International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Evaluation of Suppliers' Performance – Quality Aspect Using AHP & System Dynamics Techniques

Salonee Sonawane[1], Dr. Lewlyn L.R. Rodrigues[2]

[1]Engineering Management Student, Manipal Institute of Technology, Manipal, Karnataka, India

[2]Head of Department, Department of Humanities and Management, Manipal Institute of Technology, India

Abstract: ***One of the key components of company's integral management policy is Suppliers. Selection, Evaluation and continuous measurement of suppliers are important processes performed in organizations today. Evaluating them on regular basis on various aspects ensures growth for the company. This paper has tried to develop System Dynamics model to help evaluating a Washing Machine Company its' supplier base.***

Keywords: Suppliers' Performance, Quality, System Dynamics, AHP

1. Introduction

One of the key components of company's integral management policy has always been Suppliers since they have large and direct impact on cost, quality, technology and time-to-market of new products [1]. They form an integral part of Supply chains [2]. Their capabilities heavily influence the organization's ability to produce a quality product at a reasonable cost and within the time frame. The contracts with them usually range from weeks to years. So monitoring suppliers' performance has many merits [3] [4]. For instance, every company with Supplier Evaluation in place achieves 20% improvement in various metrics like quality, cost etc. [5]. Supplier evaluation means recording and ranking the performance of suppliers. Generally, the buyer establishes a set of evaluation criteria that can be used to evaluate and also compare performance of suppliers. The various aspects that are considered during Supplier evaluation are quality, cost, delivery, service etc. [6] [7]. The data required for supplier evaluation can be obtained from various methods like Paper/Web based Questionnaire, site visits and third party certifications [8]. So in this paper, attempt is made to build a model that will evaluate the Suppliers' performance - quality aspect using System Dynamics on the basis of a previously build AHP model. This model pertains to a particular company who is a Washing Machine Manufacturer in India. Its main product is Front Loading Washing Machine supported by Top Loading Washing Machine and Dryers.

System Dynamics (SD) is mainly used to study and also to understand the behavior of a dynamic system so that it is possible to know the behavior of the system in the changing conditions of the controlling parameters through mathematically stimulated models [9][10]. The software used in this paper is Vensim. The great advantage of the software is that it is freely available for academic and educational purposes, and is specifically designed to lower the barriers for the beginning System Dynamics modeler [11].

2. Literature Review

Literature review in the field of supplier selection and evaluation reveals that researchers have used various methods to understand and build various models that will assist in selecting and evaluating suppliers like Analytic Hierarchy Process (AHP), Unit Total Cost, Total Cost of Ownership (TCO), Activity Based Costing (ABC) Approach, Artificial Intelligence and Expert Systems, Life Cycle Costing Approach, Multi-Objective Programming, Multi Attribute Utility Theory (MAUT), Dynamic Programming, and Statistical methods- Data Envelopment Analysis (DEA), Cluster Analysis (CA), and Monte Carlo Simulation Approach. Among these the most prevalent are TCO and AHP. But after comparing these two it was revealed that AHP helps to evaluate and compare suppliers on different qualitative and also quantitative evaluation criteria instead of only cost data as in TCO [12] -[15].

AHP is a Multiple Criteria Decision Making (MCDM) technique which evaluates and weighs the different criteria [16]. After application of AHP to various scenarios, for easy using and calculating the future model – various tools have been used like Microsoft Visual Studio[16], MS Excel[17], Expert Choice[18]. In a study that was conducted for Washing Machine Company, various criteria were listed on which suppliers' quality was found to be depended after a study of 6 months [19]. The work done in this paper is taken to next step by developing System Dynamics model on the basis of these criteria.

System Dynamics have long been used to evaluate and study supply chains. For instance, system dynamics was used to model performance tracking and auditing wherein independent causal loop models were created for Human Resources, Technical Risk etc. [20]. Also, to study the relationships between various supply chain partners a SD model was developed which had concluded that every partner is responsible for supporting each other to allow optimization of the supply chain [21]. Another SD model was developed to represent supply chain collaboration between suppliers and buyer. It concluded that critical details like supplier selection, matching inter-organizational needs and capabilities, defining standards and goals, and numerous operational decisions such as the allocation of the order quantity among multiple suppliers are required to maintain the trust level between

suppliers and buyers [22]. In this paper, SD model is developed to evaluate the Suppliers' performance, giving consideration to quality.

3. Methodology

3.1 Overview of the Model

The model, Figure 1, consists of three main evaluation criteria which will be further modelled into three different independent subsystems. They are:

1. Processes Quality
2. System Quality
3. Gauge Calibration

The local weights found by AHP are used in subsystem models to establish relation between the various parameters [19].

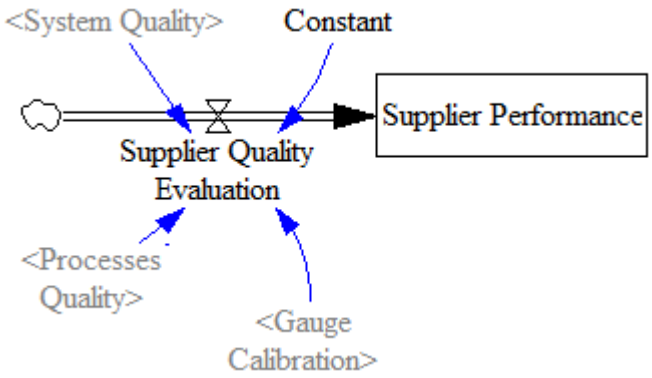

Figure 1: Overview of the Model

3.2 Model Subsystems

3.2.1 Processes Quality

This subsystem model, Figure 2, takes care of the various checkpoints at the Incoming, Process and Outgoing Inspection levels.

For example:
With Process Validation it is ensured that the product manufactured is within the acceptance range as decided with the buyer.
Processes which require physical inspection of the product requires display of limit samples in the work area for instance in case of molding, limit sample of the part should be displayed that will enable the person in charge to visually inspect and take the necessary actions required like noting and changing process parameters if discrepancies occur.

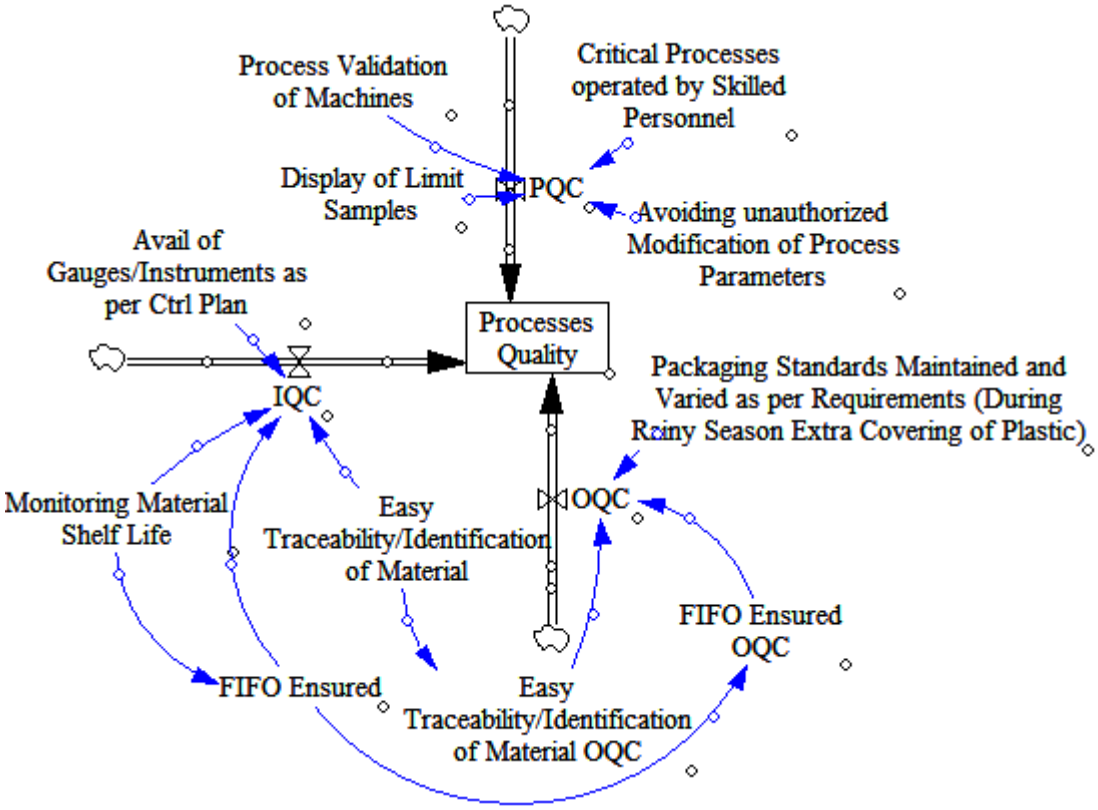

Figure 2: Processes Quality Subsystem Model

3.2.2 System Quality

This subsystem model, Figure 3, tries to pinpoint the system requirements at the suppliers' end so as to ensure the required standards of quality are maintained. Organizations trying to climb next levels of excellence need to have their suppliers aligned with their direction [23]. Since ABC Company pursues continuous improvement programs like Six Sigma, Total Quality Management etc. it expects its' suppliers to do the same.

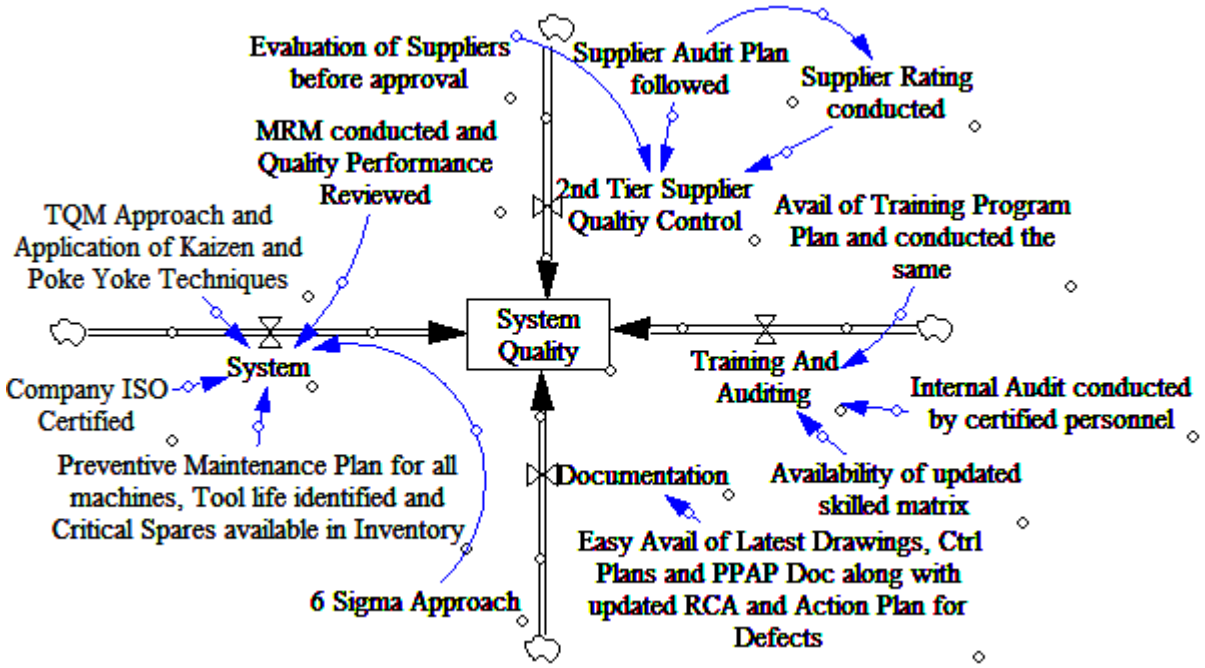

Figure 3: System Quality Subsystem Model

3.2.3 Calibration

It has been observed that good measurement quality minimizes the cost of production processes as accurate measurements can help to reduce process variation, scrap, rework and other costs of poor quality [23]. Hence this subsystem model is created to take care of these points.

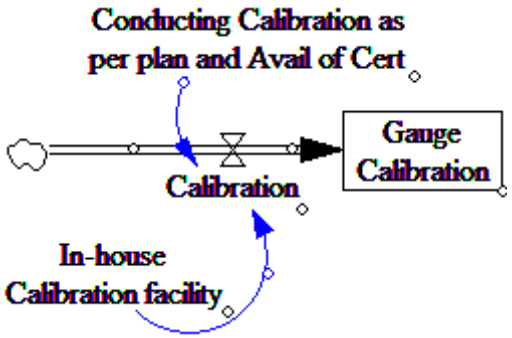

Figure 4: Gauge Calibration Subsystem Model

4. Results

After the model was developed site visits were conducted. Five Suppliers were chosen and their performance was compared. Out of these five suppliers, three (Suppliers 2, 3 and 4) had poor defects PPM (Parts per Million) and two (Supplier 1 and 5) had defects PPM within the acceptable limits. In PPM, rejections for the month are extrapolated to find the number of rejections if the production was 1 million. Their performances were compared for all the Subsystem Models. Following are the results that were obtained. The graphs suggest the likeable performance of suppliers for the period of next 2 years if the suppliers continue the way they are working towards improving quality.

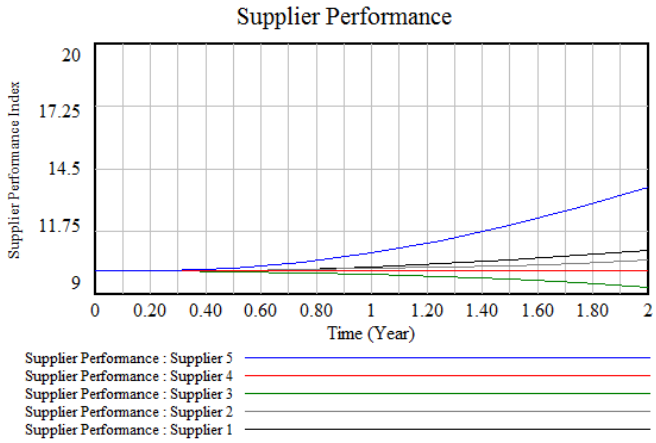

Figure 5: Supplier Performance of Five Suppliers

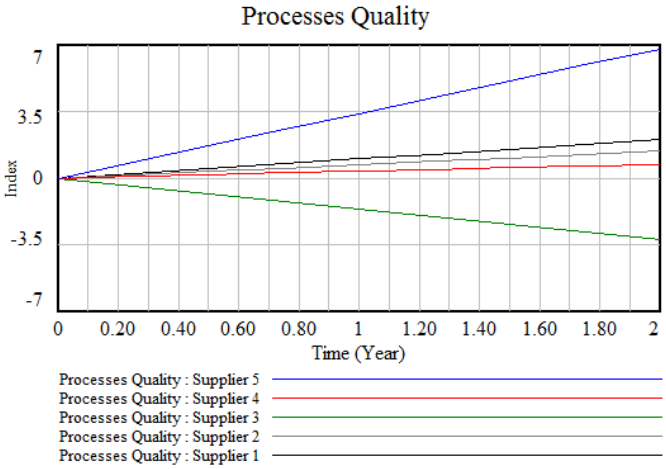

Figure 6: Processes Quality Performance of Five Suppliers

From fig 5, it was observed that Supplier 3 had the least performance among the five suppliers. The areas that it needs to improve are Processes quality and Gauge Calibration. Since Supplier 4 did not possess any data regarding its' Gauge Calibration it was not evaluated for it. From Figures 7 and 8, Supplier 4 has to work on Systems Quality and Calibration of Gauges, and Supplier 2 on calibration of gauges. It was decided that with the suppliers their respective data would be shared and the action plan to improve on their weak areas would be charted out.

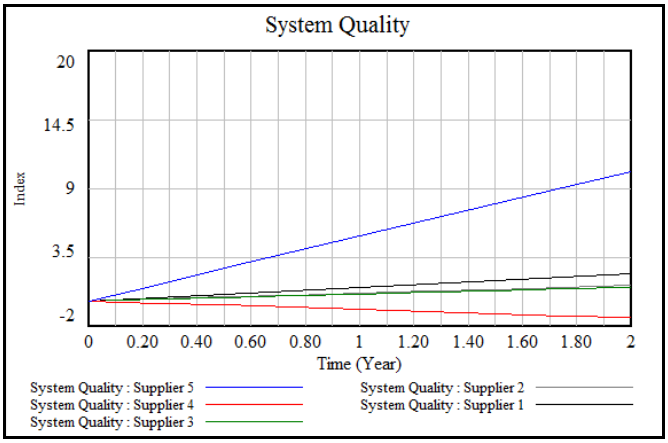

Figure 7: System Quality Performance of Five Suppliers

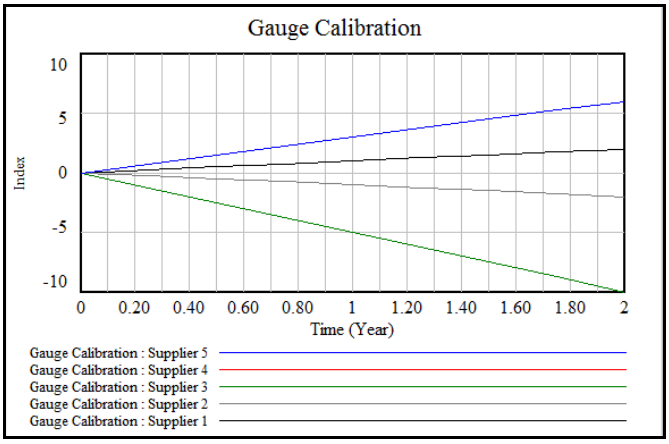

Figure 8: Gauge Calibration Performance of Five Suppliers

5. Conclusion

In this paper, a model, which adopts System Dynamics and has the basis in AHP, is constructed to evaluate the Suppliers' Performance – Quality Aspect for a Washing Machine Company in India. The model assisted in thorough thinking and decision making. The model enabled to assess and monitor suppliers' performance – quality aspect. Since the model requires site visits, the model is preferably to be applied for suppliers whose defects ppm was not within the acceptable limits. It could also be applied to suppliers who have requested for development assistance to the company. This would help the company to highlight strengths and weaknesses of the suppliers. For suppliers whose product quality is not up to the mark the company can pinpoint its' weaknesses and ask to improve those areas particularly instead of just a vague "Improve Quality" phrase. The data of the "Best Performer" can be used to create competitiveness among the Suppliers. Continuous reviewing standards will lead to continuously improving Supplier Performance. So at the end it can be concluded that "You can't manage what you don't measure. Hence measuring supplier performance will improve them". [8]

References

[1] M. K. S. Bhutta, "Supplier Selection Problem: Methodology Literature Review," *Journal of International Information Management*, vol. 12, no. 2, 2003.
[2] K. C. Tan, "A Framework of supply chain mangagement literature," European Journal of Purchasing & Supply Management, no. 7, pp. 39-48, 2001.
[3] W. Benton, "Supplier Selection and Evaluation," in Purchasing and Supply Chain Management, 2nd ed., Mc Graw Hill Education, pp. 157-206
[4] D. R. Beil, "Supplier Selection," Wiley Encyclopedia of Operations Research and Management Science, 15 June 2010.
[5] Sherry R. Gordon, "Supplier Evaluation: Benefits, Barriers and Best Practices," in Proceedings of the 91st Annual International Supply Management Conference, Minneapolis Convention Center, Minneapolis, May 2006.
[6] Valerie J. Stueland, "Supplier Evaluations: Best Practices and Creating or Improving Your Own Evaluation," in Proceedings of the 89th Annual International Supply Management Conference, Philadelphia, PA, 2004, April 25-28.
[7] K. John, V. Y. Baby and G. S. Mangalathu, "Vendor Evaluation and Rating Using Analytical Hierarchy Process," International Journal of Engineering Science and Innovative Technology (IJESIT), vol. 2, no. 3, pp. 447-455, May 2003.
[8] S. Gordon, "Seven Steps to Measure Supplier Performance," Quality Progress, pp. 20-25, August 2005.
[9] B. J. Ranganath and L. L. Rodrigues, System Dynamics Theory and Case Studies, New Delhi: I.K. International Publishing House Pvt. Ltd., 2008.
[10] R. A. K. Letcher, A. J. Jakeman, . O. Barreteau, M. E. Borsuk, S. ElSawah, S. H. Hamilton, H. J. Henriksen, S. Kuikka, H. R. Maier, A. E. Rizzoli, H. v. Delden and A. A. Voinov, "Selecting among six modelling approaches for integrated environmental assessment and managemement," Environmental Modelling & Software, vol. 47, pp. 159-181, September 2013.
[11] Ventana System, Inc., "Vensim Personal Learning Edition," [Online]. Available: http://vensim.com/vensim-personal-learning-edition/. [Accessed May 2015].
[12] W. Ho and P. K. Dey, "Strategic sourcing: a combined QFD and AHP approach in manufacturing," Supply Chain Management: An International Journal, vol. 16, no. 6, pp. 446-461, 2011.
[13] K. S. Bhutta and F. Huq, "Supplier Selection Problem: A comparative study of the Total Cost of Ownership and Analytic Hierarchy Process approaches," Supply Chain Management: An International Journal, vol. 7, no. 3, pp. 126-135, 2002.

[14] Z. Cheng, Value-Based Management of Suppliers Relationships and Supply Contracts, Josef Eul Verlag Gmbh, 2009.
[15] J. I. Moline and A. M. Coves, "Supplier Evaluation and Selection: A review of the literature since 2007," in 7th International Conference on Industrial Engineering and Industrial Management, Valladoid, 2013.
[16] F. Tahriri, R. Osman, A. Ali, R. M. Yusuff and A. Esfandiary, "AHP approach for supplier evaluation and selection in a steel manufacturing company," Journal of Industrial Engineering and Management, vol. 1, no. 2, pp. 54-76, 2008.
[17] Massaeli, "Ranking of maximum production strategies in gas processing plant of National Iranian Gas Company using AHP," in Proceedings of the 2nd International Conference on Industrial Engineering and Operations Management, Kuala Lumpur, Malaysia, 2011, January 22-24.
[18] H. L. Nguyen, C.-M. Fong and C.-T. Ho, "Using Analytical Hierarchy Process in Decision Analysis - The Case of Vietnam State Securities Commission," iBusiness, vol. 2, no. 2, pp. 139-144, June 2010.
[19] S. Sonawane and L. L. Rodrigues, "Using AHP Approac, Evaluation of Quality - A Case Study with respect to a Washing Machine Company," International Journal of Management, Innovation and Entrepreneurial Research, vol. 1, no. 1, pp. 15-23, April 2015.
[20] K. Ross-Smith and M. Yearworth, "Dynamics of Operational Procurement: Systems Modelling for Performance Tracking and Auditing," in 29th International Conference of the System Dynamics Society, Washington, DC, 2011.
[21] A. Li, "A Supply Chain Paradox," in 29th International Conference of the System Dynamics Society, Washington, DC, 2011.
[22] Y. Tseng, W. Wang and M. Wang, "A System Dynamics Model of Evolving Supply Chain Relationships and Inter-Firm Trust," in 30th International Conference of the System Dynamics Society, St. Gallen, Switzerland, 2012.
[23] G. C. Payne, "Calibration: Why It's Important," Quality Progress, September 2005.