lacking complete coverage of all the performance measures. Their review classified the literature based on the following criteria: balanced scorecard perspective, components of measures, location of measures, decision levels, nature of measures, measurement base and traditional versus modern measures. They treated a number of metrics in five classes i.e. order planning, supplier evaluation, production level, delivery and customer and they conducted an empirical research to assign importance ratings within each class.

Cuthbertson & Piotrowicz (2008), highlighted that the majority of supply chain measures are economic and quantitative (cost, customer, responsiveness, and productivity) rather than qualitative. They also found from their studies that current performance approaches do not generally include social and environmental aspects and are

concentrated on economic aspects, not on sustainable aspects. Cai et al (2009) carried out a detailed survey in the retail industry in China and identified 20 metrics of supply chain performance as the relevant ones for the retail industry. The metrics identified are classified into four categories: resource, output, flexibility, and innovativeness and the cause and effect relationship among these metrics were also studied.

Chae (2009) suggested guidelines for designing metrics and proposed a new set of performance metrics for the SCOR model. They also reported that organizations often find there is a lack of practical guidelines as to how to develop KPIs.

Martin & Patterson (2009) discussed three main classes of performance measures by inventory, cycle time and financials. Effects of supply relations, organisational structure, partnering, supplier agreements and process improvements on the performance measures selected were investigated via a survey based study.

Zhang et al (2011) reported that supply chain co-ordination, technology application, risk management, and reliability assurance are important performance measures to ensure supply chain quality and continuous improvement. The success of the supply chain depends on how these measures are assessed and monitored.

Prasad (2012) implemented seven performance dimensions (cost, quality, time, productivity, flexibility, reliability, and customer service) to measure supply chain performance. The criticality of performance dimensions from the supply chain point of view was examined by collecting empirical data from supply chain professionals.

A complete listing of metrics for performance evaluation of supply chains proposed by various researchers is made available in Table given below. Some of the early contributors were Bower & Hout (1988), Rushton & Oxley (1989), Christopher (1992), Graham et al (1994), Toni et al (1994), Stewart (1995), Wild (1995), Dobler & Burt (1996), Klassen & McLaughtin (1996), Harrington (1996), Fisher (1997), Mason Jones & Towill (1997) and Beamon (1999) along with the Supply Chain Council (1996). Gunasekaran et al (2001), Chan (2003) and Gunasekaran & Kobu (2007) presented detailed analysis and listing of the metrics.

Table 2.1 Supply chain performance metrics identified by various researchers

Accuracy - Chan (2003)
Accuracy of forecasting techniques - Harrington (1996), Fisher (1997)
Accuracy of scheduling - Gunasekaran & Kobu (2007)
Achievement of defect free deliveries - Gunasekaran et al (2001)
Bid management cycle time - Gunasekaran & Kobu (2007)
Buyer-supplier partnership level
Toni et al (1994), Mason Jones & Towill (1997)
Capacity utilisation Wild (1995)
Cash to cash cycle time SCOR (1996)
Compliance to regulations Gunasekaran & Kobu (2007)
Conformance to specifications Gunasekaran & Kobu (2007)
Consistency Chan (2003)
Cost per operation hour Gunasekaran et al (2001)
Cost of products SCOR (1996)
Customer responsiveness Beamon (1999)
Customer query time Gunasekaran et al (2001)

Customer satisfaction Chan (2003)
Delivery flexibility Beamon (1999), Chan (2003)
Delivery lead time Rushton & Oxley (1989)
Delivery performance SCOR (1996), Gunasekaran et al (2001)
Delivery reliability Gunasekaran et al (2001)
Distribution cost Beamon (1999), Chan (2003)
Driver reliability for performance Gunasekaran et al (2001)
Effectiveness of delivery invoice Methods Gunasekaran et al (2001)
Effectiveness of master production Schedule Gunasekaran et al (2001)
Effectiveness of distribution planning Schedule Gunasekaran et al (2001)
Efficiency of purchase order cycle Time Gunasekaran et al (2001)
Expansion flexibility Chan (2003)
Extent of cooperation to improve Quality Graham et al (1994)
Fill rate SCOR (1996), Chan (2003)
Flexibility Beamon (1999)
Flexibility of service systems to meet particular customer needs Bower & Hout (1988), Christopher (1992)
Frequency of delivery Gunasekaran et al (2001)
Incentive cost and subsidies Chan (2003)
Information carrying cost Stewart (1995)
Innovativeness Chan (2003)
Intangible cost Chan (2003)
Inventory carrying cost Dobler & Burt (1996)
Inventory cost Beamon (1999), Chan (2003)
Inventory days of supply SCOR (1996)
Labor efficiency Gunasekaran & Kobu (2007)
Labor flexibility Chan (2003)
Lead time SCOR (1996), Chan (2003)
Lead time for manufacturing Gunasekaran & Kobu (2007)
Level of customer perceived value of Product Gunasekaran et al (2001)
Level of supplier"s defect free Deliveries Gunasekaran et al (2001)
Machine flexibility Chan (2003)
Manufacturing cost Chan (2003)
Material flexibility Chan (2003)
Mix flexibility Beamon (1999), Chan (2003)
Modification flexibility Chan (2003)
Net profit vs. productivity ratio Gunasekaran et al (2001)
New products Chan (2003)
New product flexibility Chan (2003)
Obsolescence cost Beamon (1999), Gunasekaran & Kobu (2007)
On time delivery Chan (2003)
Operation flexibility Chan (2003)
Order lead time Gunasekaran et al (2001)
Order entry methods Gunasekaran et al (2001)

Overhead cost Chan (2003), Gunasekaran & Kobu (2007)
Perceived value of product Gunasekaran & Kobu (2007)
Perfect order fulfillment SCOR (1996)
Planned purchase cycle time Gunasekaran et al (2001)
Price Gunasekaran & Kobu (2007)
Process innovation Klassen & McLaughtin (1996)
Product development cycle time Bower & Hout (1988)
Production flexibility SCOR (1996), Gunasekaran & Kobu (2007)
Product/Service variety Gunasekaran & Kobu (2007)
Purchase order cycle time Gunasekaran et al (2001)
Quality Graham et al (1994)
Quality of delivery documentation Gunasekaran et al (2001)
Quality of delivered goods Beamon (1999), Gunasekaran et al (2001)
Rate of return on investment Christopher (1992), Dobler & Burt (1996), Beamon (1999)
Range of products and services Gunasekaran et al (2001)
Resource utilization Chan (2003)
Responsiveness to urgent deliveries Gunasekaran et al (2001)
Return on assets SCOR (1996)
Routing flexibility Chan (2003)
Sensitivity to long term cost Chan (2003)
Stock out cost Gunasekaran & Kobu (2007)
Stock out probability Chan (2003)
Supplier assistance in solving technical problems Gunasekaran et al (2001)
Supplier ability to respond to quality Problems Gunasekaran et al (2001)
Supplier cost saving initiatives Gunasekaran et al (2001)
Supplier‟s booking in procedures Gunasekaran et al (2001)
Supplier lead time against industry norm Gunasekaran et al (2001)
Supplier rejection rate Gunasekaran et al (2001)
Supply chain response time SCOR (1996), Gunasekaran & Kobu (2007)
Total cash flow time Stewart (1995)
Total cost Beamon (1999)
Total inventory Gunasekaran et al (2001)
Total supply chain cycle time Christopher (1992), Stewart (1995)
Total transportation cost Rushton & Oxley (1989)
Trust Chan (2003)
Use of new technology Chan (2003)
Value added SCOR (1996), Gunasekaran & Kobu (2007)
Variations against budget Gunasekaran et al (2001)
Volume flexibility Beamon (1999), Chan (2003)
Warehouse cost Chan (2003)
Warranty cost SCOR (1996), Gunasekaran & Kobu (2007)

3. CONCLUSION

The literature on performance evaluation of supply chains discussed approaches and methodologies for performance evaluation of supply chains, brought out metrics for performance evaluation of manufacturing supply chains, discussed approaches and methodologies for environmental performance evaluation of manufacturing supply chains and brought out metrics for environmental performance evaluation of manufacturing supply chains. However, very little attention has been devoted to the performance evaluation of service supply chains in emerging economies and this research addresses this research gap.

Qualitative type of research which is primarily exploratory research is the suitable type of research for the research problem chosen in this research work. Qualitative research which involves describing specific situation in details using research tools like interviews, surveys, and observations, is used to gain an understanding of underlying reasons, opinions, and motivations. Qualitative Research is used to uncover trends in thought and opinions, and dive deeper into

the problem.

The sample size in qualitative type of research, which is used in this research work, is typically small, where respondents are selected to fulfill a given quota (Graziano & Raulin 1993; Welman & Kruger 2001; Creswell 2003).

In the present work, from the complete list of transportation service providing (TSP) firms, employed by the textiles company for transporting the finished products to different parts of India, the six major TSPs are chosen for the performance evaluation exercise. Similarly, from the complete list of medical support service providing (MSSP) firms and the catering service providing (CSP) firms, the major four medical support service providing (MSSP) firms and

the major four catering service providing (CSP) firms are chosen for the performance evaluation exercise.

The sampling method adopted in the research work is judgmental sampling in which the sample is chosen based on who would be appropriate for the study. Judgmental sampling is used primarily when there is a limited number of people who have expertise in the area being researched, or when the interest of the research is on a specific field or a small group.

Service sector is becoming as a lifeline for the social and economic growth of any country. Evaluating service supply chains is essential to measure the growth. Since the output of service is intangible, heterogeneous and simultaneous, identifying suitable evaluation criteria is a crucial exercise. Many critical drawbacks pervert the existing performance evaluation methods from making a significant contribution to the development and improvement of service supply chains.

The specified research problem is having the following as its research objectives:

1. List of performance metrics applicable for evaluating performance of service supply chains need to be identified, since the main challenge in evaluating performance of service supply chains is identification of the key performance metrics.

2. Multi criteria decision making approaches appropriate for carrying out performance evaluation of service supply chains need to be identified and recommended. Multi criteria decision making approaches that have desirable properties such as robustness, capability to capture holistic aspects, suitability at different levels, simple to use and easy to implement are suitable for the task of performance evaluation of service supply chains.
3. The suitability, effectiveness and applicability of the approaches recommended for performance evaluation of service supply chains need to be demonstrated by carrying out service supply chain case studies in an emerging economy.

References

[1] Abo Sinna, MA & Amer, AH 2005, „Extension of TOPSIS for multi objective large scale non linear programming problems", Applied Mathematics and Computation, vol. 162, no. 1, pp. 243-256.

[2] Agarwal, A & Shankar, R 2005, „Modeling supply chain performance variables", Journal of Asian Academy Management, vol. 10, no. 2, pp. 47-68.

[3] Agus, A & Shukri Hajinoor, M 2012, „Lean production supply chain management as driver towards enhancing product quality and business performance: Case study of manufacturing companies in Malaysia", International Journal of Quality & Reliability Management, vol. 29, no. 1, pp. 92-121.

[4] Akyuz, GA & Erkan, TE 2010, „Supply chain performance measurement: a literature review", International Journal of Production Research, vol. 48, no. 17, pp. 5137-5155.

[5] Armillotta, A 2008, „Selection of layered manufacturing techniques by an adaptive AHP decision model", Robotics and Computer Integrated Manufacturing, vol. 24, no. 3, pp. 450-461.

[6] Baltacioglu, T, Ada, E, Kaplan, MD, Yurt, O & Kaplan, YC 2007, „A new framework for service supply chains", The Service Industries Journal, vol. 27, no. 2, pp. 105-124.

[7] Bernardes, E & Zsidisin, GA 2008, „An examination of strategic supply management benefits and performance implications", Journal of Purchasing and Supply Management, vol. 14, no. 4, pp. 209-219. Computers in Industry, vol. 43, no. 3, pp. 211-225.

[8] Bhagwat, R, Chan, FTS & Sharma, MK 2008, „Performance measurement model for supply chain management in SMEs", International Journal of Globalisation and Small Business, vol. 2, no. 4, pp. 428-445.

[9] Boonitt, S & Pongpanarat, C 2011, „Measuring service supply chain management processes: The application of the Q-sort technique", International Journal of Innovation, Management and Technology, vol. 2, no. 3, pp. 217-221.

[10] Boran, FE, Genc, S & Akay, D 2011, „Personnel selection based on intuitionistic fuzzy sets", Human Factors and Ergonomics in Manufacturing & Service Industries, vol. 21, no. 5, pp. 493-503.

[11] Britto, AJ, Almeida, AT & Mota, CMM 2010, „A multi criteria model for risk sorting of natural gas pipelines based on ELECTRE TRI integrating utility theory", European Journal of Operations Research, vol. 200, no. 3, pp. 812-821.

[12] Buyukozkan, G & Cifci, G 2011, „A novel fuzzy multi criteria decision framework for sustainable supplier selection with incomplete information", Computers in Industry, vol. 62, no. 2, pp. 164- 174.

[13] Cai, J, Liu, X, Xiao, Z & Liu, J 2009, „Improving supply chain performance management: A systematic approach to analyzing iterative KPI accomplishment", Decision Support Systems, vol. 46, no. 2, pp. 512-521.

[14] Chae, B 2009, „Developing key performance indicators for supply chain: an industry perspective", Supply Chain Management: An International Journal, vol. 14, no. 6, pp. 422-428.

[15] Chen, LY & Wang, TC 2009, „Optimizing partners" choice in IS/IT outsourcing projects: The strategic decision of fuzzy VIKOR", International Journal of Production Economics, vol. 120, no. 1, pp. 233-242.

[16] Chiu, MC & Okudan, G 2014, „An investigation on the impact of product modularity level on supply chain performance metrics: an industrial case study", Journal of Intelligent Manufacturing, vol. 25, no. 1, pp. 129-145.

[17] Cho, DW, Lee, YH, Ahn, SH & Hwang, MK 2012, „A framework for measuring the performance of service supply chain management", Computers & Industrial Engineering, vol. 62, no. 3, pp. 801-818.

[18] Colicchia, C & Strozzi, F 2012, „Supply chain risk management: A new methodology for a systematic literature review", Supply Chain Management: An International Journal, vol. 17, no. 4, pp. 403-418.

[19] Cuthbertson, R & Piotrowicz, W 2011, „Performance measurement systems in supply chains: A framework for contextual analysis", International Journal of Productivity and Performance Management, vol. 60, no. 6, pp. 583-602.

[20] Dursun, M & Karsak, EE 2010, „Fuzzy MCDM approach for personnel selection", Expert Systems with Applications, vol. 37, pp. 4324-4330.

[21] Estampe, D, Lamouri, S, Paris, JL & Brahim-Djelloul, S 2013, „A framework for analysing supply chain performance evaluation models", International Journal of Production Economics, vol. 142, no. 2, pp. 247-258.

[22] Fabbe-Costes, N, Roussat, C & Colin, J 2011, „Future sustainable supply chains: what should companies scan?", International Journal of Physical Distribution & Logistics Management, vol. 41, no. 3, pp. 228-252.

[23] Fan, ZP & Liu, Y 2010, „A method for group decision-making based on multi granularity uncertain linguistic information", Expert Systems with Applications, vol. 37, no. 5, pp. 4000-4008.

[24] Geethan, KAV, Jose, S & Chandar, CS 2011, „Methodology for performance evaluation of reverse supply chain", International Journal of Engineering and Technology, vol. 3, no. 3, pp. 213-224.

[25] Georgiadis, P & Besiou, M 2010, „Environmental and economical sustainability of WEEE closed-loop supply chains with recycling: A system dynamics analysis", International Journal of Advanced Manufacturing Technology, vol. 47, no. 5-8, pp. 475-493.

[26] Giannakis, M 2011, „Management of service supply chains with a service oriented reference model: The case of management consulting", Supply Chain Management: An International Journal, vol. 16, no. 5, pp. 346-361.

[27] Gligor, DM & Holcomb, MC 2012, „Understanding the role of logistics capabilities in achieving supply chain agility: A systematic literature review", Supply Chain Management: An International Journal, vol. 17, no. 4, pp. 438-453.

[28] Golmohammadi, D & Mallat-Parast, M 2012, „Developing a grey based decision making model for supplier selection", International Journal of Production Economics, vol. 137, no. 2, pp. 191-200.

[29] Gorane, SJ & Kant, R 2015, „Supply chain practices: a content analysis in empirical research and framework for future development", International Journal of Productivity and Performance Management, vol. 64, no. 5, pp. 657-685.

[30] Guneri, AF, Cengiz, M & Seker, S 2009, „A fuzzy ANP approach to shipyard location selection", Expert Systems with Applications, vol. 36, no. 4, pp. 7992-7999.

[31] Huang, H, Zhang, L, Liu, Z & Sutherland, JW 2011, "Multi criteria decision making and uncertainty analysis for materials selection in environmentally conscious design", International Journal of Advanced Manufacturing Technology, vol. 52, pp. 421-432.

[32] Irena Đalić, Željko Stević, Jovo Ateljević, Zenonas Turskis, Edmundas Kazimieras Zavadskas, Abbas Mardani 2021, " A novel integrated mcdm-swot-tows model for the strategic decision analysis in transportation company", facta universitatis Series:Mechanical Engineering Vol. 19, No 3, Special Issue, 2021, pp. 401 - 422

[33] Jahan, A, Mustafa, F, Ismail, MY & Sapuan, SM 2011, „A comprehensive VIKOR method for material selection", Materials & Design, vol. 32, no. 3, pp. 1215-1221.

[34] Jakhar, SK & Barua, MK 2014, „An integrated model of supply chain performance evaluation and decision making using structural equation modelling and fuzzy AHP", Production Planning & Control, vol. 25, no. 11, pp. 938-957.

[35] Kache, F & Seuring, S 2014, „Linking collaboration and integration to risk and performance in supply chains via a review of literature reviews", Supply Chain Management: An International Journal, vol. 19, no. 5-6, pp. 664-682.

[36] Kuo, MS & Liang, GS 2011, „Combining VIKOR with GRA techniques to evaluate service quality of airports under fuzzy environment", Expert Systems with Applications, vol. 38, no. 3, pp. 1304-1312.

[37] Liou, JJH, Tsai, CY, Lin, RH & Tzeng, GH 2011, „A modified VIKOR multiple criteria decision method for improving domestic airlines service quality", Journal of Air Transport Management, vol. 17, no. 2, pp. 57-61.

[38] Liu, P & Zhang, X 2011, „Research on the supplier selection of a supply chain based on entropy weight and improved ELECTRE-III method", International Journal of Production Research, vol. 49, no. 3, pp. 637-646.

[39] Lovelock, C, Wirtz, J & Chatterjee J 2011, Services Marketing: People, Technology, Strategy, Pearson Education, New Delhi.

[40] Merschmann, U & Thonemann, UW 2011, „Supply chain flexibility, uncertainty and firm performance: an empirical analysis of German manufacturing firms", International Journal of Production Economics, vol. 130, no. 1, pp. 43-53.

[41] Montazer, GA, Saremi, HQ & Ramezani, M 2009, „Design a new mixed expert decision aiding system using fuzzy ELECTRE III method for vendor selection", Expert Systems with Applications, vol. 36, no. 8, pp. 10837-10847.

[42] Olugu, EU & Wong, KY 2012, „An expert fuzzy rule-based system for closed-loop supply chain performance assessment in the automotive industry", Expert Systems with Applications, vol. 39, no. 1, pp. 375-384.

[43] Opricovic, S 2011, „Fuzzy VIKOR with an application to water resources planning", Expert Systems with Applications, vol. 38, no. 10, pp. 12983-12990.

[44] Ozcan, T, Celebi, N & Esnaf, S 2011, „Comparative analysis of multicriteria decision making methodologies and implementation of a warehouse location selection problem", Expert Systems with Applications, vol. 38, no. 8, pp. 9773-9779.

[45] Parast, MM & Adams, SG 2012, „Corporate social responsibility, benchmarking, and organizational performance in the petroleum industry: A quality management perspective", International Journal of Production Economics, vol. 139, no. 2, pp. 447-458.

[46] Park, JH, Park, I, Kwun, YC & Tan, X 2011, „Extension of the TOPSIS method for decision making problems under interval-valued intuitionistic fuzzy environment", Applied Mathematical Modeling, vol. 35, pp. 2544-2556.

[47] Prasad, C 2012, „Multiple performance dimensions to measure supply chain performance", International Journal of Business and General Management, vol. 1, no. 1, pp. 40-55.

[48] Roh, J, Hong, P & Min, H 2014, „Implementation of a responsive supply chain strategy in global complexity: The case of manufacturing firms", International Journal of Production Economics, vol. 147, no. B, pp. 198-210.

[49] Shafiee, M, Lotfi, FH & Saleh, H 2014, „Supply chain performance evaluation with data envelopment analysis and balanced scorecard approach", Applied Mathematical Modelling, vol. 38, no. 21-22, pp. 5092-5112.

[50] Soni, G & Kodali, R 2010, „Internal benchmarking for assessment of supply chain performance", Benchmarking: An International Journal, vol. 17, no. 1, pp. 44-76.

[51] Triantaphyllou, E 2013, Multi Criteria Decision Making Methods: A Comparative Study, Springer Science & Business Media, Dordrecht.

[52] Vanichchinchai, A & Igel, B 2011, „The impact of total quality management on supply chain management and firm's supply performance", International Journal of Production Research, vol. 49, no. 11, pp. 3405-3424.

[53] Wang, X, Wong, TN & Wang, G 2012, „An ontological intelligent agent platform to establish an ecological virtual enterprise", Expert Systems with Applications, vol. 39, no. 8, pp. 7050-7061