EXECUTION OF VALUE ENGINEERING APPROACH FOR DESIGN DEVELOPMENT AND COST REDUCTION OF MONOBLOCK PUMP

Sri Lakshmana Kumar[1], S. Nallusamy[2] and Rakesh Modak[2]
[1]Department of Mechanical Engineering, Arba Minch University, Ethiopia
[2]Department of Mechanical Engineering, Dr. M G R Educational and Research Institute, Chennai, Tamil Nadu, India
E-Mail: srilakshmana.kumar@amu.edu.et

ABSTRACT

In this global competitive market, the modern manufacturing industries are moving towards the betterment of production by reducing cost with no compromise on the customer satisfaction. This article focused the detailed work of value engineering to be implemented for any kind of products in order to optimize the value of a particular item. This research work presents a case study clearly showing the development of design and reduction of cost involved in a monoblock pump. There are few mandatory points were observed during the study period of the product that the cost of pump is high due to the usage of expensive material as well as more material usage. In order reduce the cost without sacrificing the quality of the product, few main components of the product such as impeller, main and auxiliary winding, adaptor and end cover which are having great scope to achieve the good customer feedback in performance wise. The value engineering technique has been applied on the components to enhance the design and reduce the overall cost. For impeller material modification, for adaptor and end cover changes in design and modifications in winding turns for coil winding has been suggested and thereby the overall cost reduction has been achieved through value engineering approach. From the results it was found that, implementation of value engineering to selected four components of the product reduces the cost about 24.84% in the overall manufacturing cost.

Keywords: value engineering, monoblock pump, design, materials, job plan, cost reduction.

INTRODUCTION

Value Engineering (VE) is a systematic approach aimed to achieve the desired functions of a product, process, system or service at a minimum overall cost, and having maximum performance with consistency without in any way affecting the quality, reliability, performance and safety of the product, process, system or service. Value engineering is a vibrant tool which can be applied not only in engineering but also any kind of products and any kind of industries. The Society of American Value Engineers International (SAVE) uses the broad term-value methodology, defined as the systematic application of recognized techniques which identify the functions of the product or service, establish the worth of those functions, and provide the necessary functions to meet the required performance at the lowest overall cost. The case study is structured with defines the concept of value engineering in the first phase. Several definitions are given making the concept more cohesive and explaining the need of VE in the present scenario where cost optimization has become a critical need for every industry to survive in this competitive environment. During the second phase of the study it defines the VE job plan which should be followed for analyzing any product. A case study has been discussed clearly which facilitates to reach a solid solution of the problem discussed here at the third phase and the final conclusion and future scope of value engineering have been provided at the final phase.

LITERATURE REVIEW

In a global competitive market the manufacturers are required to maximize their product value and minimize the overall cost of the product [1-3]. Value engineering involves an objective appraisal of functions performed by parts, components, products, equipment, procedures, and services related to the cost of the product [4, 5]. The purpose of the value engineering systematic approach (VESA) is to provide each individual with a means of skillfully, deliberately and systematically analyzing and controlling the total cost of product. This total cost control is accomplished, in the main, by the systematic analysis and development of alternative means of achieving the functions that are desired and required. The purpose of VESA is well served when the user is able to define and segregate the necessary from the unnecessary and thereby develop alternate means of accomplishing the necessary at a lower cost. Hence value engineering may be defined as, an organized procedure for efficient identification of unnecessary cost [6, 7]. Similarly, lean manufacturing is a performance based practice used in industries to increase profit by removing waste, reducing cycle time and decreasing component cost [8-11].Lean practices facilitate the manufactures to minimize the overall lead time, to maximize the customer needs and to reduce the cost by means of removing waste [12-15].

There are three major segments in the value engineering process such as pre-study, value study and post-study. The VE job plan is a systematic plan to make sure that the VE analyzing team understands customer requirements and develops a cost effective solution [16]. The schematic diagram of VE job plan for this research is shown in Figure-1. No matter how many steps there are, the process is always the same, analysis, creativity, evaluation and development [17]. A key point in organizing the VE effort is the use of the job plan or value study. The level of information is a fact-finding phase used to accumulate all the factual information available in regard to the proposed area of study. The level of function

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

analysis is the heart of the value engineering methodology. The function analysis is based on two major parts such as define a function and evaluate the function relationships. The VE team evaluates the ideas generated in the creativity phase using one of a number of techniques, many of which depend upon some form of weighted vote. This level forms a crude filter for reducing the ideas generated to a manageable number for further study [18]. The function of the post-study is to assure the implementation of the approved value study change recommendations. Implementation tasks are made by the VE team, the organization‘s own personnel or together [19]. Value stream mapping was developed in an assembly process of pump parts to recognize and eradicate the wastes that do not add value to the final manufactured goods during the assembly process [20-22]. The actions of total productive maintenance are to reduce the losses related to equipment and to improve the availability, performance and quality rate [23-25]. VE idea has been applied in a big infrastructures project expansion and the results were acknowledged supplementary function and also the cost analysis for life cycle was established the growing in value for money from added functions in the particular assignments [26-29].

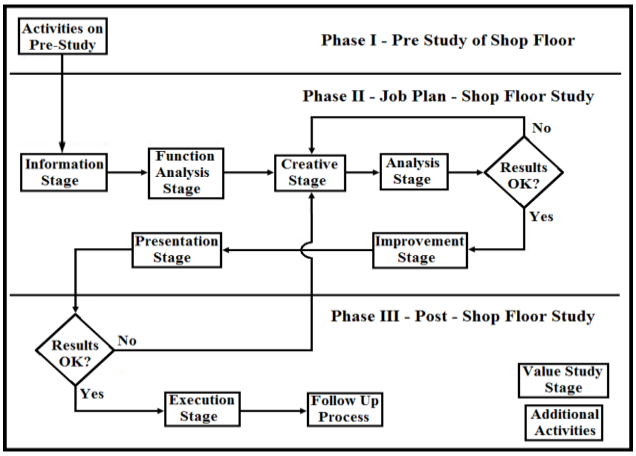

Figure-1. Schematic diagram of VE job plan.

The value engineering methodology is a systematic process that follows the job plan activities. A value methodology is applied by a multidisciplinary team to improve the value of a project through the analysis of functions. The job plan consists of the following sequential stages [7]. Information stage defines the current conditions of the project and identifies the goals of the study. Function analysis stage defines the project functions using a two-word active verb/ measurable noun context to determine which need improvement, elimination, or creation to meet the project's goals. Creative stage is to identify other ways to perform the project's function(s). Evaluation stage follows a structured evaluation process to select those ideas that offer the potential for value improvement while delivering the project's function(s) and considering performance requirements and resource limits. Development stage develops the selected ideas into alternatives with a sufficient level of documentation to allow decision makers to determine if the alternative should be implemented. Presentation stage develops a report and/or presentation that documents and conveys the adequacy of the alternative(s) developed by the team and the associated value improvement opportunity. And also implementation stage management must assure that approved recommendations are converted into actions. Until this is done, savings to offset the cost of the study will not be realized

DATA COLLECTION AND ANALYSIS

An ISO certified pump manufacturing company has been selected for this case study which is located at Chennai. The selected industry is producing different types of monoblock pump which they export to various countries around the globe. All of the products manufactured here are conforming to the international standards. One of their models 0.5 HP monoblock pumps has been selected for this study which is having few components like impeller, adaptor, main and auxiliary winding and end cover. This selected model pump has found application in the domestic field. In this article it has been discussed a case study of 0.5HP monoblock pump. The company is also manufacturing wide range of pumps like submersible and monoblock pumps in different ranges from 0.5 HP to 50HP. In this case study 0.5 HP monoblock pump is selected since it is most popular and relatively fast moving product. The components of impeller, adopter, end cover and windings were selected from 0.5HP monoblock pump and the value engineering technique has been implemented for the development of design and reduction of cost. The selected monoblock pump is shown in Figure-2.

Figure-2. 0.5 HP monoblock pump.

From the existing study it was found that the unnecessary increase in cost is due to use of expensive material, mass of materials used in major components thereby increasing the inventory. Therefore through value engineering technique, the following alternative procedures were suggested. Use of alternative less expensive material for impeller, weight reduction for main and auxiliary winding, adaptor and end cover is suggested for cost reduction and the same has been achieved after the implementation.

Impeller

Impeller is transferring the energy from the motor that drives the pump to the fluid being pumped by

ARPN Journal of Engineering and Applied Sciences

accelerating the fluid outwards from the center of rotation. The material of impeller can be changed from gun metal grade LTB-4 to stainless steel grade 410 by keeping same function. The VE job plan for impeller is given in Table-1.

Table-1. VE job plan for impeller

Information		
1	Name of component	Impeller gun metal LTB-4
2	Cost of component	Rs. 427/-
3	Number of parts	One
4	Function of the component	To pressurize the liquid
5	Total number required Current usage quantity.	2000/month
Conjecture and Assessment		
6	Primary function of the component	Pressurize the liquid
7	Changes to be made	Replace gun metal - LTB-4 by stainless steel grade 410
8	Cost of new material	Rs. 245/-
Plan		
9	Ideas of doing the job show the greatest difference between cost and use value	Stainless steel grade 410 impeller
10	Ideas to be developed	Stainless steel grade 410 impeller
11	Other functions related to work or sell and specification features must be included	
Factor	Stainless steel grade 410 impeller	
A. Function	Same as existing	
B. Number of parts	No change	
C. Space required	Same as existing	
D. Durability	Certainty	
E. Aesthetic	Very good	
Selling		
12.	Need to sell our ideas and forestall roadblocks	
A. Model		
B. Sketches		
C. Full drawing		
D. Change of cost - Product		
E. Change of cost -Capital		
F. Change of cost -Revenue		

The minimum amounts which must be spent to achieve the appropriate use and esteem factors are looking for this research. The material of impeller with the same function can be replaced by stainless steel grade- 410 which is shown in Figure-3.

Result of VE job plan is as follows.

Total cost of the existing material=Rs.427/-

Die development charges / piece

$$= \frac{\text{Die development cost}}{\text{No. of years considered X No. of pieces per year}}$$

= 25000/ (5x 2000) = Rs. 15.00

Cost of the proposed material = Die development cost + Material Cost

= 15.00 +230 = Rs.245/-

Net Saving = 427-245 = Rs.182/-

Cost of saving in percentage = 42.6 %

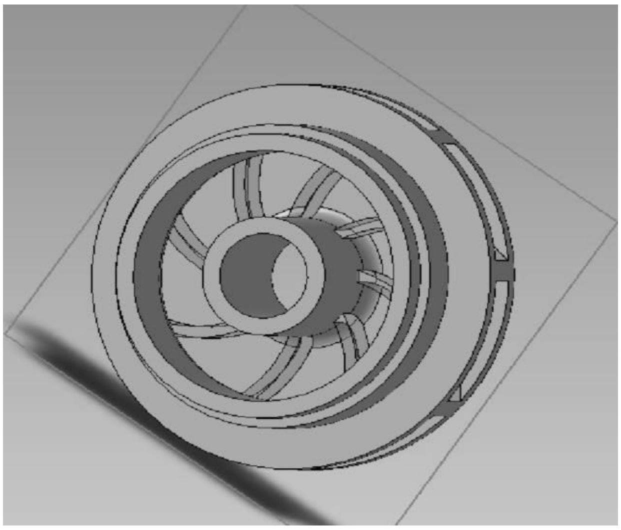

Figure-3. Stainless steel-grade 410 impeller

Windings

The main and auxiliary windings will generate the force to provide the rotational movement to the rotor shaft and to the accompanying parts of the monoblock pump. Main and auxiliary winding has been reduced from 130 to 95 by keeping same the number of turns. The VE job plan for main and auxiliary windings is given in Table-2.

VOL. 13, NO. 5, MARCH 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Table-2. VE job plan for main and auxiliary windings

Information		
1.	Name of component	Main and auxiliary winding
2.	Cost of component	Rs. 551/-
3.	Number of parts	One
4.	Function of the component	To generate force
5.	Total number required Current usage quantity.	2000/month
Conjecture and Assessment		
6.	Primary function of the component	To generate force
7.	Changes to be made	Reduce number of turns in order to reduce weight of the winding
8.	Cost of new material	Rs. 486/-
Plan		
9.	Ideas of doing the job show the greatest difference between cost and use value	Reduce number of turns in order to reduce weight of the winding
10.	Ideas to be developed	Reduce number of turns in order to reduce weight of the winding
11.	Other functions related to work or sell and specification features must be included	
Factor		Stainless steel grade 410 impeller
A. Function		Same as existing
B. Number of parts		No change
C. Space required		Same as existing
D. Durability		Certainty
Selling		
12	Need to sell our ideas and forestall roadblocks	
A. Model		
B. Sketches		
C. Full drawing		
D. Comparison of cost - Product		
E. Change of cost -Capital		
F. Change of cost -Revenue		

The main and auxiliary winding used for the selected 0.5 HP monoblock pump is shown in Figure-4.

Figure-4. Main and auxiliary winding.

The number of turns of main and auxiliary winding has been reduced from 130 to 95 with the same function and result of VE job plan is as follows.

Existing cost = Main winding cost + Auxiliary winding cost

= 380 + 171 = Rs. 551/Quantity

Proposed cost = Main winding cost + Auxiliary winding cost

= 324 + 162 = Rs. 486/Quantity

Cost of saving per quantity = Rs. 65/-

Cost of saving in percentage = 11.79 %

Adaptor

Adaptor is accommodating the stator body and end cover is shown in Figure-5. The weight of the adaptor has been reduced from 4.5 to 3.6 kg by keeping same function.

ARPN Journal of Engineering and Applied Sciences

Table-3. VE job plan for adaptor

Information		
1	Name of component	Adaptor
2	Cost of component	Rs. 295/-
3	Number of parts	One
4	Function of the component	To accommodate stator body and end cover
5	Total number required Current usage quantity.	2000 per month
Conjecture and Assessment		
6	Primary function of the component	Accommodate parts
7	Changes to be made	Reduce the weight of the adaptor
8	Cost of new material	Rs. 231/-
Plan		
9	Ideas of doing the job show the greatest difference between cost and use value	Reduce the weight of the adaptor
10	Ideas to be developed	Reduce the weight of the adaptor
11	Other functions related to work or sell and specification features must be included	
Factor		Reduce no. of turns in order to reduce weight of the winding
A. Function		Same as existing
B. No. of parts		No change
C. Space required		Same as existing
D. Durability		Compact

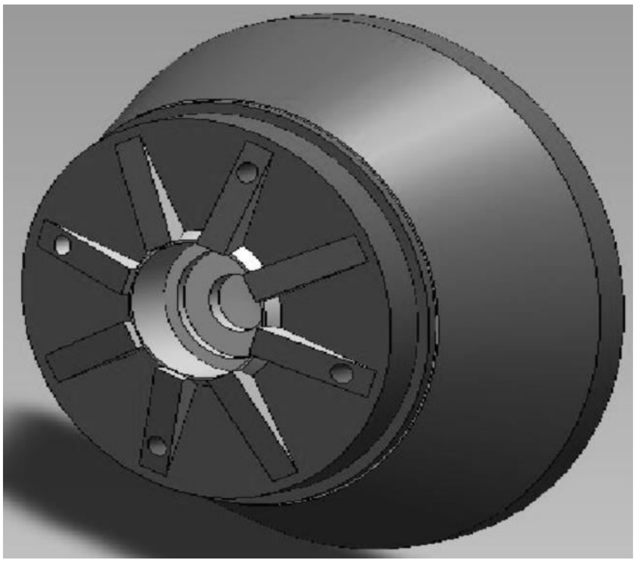

Figure-5. Adaptor.

The weight of the adaptor has been reduced from 4.5 kg to 3.6 kg with the same function. VE job plan is given in Table-3 and the results are as follows.

Existing weight of the material = 4.5 Kg
Proposed weight of the material = 3.6 Kg
Existing and proposed material cost = Rs. 60/-
Labour cost for existing material = Rs. 25/-
Labour cost for proposed material = Rs. 15/-
Therefore, the total cost of the existing material
= (4.5x60) + 25 = Rs. 295/-
The total cost of the proposed material
= (3.6x60) + 15 = Rs. 231/-
Net saving cost = 295-231= Rs.64/-
Cost of saving in percentage = 21.69 %

End cover

End cover is maintaining the monoblock force of the rotor shaft and also ensures the smooth running of the shaft. The weight of the end cover has been reduced from 1.5 Kg to 1 Kg by keeping same function and the VE job plan for end cover is given in Table-4.

Table-4. VE job plan for end cover

Information		
1	Name of component	End cover
2	Cost of component	Rs. 104/-
3	Number of parts	One
4	Function of the component	To maintain the monoblock force
5	Total number required Current usage quantity.	2000 per month
Conjecture and Assessment		
6	Primary function of the component	To maintain the monoblock force
7	Changes to be made	Reduce the weight of the end cover
8	Cost of new material	Rs. 74/-
Plan		
9.	Ideas of doing the job show the greatest difference between cost and use value	Reduce the weight of the end cover
10.	Ideas to be developed	Reduce the weight of the end cover
11.	Other functions related to work or sell and specification features must be included	
Factor		Reduce no. of turns in order to reduce weight of the winding
A. Function		Same as existing
B. No. of parts		No change
C. Space required		Same as existing
D. Durability		Compact

VOL. 13, NO. 5, MARCH 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

The end cover of the monoblock pump is shown in Figure 6.The weight of the end cover has been reduced from 1.5 Kg to 0.5Kg with the same function and result of VE job plan is as follows.

Existing weight of the material = 1.5 Kg
Proposed weight of the material = 1.0 Kg
Existing and proposed material cost = Rs. 60/-
Labour cost for existing material = Rs. 14/-
Labour cost for proposed material = Rs. 14/-

Therefore, the total cost of the existing material
= (1.5x60) + 14 = Rs.104/-

The total cost of the proposed material
= (1.0x60) + 14 = Rs. 74/-

Net saving cost = 104-74= Rs.30/-

Cost of saving in percentage = 28.85 %

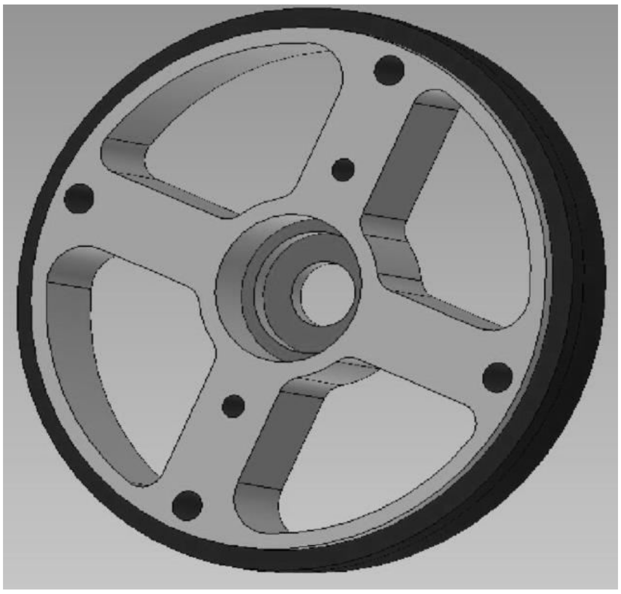

Figure-6. End cover.

After analyzing the data for all four major components the results were compared and tabulated in Table-5. Similarly, the cost comparison chart with % of reduction were developed and shown in Figure-7.

Table-5. Comparison results of cost in rupees

Component name	Existing cost	Proposed cost	Net saving	% of Cost reduction
Impeller	427	245	182	42.60
Main and auxiliary windings	551	485	65	11.79
Adaptor	295	231	64	21.69
End cover	104	74	30	28.85
	1377	1035	342	24.84

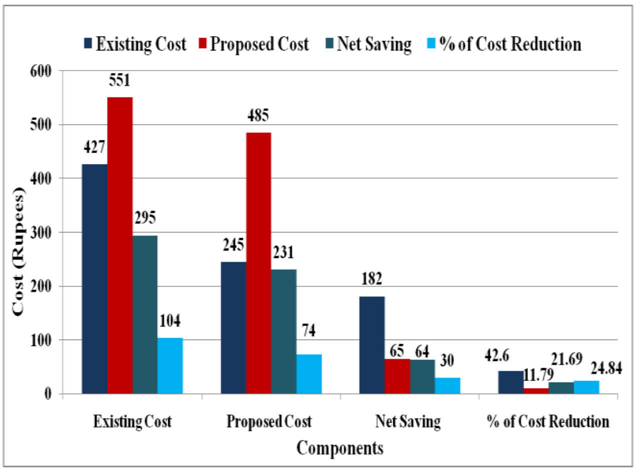

Figure-7. Cost comparison chart with % of reduction.

CONCLUSIONS

In this case study, the unnecessary increase in cost due to use of expensive material, complicated design, increase in variety of hardware items and thereby increasing the inventory was observed. Value engineering is executed by implementing design modifications and materials change in components. From the observed results the following conclusions were made.

- Material modification was suggested for impeller part.
- Design changes were suggested for adaptor, end cover and coil winding turns reduction modification was suggested for main and auxiliary winding.
- Due to the above suggestions the cost reduction of the product has been achieved through value engineering technique.
- It is clear that the execution of value engineering to the selected four components results in net saving of 24.84%.
- The substantial cost reduction was also achieved through value engineering technique in 0.5HP monoblock pump.

REFERENCES

[1] Pimpanont P and Chutima P. 2016. Applications of value engineering in head stack assembly process: A case study. International Journal of Materials, Mechanics and Manufacturing. 4(1): 46-51.

[2] Behncke GH, Maisenbachera and Maurera. 2014. Extended model for integrated value engineering. Proc. Conference on Systems Engineering Research. 781-787.

[3] Nallusamy S. 2016. Frequency analysis of lean manufacturing system by different critical issues in Indian automotive industries. International Journal of Engineering Research in Africa. 23: 181-187.

[4] Achawakorn K, Jearsiripongkul, Suksawat and Fanchaeng. 2013. The effect of pivot bearing

assembly process on natural frequency of actuator arm. Journal of Energy and Power Engineering. 7: 301-305.

[5] Annappa CM and Panditrao KS. 2013. Optimization of furniture product in furniture industry by using value engineering with function analysis, function evaluation and decision matrix-A case study. Int. Journal of Application or Innovation in Engg. & Mgt. 2: 55-64.

[6] Amitsharma and Belokar. 2012. Implementation of value engineering-A case study. Int. J. of Marketing, Financial Services & Mgt. Research. 1(3): 64-70.

[7] Prem Singh and Jagdeep Singh. 2016. Application of value engineering on chassis component for HCV-A case study. International Journal of Knowledge Engineering. 2(1): 43-49.

[8] Nallusamy S and Adil Ahamed. 2017. Implementation of lean tools in an automotive industry for productivity enhancement-A case study. International Journal of Engineering Research in Africa. 29; 175-185.

[9] Nallusamy S and Saravanan V. 2016. Enhancement of overall output in a small scale industry through VSM, line balancing and work standardization. Int. Journal of Engineering Research in Africa. 26: 176-183.

[10] Nallusamy S and Saravanan V. 2016. Lean tools execution in a small scale manufacturing industry for productivity improvement-A case study. Indian Journal of Science and Technology. 9(35): 01-07.

[11] Nallusamy S. 2015. Lean manufacturing implementation in a gear shaft manufacturing company using value stream mapping. International Journal of Engineering Research in Africa. 21: 231-237.

[12] Nallusamy S, Dinagaraj, Balakannan and Satheesh. 2015. Sustainable green lean manufacturing practices in small scale industries-A case study. Int. Journal of Applied Engineering Research. 10(62): 143- 146.

[13] Suganthini Rekha, Periyasamy, Nallusamy S. 2016. An optimized model for reduction of cycle time using value stream mapping in a small scale industry. International Journal of Engineering Research in Africa. 27: 179-189.

[14] Nallusamy S. 2016. Productivity enhancement in a small scale manufacturing unit through proposed line balancing and cellular layout. International Journal of Performability Engineering. 12(6): 523-534.

[15] Nallusamy S, 2016. Efficiency enhancement in CNC industry using value stream mapping, work standardization and line balancing. International Journal of Performability Engineering. 12(5): 413-422.

[16] Zhang and Mao X. 2009. Developing a knowledge management system for improved value engineering practices in the construction industry. Automation in construction. 18: 779-789.

[17] Annappa CM and Panditrao KS. 2012. Application of value engineering for cost Reduction-A Case study of Universal Testing Machine. International Journal of Advances in Engineering & Technology. 4(1): 618-629.

[18] Sharma A, Srivastava, Belokar. 2011. A case study analysis through the implementation of value engineering. International Journal Engineering Science and Technology. 3(3): 2204-2213.

[19] Desai TN, Prajapati and Patel HR. 2016. Application of value engineering to rework reduction in ship building project. MATEC Web of Conferences. 40: 1-5.

[20] Nallusamy S. 2016. A proposed model for lead time reduction during maintenance of public passenger transport vehicles. International Journal of Engineering Research in Africa. 23: 174-180.

[21] Nallusamy S. 2016. A proposed model for sustaining quality assurance using TQM practices in small and medium scale industries. International Journal of Engineering Research in Africa. 22: 184-190.

[22] Nallusamy S. 2016. Overall performance improvement of a small scale venture using critical key performance indicators. International Journal of Engineering Research in Africa. 27: 158-166.

[23] Nallusamy S and Majumdar G. 2017. Enhancement of overall equipment effectiveness using total productive maintenance in a manufacturing industry. International Journal of Performability Engineering. 13(2): 01-16.

[24] Nallusamy S, Balaji and Sundar. 2017. Proposed model for inventory review policy through ABC analysis in an automotive manufacturing industry. International Journal of Engineering Research in Africa. 29: 165-174.

[25] Nallusamy S. 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. 25: 119-126.

[26] Berawi et al. 2014. Enhancing value for money of mega infrastructure projects development using value engineering method. Proc. Int. Conf. on Health and Social Care Information Systems & Tech. 1037-1046.

[27] Atabay S and Galipogullari. 2013. Application of value engineering in construction projects. Journal of Traffic and Transportation Engineering. 1: 39-48.

[28] Shu *et al.* 2010. Study on the decision making of district cooling and heating systems by means of value engineering. Renewable Energy. 35: 1929-1939.

[29] Amit Sharma and Belokar RM. 2012. Enhancing value of slit housing using value engineering-A case study. Int. Journal of Scientific & Engg. Research. 3(5): 01-04.