Evaluation of Six Sigma in Automobile Manufacturing Industries

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ABSTRACT

Six Sigma is a very common Quality management system that has been accepted world wide as one of the powerful arrows in the quiver of the management. We know that customers' expectations are soaring high and the competition is very fierce. In this regard, Six Sigma is expected to produce the required results based on a logical sequence known as DMAIC (D-Define, M – Measure, A – Analyse, I – Improve, C – control) process. Many studies and researches have revealed the truth about Six Sigma. However, many cases have also emerged wherein the implementation of Six Sigma has not yielded the expected results. This indicates that the benefits of Six Sigma is not uniform everywhere. Hence it is very important for each industry to analyze the implementation of Six Sigma in their organization to understand the real outcome of the Six Sigma implementation. This paper makes one such study at automobile manufacturing industries at Mysore, Karnataka, India. The research includes qualitative analysis based on the opinions of employees instrumental in implementing Six Sigma. The study revealed that, the automobile companies have gained in terms of financial benefits, growth, productivity, peoples' equity and customer satisfaction due to Six Sigma implementation.

Introduction

A quality management system targets three important components which are quality control, quality assurance and quality improvement. It focuses not only on product quality, but also on the means of achieving it. Therefore, quality should be assured at all stages of the product chain more consistently. In a quest to provide better products and service to their customers, businesses are constantly on the lookout for ways to improve the overall quality and improve the value of the company. The quality improvement technique they choose will prove to be critical in this regard (Henderson and Evans, 2000).

Six Sigma offers a disciplined approach to improve service effectiveness (i.e. meeting the desirable attributes of a service) and service efficiency (i.e. time and costs). Six Sigma is the relentless and rigorous pursuit of the reduction of non-value added activities and variation in core service processes to achieve continuous and breakthrough improvements in service performance that impact the bottom line results

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of an organization. The focus is not on counting the defects in processes, but, rather on the number of opportunities that could result in defects (Antony and Banuelas, 2001).

The concept of Six Sigma aims at identifying the problem in a process, prepare a project to match the process, evaluate the process and identify opportunities in order to improve the process as a whole.

Harry and Shroeder (2000) claim that "Six Sigma represents a new holistic, multidimensional systems approach to quality that replaces the 'form, fit and function' specification of the past" and *the Financial Times* wrote in October 1997 that "Six Sigma is a program aimed at the near elimination of defects from every product, process, and transaction".

The reported benefits and savings are composed and presented from investigating various literatures in Six Sigma (Antony and Banuelas, 2002; Buss and Ivey, 2001; McClusky, 2000).

Literature Review

Shrivastava and Tushar (2008), in their study of a manufacturing enterprise reveal that there are many benefits of Six Sigma implementation like cost savings, reduced time to market, improved processes, etc.

Easton and Rosenzweig (2010), in their research of The Role of Experience in Six Sigma Project Success, suggest that a well-developed and deployed structured problem-solving process—characteristic of effective Six Sigma deployments—may reduce the importance of team familiarity in the context of improvement teams.

Kull and Wacker (2010), in their study of Asian industries that have implemented Six Sigma find that specific country cultural values impact how effective Quality Management (QM) investments are. They feel that Uncertainty Avoidance (UA) has a positive influence on QM effectiveness. This suggests that employees in cultures desiring predictability and law-like understanding will be motivated to frequently apply QM's systematic approaches, as in Six Sigma's improvement heuristics.

Brun (2011), in her research of success of Six Sigma in Italian companies could conclude that the Italian companies need to be further explored, validated and reorganized that could constitute a Road Map for Six Sigma implementation in Italian companies. This opens up an ample scope of research on Six Sigma implementation. Pathak and Desai (2011), in their research of Six Sigma success that Six Sigma is perhaps the most successful business improvement strategy developed in last fifty years. Its relevance extends even beyond manufacturing to services, government & the public sectors to service, healthcare & nonprofit organizations.

Nair et al. (2011), in their investigation of Six Sigma projects, have observed that it is important to maintain a balance between the adoption of structured methods and the creation of an environment of psychological safety. This asserts that the effectiveness of an organization is contingent on the congruence between structural and environmental variables.

Fursule, et al. (2012), in their research, "Understanding benefits and limitations of Six Sigma Methodology", have attributed the fact that the Six Sigma implementation is very beneficial in various ways.

However, Clifford (2001) and Dalgleish (2003) argue that Six Sigma offers nothing new and simply repackaging traditional QM practices. Stamatis (2000) has found that the large returns from Six Sigma at some companies were due to the initial quality level of these companies being

so low that anything would have drastically improved their quality.

The literature review revealed that Six Sigma has contributed to the growth of the organization in many ways provided its implementation is done in the right way and direction. Most of the studies have highlighted the implications of Six Sigma on factors like, financial benefits, reduction of cost, improvement of sales, reduced defect rate, and the importance of human factor. Above studies were based on the company records. Any program has to be implemented with the help of the work force only. Hence, it was thought to understand what facts exist in the mind of employees who have worked in the field of Six Sigma, as their opinion will decide the fate of continuation of Six Sigma projects. Hence it was found necessary to take up this qualitative research. Thus this report highlights the opinion of the employees about the benefits of Six Sigma implementation.

Objectives of the Study

The objectives of this research are;

- To evaluate whether Six Sigma has contributed to the improvement of the organization in terms of growth of the company, financial benefits, peoples' equity, productivity, and customer satisfaction.
- To study whether managers and workers differ in their opinions towards implementation of Six Sigma.

Research Design

To start the study, the data was collected using questionnaire method. Questionnaire was designed around various parameters that contributed for growth of the company, financial benefits, peoples' equity, productivity, and customer satisfaction.. After several drafts of the questionnaire (five), it was pilot-tested twice. The first test involved two professors and practitioners in Six Sigma, and the second one four black-belts working on Six Sigma projects at industries. The objective was to evaluate and validate the survey's questions and provide suggestions for improving the survey in both form and contents. The findings from the pilot study were evaluated and used to improve the questionnaire. Finally the questionnaire included the questions to understand the contribution of Six Sigma towards five major variables viz. growth of the company, financial benefits, productivity, peoples' equity and customer satisfaction which further included nine parameters that define the growth of the company, eight parameters that define the financial benefits, sixteen parameters that defined the productivity, twenty seven parameters defining peoples' equity and eighteen parameters that defined the customer satisfaction (Total 78). Questions were framed around these parameters in the simplest language that could be understood by all. The questionnaire was explained to some of them in their vernacular language to get the feed back in the most appropriate manner. Five point Likert Scale (strongly disagree to strongly agree) was used to collect responses in an objective manner. The responses thus obtained were analyzed at two levels such as considering both employees and managers together, then analyzing their responses separately to study whether they differ in their opinion. Statistical tool like SPSS V18 was used to analyze the opinions of the respondents.

Sample

Sample Population consisted of all 71 employees who were involved in Six Sigma implementation at three automobile manufacturing units. The respondents included both managers and workers who were trained in Six Sigma implementation. Those who were trained in Six Sigma included master black belt, black belts and green belts. Out of 71 employees 44 belonged to worker level and 27 belonged to managerial level.

Table 1 : Sample distribution table

Name of company	Description	Designation of the respondent		Total
		Worker	Manager	
A	Automobile – OEM*	16	10	26
B	Automobile – Accessories	10	5	15
C	Automobile – OEM	18	12	30
Total		44	27	71

***OEM: Original Equipment Manufacturer**

Hypotheses of the Study

The following hypotheses were drawn to study the impact of Six Sigma implementation based on the following variables.

a. Growth of the company

b. Financial benefits

c. Productivity

d. Peoples' equity and

e. Customer satisfaction

As suggested by statisticians, only alternate hypotheses have been stated here. The negative form of these is considered as null hypotheses. Hence while testing hypotheses, if the significance value is less than 0.05 the below stated hypotheses are accepted otherwise, rejected.

H1. Existing practices of Six Sigma improve growth of the company
H2. Existing practices of Six Sigma bring about the financial benefits for the company.
H3. Six Sigma contributes towards improvement of productivity
H4. Six Sigma contributes towards improvement of peoples' equity
H5. Six Sigma implementation improves the customer satisfaction

Results and Analysis

The responses were entered in the SPSS V18 software. The following results were obtained. The respondents' reply for the above variables is tabulated as shown below.

This is tabulated considering the responses of all the respondents for each variable. For example in the respondents opinion towards the growth of the company, 2.19% strongly disagreed, 4.85% disagreed, 26.92 could not conclude properly, 59.00% agreed and 7.04% strongly agreed that Six Sigma implementation has helped the company to grow.

Table 2 : Details of responses for the defined variables

Scale parameters	Percentage of responses				
	Growth of the company	Financial benefits	Productivity	Peoples' equity	Customer satisfaction
Strongly disagree	2.19	0.18	0.63	4.28	3.87
Disagree	4.85	6.87	5.48	7.77	6.43
Can't say	26.92	16.37	20.27	20.66	21.21
Agree	59.00	70.25	63.54	57.33	60.04
Strongly agree	7.04	6.34	10.09	9.96	8.45

The frequency of responses indicates an inclination towards the success of Six Sigma in improving the parameters defined earlier. But it is very important to test the statistical significance of these values, which would bring in the real facts behind the implementation of Six Sigma as per the knowledge of the employees. The testing instrument was tested for reliability and the cronbach's alpha on 78 items was obtained as 0.955. According to Nunnaly (1978), if the cronbach's alpha value is more than 0.7, the testing instrument is reliable. It was also tested that if any of the 78 items deleted, whether the cronbach's alpha improves. But in every case the cronbach's alpha was found to be reducing if any of the item is deleted. Hence, the reliability of the testing instrument was established.

Testing of Hypothesis H1

H1. Existing practices of Six Sigma improved growth of the company

After calculating the percentage of responses for each category of the Likert scale, the overall mean was calculated as shown in table 3 below.

The companies have a policy of accepting the survey results if the mean value is 3.6 and above. Hence, the overall test value is calculated as (individual test value * number of factors used to measure the variable). In this case the test value was set at an overall value for the category of Market growth as 32.4. (i.e. 3.6 * 9 = 32.4) and one sample t-test for a 95% confidence level was administered to test the hypothesis H1.

Table 3 : Mean observed and expected values on growth of the company and results of one sample t-test

Variable	N	Mean observed	Std. Deviation	Mean expected	t value	P value
Growth of the company	71	33.25	3.35	32.4	2.147	0.035 (Significant)

The result of the one sample t-test show that the calculated mean value is 33.25 as against the test value of 32.4. The difference in mean values between observed and expected on growth of the company is significant, t (70) = 2.147, p (0.035) < 0.05. As the test statistics revealed a significant higher value of calculated value of mean, **hypothesis H1 is accepted** (Zikmund, 2003)**. In other words corresponding null hypothesis gets rejected**.

Testing of Hypothesis H2

The procedure followed for testing H1 is used for testing the second Hypothesis H2.

H2. . Existing practices of Six Sigma bring about the financial benefits for the company.

The following table 4 gives values of mean and standard deviation based on the output form SPSS software.

Here also, the expected mean value is considered as 3.6 as per the requirements of the company. The overall test value is calculated as 28.8 (i.e. 8 * 3.6 = 28.8) and one sample t-test for a 95% confidence level was administered to test the hypothesis H2.

Table 4 : Mean observed and expected values on financial benefits and results of one sample t-test

Variable	N	Mean observed	Std. Deviation	Mean expected	t value	P value
Financial Benefits	71	30.81	2.11	28.8	8.042	.001 (Highest Significance)

The result of the one sample t-test show that the calculated mean value is 30.81 as against the test value of 28.8, Hence we can infer that the difference in mean values is really significant, t (70) = 8.042, p (0.001) < 0.05. **Hence the hypothesis H2 is accepted**. **In other words corresponding null hypothesis gets rejected**.

Testing of hypothesis H3

H3. Six Sigma contributes towards improvement of productivity

Productivity is a very important parameter that will help the company to minimize the input and maximize the output. Six Sigma is expected to contribute towards the improvement of the productivity. The following table 5 gives values of mean and standard deviation based on the output form SPSS software.

Here also the expected mean value is considered as 3.6 as per the requirements of the company. The overall test value is calculated as 64.8 (this is calculated by multiplying the test value with the number of factors i.e. 18 * 3.6 = 64.8) and one sample t-test for a 95% confidence level was administered to test the hypothesis H3.

Table 5: Mean observed and expected values of productivity and results of one sample t-test

Variable	N	Mean observed	Std. Deviation	Mean expected	t value	P value
Productivity	71	67.23	7.29	64.8	2.81	.006 (High Significance)

The result of the one sample t-test show that the calculated mean value is 67.23 as against the test value of 64.8, which means there is a significant contribution of Six Sigma towards the improvement of the productivity. Hence we can infer that the difference in mean values is really significant, t (70) = 2.81, p (0.006) < 0.05. **Hence the hypothesis H3 is accepted**. **In other words the corresponding null hypothesis gets rejected**.

Testing of Hypothesis H4

H4. Six Sigma contributes towards improvement of peoples' equity

Peoples' equity is the conglomeration of all such factors that contribute towards the motivation of the work force such as morale, pride in work, incentives, skill development, etc. It is implicit that the changes brought in an organization will be supported and encouraged if the work force enthusiastically participates in the change process. For that to happen it is very important to understand whether the change has motivated the work force. Six Sigma is a change that has to be accepted by the work force and hence it is very important to examine if Six Sigma has improved peoples' equity.

The following table 6 gives values of mean and standard deviation based on the output form SPSS software.

Here also the expected mean value is considered as 3.6 as per the requirements of the company. The overall test value is calculated as 97.2 (this is calculated by multiplying the test value with the number of factors i.e. 27 * 3.6 = 97.2) and one sample t-test for a 95% confidence level was administered to test the hypothesis H4.

Table 6 : Mean observed and expected values of peoples' equity and results of one sample t-test

Variable	N	Mean observed	Std. Deviation	Mean expected	t value	P value
Peoples' equity	71	97.4	13.89	97.2	0.152	.880 (not Significant)

The result of the one sample t-test show that the calculated mean value is 97.4 as against the test value of 97.2, which means there is a non significant contribution of Six Sigma towards the improvement of peoples' equity. Since the test statistics revealed an equality of means, t (70) = 0.152, p (0.880) > 0.05, we can infer that though the difference in mean values is not really significant, as the equality of means is established, **the hypothesis H4 is accepted**. **In other words the corresponding null hypothesis gets rejected**.

Testing of Hypothesis H5

H5: Six Sigma implementation improves the customer satisfaction

Customers are the ring masters in the present context. They make the companies to dance according to their tunes. Hence it is required to check the contribution of Six Sigma towards improvement of customer satisfaction.

The following table 7 gives values of mean and standard deviation based on the output form SPSS software.

Here also the expected mean value is considered as 3.6 as per the requirements of the company. The overall test value is calculated as 57.6 (this is calculated by multiplying the test value with the number of factors i.e. 16 * 3.6 = 57.6) and one sample t-test for a 95% confidence level was administered to test the hypothesis H5.

Table 7: Mean observed and expected values of Customer satisfaction and results of one sample t-test

Variable	N	Mean observed	Std. Deviation	Mean expected	t value	P value
Customer satisfaction	71	58.83	7.74	57.6	1.339	.185 (not Significant)

The result of the one sample t-test show that the calculated mean value is 58.83 as against the test value of 57.6. Since the test statistics revealed an equality of means, t (70) = 1.339, p (0.185) > 0.05, we can infer that though the difference in mean values is not really significant, as the equality of means is established, **the hypothesis H5 is accepted**. **In other words the corresponding null hypothesis gets rejected**.

Discussions and Conclusions

Six Sigma is seen as a savior by many companies. They feel that their position in the market can be significantly improved with the help of Six Sigma. This empirical study was done to evaluate the implementation of Six Sigma in select automobile industries. The industries under study have a practice of accepting the survey results if the observed mean value is at least 3.6 and above on a 5 point Likert scale . The survey results revealed the following facts about the implementation of Six Sigma in the manufacturing company

1. The observed mean value (33.25) of opinions towards the growth of the company was slightly more than the expected value (32.4). Since the test results (.035 < .05) reveal a significant difference between observed and expected mean values, one can infer that there is significant contribution of Six sigma in growth of the company . Hence, it can be concluded that existing practices of Six Sigma has contributed to the growth of the company. Hence growth of the company is dependent on the practices of Six Sigma.

2. In case of financial benefits, the test revealed that there is a significant contribution of Six Sigma towards the financial benefits as the observed mean value (30.81) is significantly greater than the expected value (28.8). This is further substantiated by test results (.001<.05), that revealed a significant difference between the expected and observed mean values. In other words, this fact can be attributed as that the company has reaped financial benefits due to implementation of Six Sigma. Hence financial benefits are dependent on the practices of Six Sigma.

3. With reference to the productivity, the test proved that the calculated mean value (67.23) is greater than the test value (64.8). The test value (.006<.05) also revealed that this difference is significant, which means there is a significant contribution of Six Sigma towards the improvement of the productivity. In other words, it is very clear that the company has improved in terms of productivity due to implementation of Six Sigma. Hence productivity is dependent on the practices of Six Sigma.

4. With regard to peoples' equity, the test results show that the calculated mean value is 97.45 as against the test value of 97.2. The test results revealed a non significant (.880>.05) difference between calculated and expected mean values. Since the test results revealed an equality of means, one can infer that the there is some contribution of Six Sigma towards the improvement of peoples' equity. In other words, it is clear that the people have enjoyed and have been benefitted after the implementation of Six Sigma at least to some extent. Hence peoples' equity is dependent on the practices of Six Sigma.

5. In case of customer satisfaction, the test results indicate that the calculated mean value (58.83) is greater than the test value (57.6). The test results (.185 > .05) indicated a non significant difference

between calculated and expected mean values. This can be inferred as both the means are equal. Hence we can conclude that implementation of Six Sigma has some contribution towards the improvement of customer satisfaction. In other words, it is very clear that the customers are also benefitted due to Six Sigma and hence their satisfaction level has gone up after the implementation of Six Sigma. Hence customer satisfaction is dependent on the practices of Six Sigma.

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