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DEVELOPMENT OF STRUCTURE ON PERFORMANCE ANALYSIS FOR LOGISTICS AND WAREHOUSE ON SCM IN FOOD INDUSTRIES

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ABSTRACT

In present scenario, supply chain management is known as a key cause for achieving competitive advantage in any business. Specially, in food industries supply chain offering freshest products to customers remains challenge for retailers. Freshness of the food can delivered through a highly efficient food supply chain management. Performance measures and metrics will use as an organizational decision tool for strategic planning towards an improvement of organization. Most of the organisation realizes that, to evolve an efficient and effective supply chain, supply chain management needs to be assessed for its performance. Hence in this research an attempt was made to evaluate the performance of logistics and warehouse to develop a frame work in food supply chain management.

Keywords: Food Industry, Sales, Frequency, Demand, Structure

1.0 Introduction

Currently most of the organizations focus on the customer through a corporate mission. To become as number one organization in delivering value to customers is a typical mission statement. How a company is performing from its customers perspective has become, therefore, a priority for top management. The balance scorecard demands that managers translate their general mission statement on customer service into specific measures that show the factors that really matters to customers. Normally, customers tend to fall into four categories like time, quality, performance and service, and cost. The balance scorecard allows the managers to look at the business from four important perspectives such as financial perspective, customer perspective, internal business perspective and innovation and learning perspective. Many strategic goals of organizations recognize not only the important on minimizing resources, but also the overall importance of the output of the system. Metrics will use in performance

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measurement influence the decisions on strategic, tactical, and operational levels. A classification based on these three levels, each metric can assign to a level where it would be most appropriate. At the strategic level Supply Chain Management (SCM) is a relatively new and rapidly expanding discipline that is transforming the way that manufacturing and non-manufacturing operations meet the needs of their customers. Supplier partnerships and strategic alliances refer to the co-operative and more exclusive associations between organizations and their upstream suppliers and downstream of supply chain till end users or customers. To meet objectives, the output of the processes enabled by the supply chain has measured and compared with a set of standards. In order to control, the process parameter values need to keep within a process limit and stay relatively constant. This will allow comparison of planned and actual parameter values and once done then the parameter values can influence through certain reactive measures to improve the performance or re-align the monitored value to the process parameter value.

2.0 Literature Review

Supply chain is a network of organizations through upstream and downstream linkages in the different processes and activities that produce value in the form of products and services in the hands of the last consumer. SCM is a set of approaches used to effectively integrate suppliers, manufacturers, logistics, and customers for improving the long-term performance of the companies and the supply chain [1-5]. SCM is the task of integrating organizational business units along with coordinating material, financial, transportation and information flows to fulfill customer demands with the aim of improving competitiveness. Corporate performance measurement and its application continue to grow and encompass both quantitative and qualitative measurements and approaches [6-10]. The variety and level of performance measures depends greatly on the goal of the organization or the specific strategic business unit's characteristics. For example, when measuring performance, companies must consider existing financial measures such as return on investment, profitability, market share and revenue growth at a more competitive and strategic level [11-15]. Other measures such as customer service and inventory SCM performance like supply and turnover are more operationally focused, but may necessarily be linked to strategic level measures and issues. Overall, these difficulties in developing standards for performance measurement are traced to the various measurement taxonomies [16-20]. The major level to measure performance in supply chain are strategic level, tactical level and operational level and also tangible versus intangible measures, variations in collection and reporting, an organization's position along the supply chain or functional variation within organizations [21-25]. Several studies have been conducted on performance measures in SCM. Agri food supply chains are very sensitive to policy changes concerning the environmental issues. The consumers' preference variation, environment plays a crucial role in agri food supply chain performance assessment, because agricultural products are strongly influenced by nature. The environmental variability can be reflected in the quantity and the quality of the farm products [26-30]. The perishability of fresh products such as fruits and vegetables put anxieties on logistics and quality management. Given these facts we can say that food quality and environmental issues have a great impact on agri food supply chain

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performance. Thus, based on the specifications of agri food production, when developing a performance measurement system for agri food supply chains, the indicators that reflect the quality aspects of products are highly relevant like freshness, food safety, environmental issues, etc. and together with other financial and non-financial indicators, included into one-performance measurement system [31-35]. Based on performance indicators in agri food chains, the frame work has been majorly grouped under the four categories as efficiency, flexibility, responsiveness, food quality. The specific characteristics of agri food supply chains are captured in the measurement framework in the category food quality. The latter is based on the framework of food quality developed. Food and food production systems are typically living materials with the large variation, which change over a period of time. So, food can be considered as a complex system with a dynamic and variable behaviour, it changes in time and changes may differ for similar food products [36-40]. Based on the above study, framework for performance measure and metrics should consists the four major supply chain activities/processes like plan, source, make/assemble, deliver was carried out.

3.0 Methodology

The food supply chain industry operates as a hub and spoke model. The Hub and spoke business model of retail vegetable selling is shown in Figure 1. Buying centers, hub and stores are operational units of the organized retailers in food supply chain. Small farmers and contract farmers who performed a trade contract with the local retailers are the primary source of supply of vegetables to the organized retailers. The buying centers purchases the vegetable directly from the farmers and transport to the hubs. A hub is performed by one or more buying centre and a buying centre supplies to one or more hubs. Hub buys a small volume of vegetables from the local market to balance demand supply gap. Hub in turn, distributes vegetables to retail outlets attached to it. A store is served through hub only. Retail store sells vegetable in retail quantity to the customers.

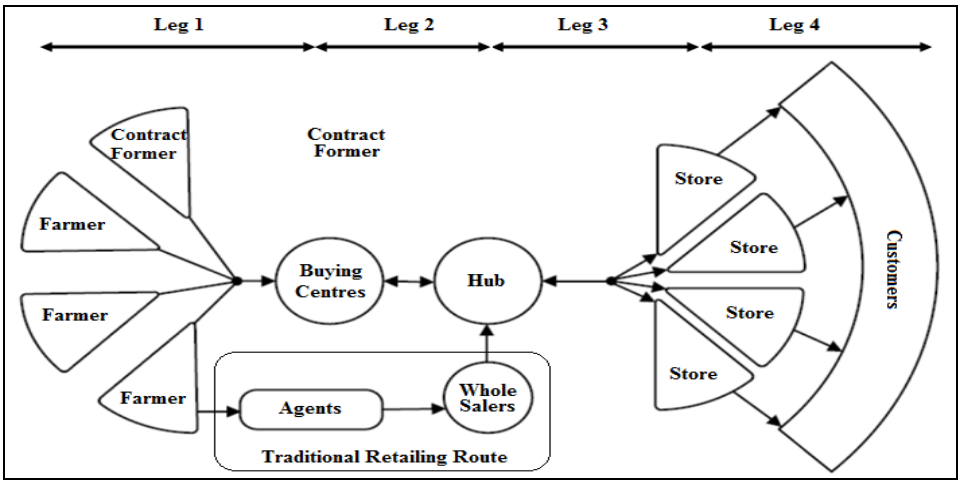

Figure 1. Proposed model for hub and spoke business

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Vegetables travel in four stages, namely farmers to organized retailer's buying centers of leg 1, buying centre to hubs of leg 2, from hub to retail stores of leg 3 and retail outlet to the customer of leg 4. Farmers transport vegetables from agricultural location to the buying centers or local market. The transport of vegetables in the second phase from buying centers to the hub is organized by buying centre. Fresh vegetables are transported in the third phase from hub to retail stores. The sorting and grading are done at the hub without packaging. The framework for performance measures of food SCM has been arrived based on the twenty seven questionnaires was collected from the retailers. The questionnaires were covered broadly in the area of price, quantity, quality, operation, time and uncertainty on customer sight. The response rate was about 60%, but this response rate can be considered as majority of the customer's expectation. The major anticipation of customers is quality, freshness and variety these are the major influence for the customer to visit retail shops. The questionnaire analysis result has shown that the price of vegetable influences on sales volume, about 85% of response rate was there is no influence on the price of vegetables in sales volume.

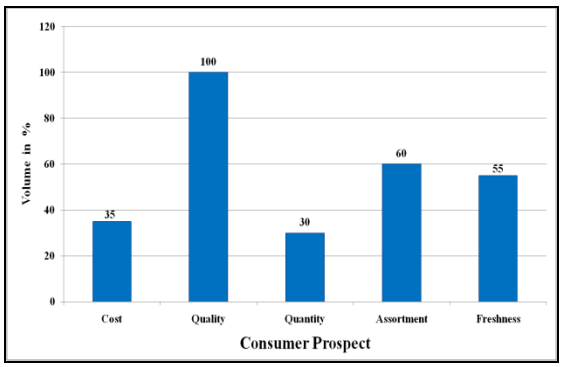

Figure 2. Customer expectations

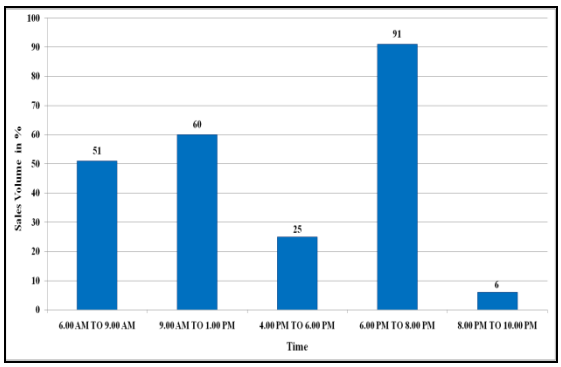

Figure 3. Sales volume vs time

The Figure 2 shows the response for customer's expectation from retailers, more than 50% percentage of customer's response was quality, variety, and freshness of the vegetables. Figure 3 shows the highest sales time on retail shop, more than 50% percentage of the retail shop responded as forenoon and after working hours. The key performance indicators have been selected based on questionnaire analysis. The key performance as follows,

- Demand fill rate is a measure of percentage of items ordered that is actually received to determine whether an order is filled in the correct quantities with the correct products for a defined period of time.
- Frequency of order fill rate is a measure of percentage of an order has been fulfilled in a defined period of time.
- Percentage of deflated quantity is a measure of percentage of products received in a shipment with the deflated quantity.
- On time arrival is measure of percentage of shipments arriving on time for a set delivery date during on a defined period of time.

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- Order Compliance is a measure of percentage of orders that meet the set criteria like correct products received in the correct amounts, at the correct time, in the correct packaging; quantity shipped equals quantity received, etc. out of all orders fulfilled during on a defined period of time.

4.0 Results and Discussion

4.1 Frequency of Order Fill Rate

The results of frequency of order fill rate of retail store for different vegetables are given in Table 1 and has been arrived based on the demand from retail shops on a defined period of time. The frequency of order fill rate results for hub are given in Table 2 and has been arrived based on the demand from retail shops on a defined period of time. Similarly, the results of frequency of order fill rate for wholesaler are given in Table 3 and has been arrived based on the demand from the hub on a defined period of time. The frequency of order fill rate of the hub depends on the order and supply quantity of vegetables from the wholesaler and local purchase for a defined period of time.

Table 1. Results of frequency of order fill rate

Sl. No.	Vegetables	First Month (%)	Second Month (%)	Third Month (%)
1	Onion	55	100	100
2	Tomato Organic	88	80	60
3	Tomato Apple	100	100	90
4	Carrot	88	80	75
5	Potato	100	100	90
6	Coconut	65	62	90
7	Cabbage	100	90	85
8	Cauliflower	100	62	85
9	Ladies Finger	65	100	75
10	Beans	88	100	65
11	Cucumber	75	62	52

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Table 2. Results of frequency of order fill rate

Sl. No.	Vegetables	First Month (%)	Second Month (%)	Third Month (%)
1	Onion	100	100	100
2	Tomato Organic	75	70	85
3	Tomato Apple	85	100	85
4	Carrot	30	90	52
5	Potato	100	100	100
6	Coconut	85	90	100
7	Cabbage	85	45	52
8	Cauliflower	100	70	100
9	Ladies Finger	65	100	90
10	Beans	100	100	60
11	Cucumber	75	90	90

Table 3. Results of frequency of order fill rate

Sl. No.	Wholesaler	Vegetables	Second Month (%)	Third Month (%)
1	Wholesaler 1	Cabbage	80	100
2	Wholesaler 2	Carrot	90	100
3	Wholesaler 3	Ladies Finger	45	65
4	Wholesaler 4	Cucumber	60	75
5	Wholesaler 5	Cauliflower	70	90

4.2 Demand Fill Rate

The demand fill rate results of retail store are given in Table 4 is a measure of the percentage of items ordered that are actually received to determine whether an order is filled in the correct quantities with the correct products for a defined period of time. The demand fill rate results of the hub are given in Table 5 is a measure of the percentage of items ordered that are actually received to determine whether an order is filled in the correct quantities with the correct products for a defined period of time. Similarly, the results of demand fill rate for wholesaler are given in Table 6 is a measure of the percentage of items ordered that are actually received to determine whether an order is filled in the correct quantities with the correct products for a defined period of time.

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Table 4. Fill rate results of retail store

Sl. No.	Vegetables	First Month (%)	Second Month (%)	Third Month (%)
1	Onion	100	105	105
2	Tomato Organic	95	100	95
3	Tomato Apple	100	100	100
4	Carrot	95	100	100
5	Potato	125	130	115
6	Coconut	105	100	115
7	Cabbage	100	95	95
8	Cauliflower	115	105	120
9	Ladies Finger	235	165	100
10	Beans	105	110	95
11	Cucumber	105	100	105

Table 5. Demands fill rate results of hub

Sl. No.	Vegetables	First Month (%)	Second Month (%)	Third Month (%)
1	Onion	150	165	135
2	Tomato Organic	100	100	100
3	Tomato Apple	100	100	100
4	Carrot	92	100	95
5	Potato	215	180	165
6	Coconut	125	120	120
7	Cabbage	100	100	100
8	Cauliflower	125	105	120
9	Ladies Finger	115	150	220
10	Beans	105	105	100
11	Cucumber	105	110	110

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Table 6. Demands fill rate results of wholesaler

Sl. No.	Wholesaler	Vegetables	Second Month (%)	Third Month (%)
1	Wholesaler 1	Cabbage	100	100
2	Wholesaler 2	Carrot	100	100
3	Wholesaler 3	Ladies Finger	95	95
4	Wholesaler 4	Cucumber	95	100
5	Wholesaler 5	Cauliflower	100	100

4.3 Percentage of Deflated Quantity

The percentage of damage quantity results for three months are given in Table 7 is a measure of the percentage of products received in a shipment with that of deflated quantity. The rest of the vegetables have a limited shelf life, which may not be able to store in a hub for a long time. Also the customer expectation was quality and freshness of vegetables.

Table.7 Percentage of damage quantity

Vegetables	First Month (%)	Second Month (%)	Third Month (%)
Onion	0.55	0.30	1.00
Potato	7.60	0.55	0.60

4.4 On Time Arrival

On time arrival is a measure of the percentage of shipments arriving on time for a set delivery date during on a defined period of time are given in Table 8, Table 9 and Table 10.

Table 8. On time arrival of wholesaler for first month

Sl. No.	Wholesaler	Vegetables	On Time Arrival (Specified Time) (%)	On Time Arrival (Specified Time + 60 min) (%)	On Time Arrival (Specified Time + 120 min)
1	Wholesaler 1	Cabbage	100	100	100
2	Wholesaler 2	Carrot	85	90	90
3	Wholesaler 3	Ladies Finger	60	90	100
4	Wholesaler 4	Cucumber	60	80	85
5	Wholesaler 5	Cauliflower	100	100	100

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Table 9. On time arrival of wholesaler for second month

Sl. No.	Wholesaler	Vegetables	On Time Arrival (Specified Time) (%)	On Time Arrival (Specified Time + 60 min) (%)	On Time Arrival (Specified Time + 120 min)
1	Wholesaler 1	Cabbage	90	100	100
2	Wholesaler 2	Carrot	35	70	85
3	Wholesaler 3	Ladies Finger	75	100	100
4	Wholesaler 4	Cucumber	35	75	85
5	Wholesaler 5	Cauliflower	95	95	100

Table 10. On time arrival of wholesaler for third month

Sl. No.	Wholesaler	Vegetables	On Time Arrival (Specified Time) (%)	On Time Arrival (Specified Time + 60 min) (%)	On Time Arrival (Specified Time + 120 min) (%)
1	Wholesaler 1	Cabbage	100	100	100
2	Wholesaler 2	Carrot	25	75	92
3	Wholesaler 3	Ladies Finger	55	92	100
4	Wholesaler 4	Cucumber	15	70	92
5	Wholesaler 5	Cauliflower	100	100	100

4.5 Order Compliance

Order Compliance is a measure of the percentage of orders that meet the correct products received in the correct amounts, at the correct time out of all orders fulfilled during on a defined period of time. The results in Table 8, Table 9 and Table 10 are a measure for the on time arrival of vegetables on a specified time at the hub. Certainly, order compliance will be equal to the on time arrival. Because from the results of Table 6 is clear to understand that the wholesaler always supplies the demand quantity.

5.0 Conclusions

The objective of performance evaluation of demand, supply, quality and freshness of perishable products was carried out and will have a high influence on customers need. Based on the measures the following conclusions were made.

- The supply of vegetables is being highly influenced on seasonal, weather and harvesting conditions, also the growth and harvesting details may not be readily available in our scenario. The performance measures can integrate with enterprise resource planning software to get a live update on meeting fill rates, demand fulfillment.

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- ❖ The on time arrival of wholesalers determines the on time delivery from hub to retail store, also these have an impact on the hub operation and utilization of the resource.
- ❖ The vegetables have a limited, perishable life; within the stipulated time it has to reach customers.
- ❖ The customer expectations are quality and freshness can meet through a high velocity of the supply chain.

References

[1] M.A. Wibowo and M.N. Sholeh, (2015), "The analysis of supply chain performance measurement at construction project", Procedia Engineering, Vol. 125, pp. 25-31.
[2] S. Nallusamy, Christina Mary P. Paul and Pragna. B. Dolia, (2018), "Development of inventory model for health care system in multi-speciality hospitals using ARENA", Indian Journal of Public Health Research and Development, , Vol. 9, No. 2, pp. 276-282.
[3] Wang, Mathiyazhagan, L. Xu and Diabat, (2016), "A decision making trial and evaluation laboratory approach to analyze the barriers to green supply chain management adoption in a food packaging company", Journal of Cleaner Production, Vol. 117, pp. 19-28.
[4] S. Nallusamy, D. Sri Lakshmana Kumar, K.Balakannan and P.S.Chakraborty, (2015), "MCDM tools application for selection of suppliers in manufacturing industries using AHP, Fuzzy Logic and ANN", International Journal of Engineering Research in Africa, Vol. 19, pp. 130-137.
[5] A. Kaleel Ahmed, C.B. Senthil Kumar and S. Nallusamy, (2018), "Study on environmental impact through analysis of big data for sustainable and green supply chain management", International Journal of Mechanical and Production Engineering Research and Development, Vol. 8, No. 1, pp. 1245-1254.
[6] S. Nallusamy, R. Nivedha, E. Subash, V. Venkadesh, S. Vignesh and P. Vinoth kumar, (2018), "Minimization of rejection rate using lean six sigma tool in medium scale manufacturing industry", International Journal of Mechanical Engineering and Technology, Vol. 9, No. 1, pp. 1184-1194.
[7] S. Nallusamy, R. Suganthini Rekha, K. Balakannan, P.S. Chakraborty and Gautam Majumdar, (2015), "A proposed agile based supply chain model for poultry based products in India", International Journal of Poultry Science, Vol. 14 (1), pp. 57-62.
[8] K.M. Ayshath Zaheera, C.B. Senthil Kumar and S. Nallusamy, (2018), "Execution of selection process in regular area of industrial application with its current features for manufacturing enhancement in SMEs", International Journal of Mechanical and Production Engineering Research and Development, Vol. 8, No. 1, pp. 1191-1198.
[9] S. Nallusamy, Vijay Kumar, Vivek Yadav, U. Kumar Prasad and S.K. Suman, (2018), "Implementation of total productive maintenance to enhance the overall equipment effectiveness in medium scale industries", International Journal of Mechanical and Production Engineering Research and Development, Vol. 8, No. 1, pp. 1027-1038.
[10] Zheng and Ling, (2013), "Emergency transportation planning in disaster relief supply chain management: A cooperative fuzzy optimization approach", Soft Computing, Vol. 17(7), pp. 1301-1314.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 1, March - May, 2018
Pages 97-109 | Cosmos Impact Factor (Germany): 5.195
Received: 04.03.2018 Published : 11.04.2018

[11] S. Nallusamy, A.M. Muhammad Umarmukdhar and R.Suganthini Rekha, (2015), "A proposed supply chain model for productivity enhancement in medium scale foundry industries", International Journal of Engg. Research in Africa, Vol. 20, pp. 248-258.
[12] V. Saravanan, S. Nallusamy and Abraham George, (2018), "Efficiency enhancement in a medium scale gearbox manufacturing company through different lean tools - A case study", International Journal of Engineering Research in Africa, Vol. 34, pp. 128-138.
[13] S. Nallusamy and Adil Ahamed M.A., (2017), "Implementation of lean tools in an automotive industry for productivity enhancement - A case study", International Journal of Engineering Research in Africa, Vol. 29, pp. 175-185.
[14] Zhong, Newman, Huang and Lan, (2016), "Big Data for supply chain management in the service and manufacturing sectors: challenges, opportunities and future perspectives", Computers and Industrial Engineering, Vol. 101, pp. 572-591.
[15] S. Nallusamy, (2015), "Lean manufacturing implementation in a gear shaft manufacturing company using value stream mapping", International Journal of Engineering Research in Africa, Vol. 21, pp. 231-237.
[16] V. Ramakrishnan, S. Nallusamy and M. Rajaram Narayanan, (2018), "Study on lean tools implementation in various Indian small and medium scale manufacturing industries", International Journal of Mechanical and Production Engineering Research and Development, Vol. 8, No. 1, pp. 969-976.
[17] S. Nallusamy and Gautam Majumdar, (2017), "Enhancement of overall equipment effectiveness using total productive maintenance in a manufacturing industry", International Journal of Performability Engineering, Vol. 13, No. 2, pp. 01-16.
[18] S. Nallusamy, (2016), "A proposed model for sustaining quality assurance using TQM practices in small and medium scale industries", International Journal of Engineering Research in Africa, Vol. 22, pp. 184-190.
[19] V. Saravanan, S. Nallusamy and K. Balaji, (2018), "Lead Time Reduction through Execution of Lean Tool for Productivity Enhancement in Small Scale Industries", International Journal of Engineering Research in Africa, Vol. 34, pp. 116-127.
[20] S. Nallusamy, R. Balaji and S. Sundar, (2017), "Proposed model for inventory review policy through ABC analysis in an automotive manufacturing industry", International Journal of Engineering Research in Africa, Vol. 29, pp. 165-174.
[21] S. Nallusamy, (2016), "Frequency analysis of lean manufacturing system by different critical issues in Indian automotive industries", International Journal of Engineering Research in Africa, Vol. 23, pp. 181-187.
[22] V. Ramakrishnan and S. Nallusamy, (2017), "Implementation of total productive maintenance lean tool to reduce lead time - A case study", International Journal of Mechanical Engineering and Technology, Vol. 8, No. 12, pp. 295-306.
[23] S. Nallusamy, (2016), "Overall performance improvement of a small scale venture using critical key performance indicators", International Journal of Engineering Research in Africa, Vol. 27, pp. 158-166.
[24] S. Nallusamy, (2016), "A proposed model for lead time reduction during maintenance of public passenger transport vehicles", International Journal of Engineering Research in Africa, Vol. 23, pp. 174-180.

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ISSN : 2456-172X | Vol. 3, No. 1, March - May, 2018
Pages 97-109 | Cosmos Impact Factor (Germany): 5.195
Received: 04.03.2018 Published : 11.04.2018

[25] Gunji Venkata Punna Rao, S. Nallusamy and M. Rajaram Narayanan, (2017), "Augmentation of production level using different lean approaches in medium scale manufacturing industries", International Journal of Mechanical Engineering and Technology, Vol. 8, No. 12, pp. 360-372.
[26] S. Nallusamy, S. Satheesh, P.S. Chakraborty and K. Balakannan, (2015), "A review on supplier selection problem in regular area of application", International Journal of Applied Engineering Research, Vol. 10 No.62, pp. 128-132.
[27] Ray Zhong, Xun Xu and Lihui Wang, (2017) "Food supply chain management: systems, implementations and future research", Industrial Management and Data Systems, Vol. 117(9), pp. 2085-2114.
[28] S. Nallusamy, (2016), "Productivity enhancement in a small scale manufacturing unit through proposed line balancing and cellular layout", International Journal of Performability Engineering, Vol. 12, No. 6, pp. 523-534.
[29] S. Validi, A. Bhattacharya and P. Byrne, (2014), "A case analysis of a sustainable food supply chain distribution system - A multi-objective approach", International Journal of Production Economics, Vol. 152, pp. 71-87.
[30] S. Nallusamy, M. Ganesan, K. Balakannan and C. Shankar, (2015), "Environmental sustainability evaluation for an automobile manufacturing industry using multi-grade fuzzy approach", Int. Journal of Engg. Res. in Africa, Vol.19, pp.123-129.
[31] S. Nallusamy, (2016), "Enhancement of productivity and efficiency of CNC machines in a small scale industry using total productive maintenance", International Journal of Engineering Research in Africa, Vol. 25, pp. 119-126.
[32] V. Ramakrishnan and S. Nallusamy, (2017), "Optimization of production process and machining time in CNC cell through the execution of different lean tools", International Journal of Applied Engineering Research, Vol. 12, No. 23, pp. 13295-13302.
[33] S. Nallusamy, G.B. Dinagaraj, K. Balakannan and S. Satheesh, (2015), "Sustainable green lean manufacturing practices in small scale industries-A case study", International Journal of Applied Engineering Research, Vol. 10(62), pp. 143-146.
[34] Ilkka Sillanpaa, (2015), "Empirical study of measuring supply chain performance", Benchmarking: An International Journal, Vol. 22 (2), pp. 290-308.
[35] S. Nallusamy and V. Saravanan, (2016), "Enhancement of overall output in a small scale industry through VSM, line balancing and work standardization", International Journal of Engineering Research in Africa, Vol. 26, pp. 176-183.
[36] K. Balakannan, S. Nallusamy, P.S. Chakraborty and Gautam Majumdar, (2015), "Selection and evaluation of supplier by decision model of hybrid data envelopment analysis", International Journal of Applied Engg. Research, Vol.10 (62), pp.123-127.
[37] S. Nallusamy, (2016), "Efficiency enhancement in CNC industry using value stream mapping, work standardization and line balancing", International Journal of Performability Engineering, Vol. 12, No. 5, pp. 413-422.
[38] S. Nallusamy and V. Saravanan, (2016), "Lean tools execution in a small scale manufacturing industry for productivity improvement- A case study", Indian Journal of Science and Technology, Vol. 9, No. 35, pp. 1-7.
[39] K. Balakannan, S. Nallusamy, P.S. Chakraborty and Gautam Majumdar, (2016),

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 1, March - May, 2018
Pages 97-109 | Cosmos Impact Factor (Germany): 5.195
Received: 04.03.2018 Published : 11.04.2018

"Performance evaluation of supply chain and logistics management system for efficiency enhancement of automotive industries in India", Indian Journal of Science and Technology, Vol. 9, No. 35, pp. 1-9.

[40] Yakovleva, (2007), "Measuring the sustainability of the food supply chain: A case study of the UK", Journal of Environmental Policy and Planning, Vol. 9 (1), pp. 75-100.