

Six Sigma Methodology in Blended Learning in Educational Sector



ISBN: 978-81-924713-8-9

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The present study entitled 'SIX SIGMA METHODOLOGY IN BLENDED LEARNING IN EDUCATIONAL SECTOR' is intended to examine the impact of Internet Facilities on Students performance through a Blended Learning as a medium in an Academic Institution. It was examined that how the Blended Learning encompasses a variety of tools to create flexible, rich learning environments that stimulate learners and maximizes the potential for learning. Another objective is Application of Six Sigma methodology in this study is to improve the medium of learning i.e. Internet Connectivity through a set of procedures in an effective way. Blended Learning is defined as "the approach combines the best elements of online and face-to-face learning. It is likely to emerge as the predominant model of the future and to far more common than either one alone" (John Watson). Six Sigma can be again viewed as a discipline or an approach driven by data and methodology for eliminating defects in any process- from manufacturing to transactional and from product to service.

Keeping the aforesaid two objectives in mind, data was collected from a sample of 119 students residing in various hostel blocks using stratified random sampling technique. One questionnaire was developed after an extensive literature review to measure the impact of Internet Connectivity in Blended Learning of the students. The Questionnaire to measure was based on the model developed by Shawn M.Glynn (2011).The scale was developed by referring to previous models

The statistical analysis used was correlation and regression, reliability statistics, KMO, Bartlett's test and One-Way ANOVA. The data was entered into SPSS version 20.The study on Reliability test shows that questionnaire developed was valid. It is also revealed from KMO and Bartlett's test that the sampling done was adequate. The study also revealed that there is highly positive correlation between Internet Connectivity and student's performance. The Regression value accounts for 26% of variance in the influence of Blended Learning in educational sectors. One-Way ANOVA model revealed that the study is statistically significant.).

The Six Sigma Methodology has a standard five-phase framework (DMAIC) for finding past, tuning present and forecast future. The application of six sigma is that to increase the sigma level from 1.33 to reduce the defects in Internet Connectivity and thereby to increase the student's performance. This study reviews that the main root cause of defect in internet connectivity is caused by physical interference (between that network itself and other networks) and the problem can be solved by blocking Rogue Access Points by sending traffic.

Keywords: Blended Learning, Internet Facility, Students Performance, Six Sigma (DMAIC)

1. Introduction

Blended learning is just one piece of expanding technology landscape, but it has attracted particular attention for its potential to blend existing pedagogy and practice with new innovations in teaching and learning. "Blended learning is a formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home."(Staker and Horn-2012).India ranks fifteenth position in the world for service outputs and employs around 23% of workforce of the country. Since with the launch of Mangalyaan, it is proved that India is innovating and Education has a vital role on these achievements. Six Sigma is a methodology which was used widely in manufacturing sector but now it is used in Service Sector to increase customer satisfaction and to reduce the defects. It is a data-driven approach. It can be said that, in an Educational Sector students are the products and the customers are companies that will recruit these students. According to Pande et al. (2002), most service organizations operate at sigma quality levels of 1.5-3.0 that is, a defect rate between 455000 and 66800. Since, Internet is a facilitator of Blended Learning and the student's performance has a positive relation with Internet. Application of Six Sigma methodology in this study is to improve the medium of learning i.e. Internet Connectivity through a set of procedures in an effective way.

2. Significance of the Study

The study will highlight the importance of internet resource for ensuring effective blended learning in educational organizations, since the blended learning comprises mainly of learning through internet (i.e) E-Learning. Since the internet

resource is the essential one for such type of learning, the connectivity should be a effective thing and so the six sigma methodology is applied to reduce the defects and flaws in the internet connectivity (mainly internet speed) and make blended learning a successful one, so that students performance can be increased in the organizations.

3. Review of the Literature

Dr. P.Ramasubramanian, (2012) in their study titled “Six Sigma in Educational Institutions” to find success, institutions of higher education must demonstrate that they can offer what others cannot. This paper narrates the implementation of six sigma in a technical institution, the benefits of implementation and how six sigma may be used to improve the performance of all institutional operations from student graduation to recruitment, including all the processes.

K.G Durga Prasad *et al.*, (2012) in their study titled “Application of Six Sigma Methodology in an Engineering Educational Institution” empirical testing to enhance the academic standards and credibility of the institution, conducted among six core engineering branches. The study found that five quality characteristics which are responsible for 80% of the effect (% of failure students). It is essentially required to improve the quality characteristics such as Motivated Faculty, Modern Communicational Facilities, Industrial-Institution Interaction and Opportunity for knowledge up gradation and Library modernization for achieving six sigma quality in an engineering educational institution.

Vivekananth.P, (2014) “Six Sigma in Education” this paper discusses the ways Six Sigma can be used to teach efficiently. The quality control philosophy a Japanese philosophy of participative culture is discussed.

Buket Akkoyunlu *et al.*, (2008) in their research paper entitled “A Study of Student’s Perceptions in a Blended Learning Environment Based on Different Learning Styles” examined the students’ learning styles and their views on blended learning. Results revealed that students’ views on blended learning process, such as ease of use of the web environment, evaluation, face to face environment etc., differ according to their learning styles.

Kifayah Amar., (2008) in their research paper entitled ” A Review of Six Sigma Implementation Frameworks and Related Literature” a study was made examine four implementation frameworks found in the literature from two perspectives. Firstly, from a critical success factor perspective and secondly from the perspective of Rogers’ diffusion of innovations theory. None of the frameworks examined comprehensively address issues suggested by Rogers’ diffusion of innovations theory. The most robust framework appears to be the one developed by Burton and Sams. Our research suggests a customized implementation framework needs to be designed for Indonesian SMEs based on Rogers’ diffusion of innovations approach, but also drawing from literature on critical success factors.

Boyle, T *et al.*, (2003) in their research paper entitled “Using blended learning to improve student success rates in learning to program” their aim was to improve student success rates in learning to program. The project team introduced a number of changes in module organization, tutorial support and online resources. The blend represents a mixture of traditional and novel elements, with the novel elements more marked in the online developments. Results demonstrated marked improvements in pass rates. Evaluation of the students’ use of the new environment indicated a generally positive evaluation of the main elements of the blend and widespread use of the new online features.

Dowling, C *et al.*, (2003) in their research paper entitled “Do hybrid flexible delivery teaching methods improve accounting students’ learning outcomes?” investigated the association between the learning outcomes of students and two teaching modules: traditional face-to-face and hybrid flexible delivery. Results indicated that the hybrid flexible delivery model is more positively associated with students’ final marks and improved learning outcomes.

Schweizer, K *et al.*, (2003) in their study titled “Blended learning as a strategy to improve collaborative task performance” examined how groups of learners work together in blended learning and e-learning environments. Three pure e-learning courses were compared to one blended learning course where participants formed learning teams who met at three points in time. All participants received joint learning material, in order to build shared knowledge, and individualized information to build unshared knowledge. Variables analyzed include students’ extent of online activity, the groups’ task performance, and coherence of the groups’ discourse. Results indicated that achievement in a particular group does not depend solely on the mode of communication used in the course.

4. Reliability

Table1.1 Reliability Statistics

Cronbach's Alpha	N of Items
0.606	27

Interpretation: The reliability co-efficient for the variables chosen for the study should have to be more than 0.50 to consider it as an acceptable value. In this study the reliability analysis shows that the alpha value is greater than 0.50 indicating the evidence of reliability of the instrument is 0.606. The factors and dimensions included for analysis carry a good degree of reliability to support the objective formulated. Hence it is concluded that the data collected in this study is highly reliable.

5. Factor Analysis

Table 1.2 KMO and Bartlett's Test^f

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.579
	Approx. Chi-Square	665.736
Bartlett's Test of Sphericity	df	351
	Sig.	0.000

Interpretation: The KMO measures the sampling adequacy which should be greater than 0.5. For a satisfactory factor analysis to proceed. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is an index for comparing the magnitudes with the partial correlation coefficients. Large values of KMO measure indicate that a factor analysis variable is a good idea. The sample is worth enough to measure variables. Hence the above test shows the uniqueness and homogeneous.

6. Correlation

Table 1.3 Correlation

		University Internet Speed	Student's Performance
University Internet Speed	Pearson Correlation	1	-.159
	Sig. (2-tailed)		.085
	N	119	119
Student's Performance	Pearson Correlation	-.159	1
	Sig. (2-tailed)	.085	
	N	119	119

Interpretation: The table 1.3 shows the relationship between Satisfaction of University Internet Speed and Student Performance in Academics. This have a highly positive correlation and the value is 0.085. This shows that if there is any change in Satisfaction of University Internet Speed it may impact in Student Performance in Academics.

7. Regression

Table 1.4 Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.510 ^a	0.260	0.214	0.954

a. Predictors: (Constant), Internet role skill development, University blocks Educational site, satisfaction e-learning, satisfaction Internal Assessment, Academic Performance, helps assignment, Internet role educational communication.

Interpretation: From the table 1.4, the R Square value is 0.260 and adjusted R-Square value is 0.214 and this enlighten that the Model account for 26% of variance in the influence of Blended learning in educational sectors study. This is the clear indication that this Model is a good Model.

ANOVA

Table 1.4 ANOVA

ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	35.610	7	5.087	5.586	.000 ^b
1 Residual	101.096	111	.911		
Total	136.706	118			

a. Dependent Variable: Happy to use Educational Sites

b. Predictors: (Constant): Internet skill development, University blocks Educational site, satisfaction e-learning, satisfaction Internal Assessment, Academic Performance, helps assignment, Internet educational communication.

Interpretation: From the table 1.4, ANOVA table it is inferred that the F-Value is 5.586 and the significance is 0.000. As the significance is less than 0.05. It clearly reveals that the model taken for the study is statistically significant.

8. Coefficients

Table 1.5 Standardized Beta Coefficient

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.830	.650		1.276	.204
University blocks Educational site	.081	.068	.100	1.189	.237
satisfaction e-learning	.060	.075	.069	.804	.423
helps Assignment	.372	.091	.357	4.107	.000
Academic Performance	-.092	.083	-.097	-1.115	.267
Internet role educational communication	.125	.091	.122	1.376	.172
satisfaction Internal Assessment	-.033	.079	-.036	-.418	.677
Internet role skill development	.235	.074	.272	3.169	.002

a. Dependent Variable: Happy to use Educational Sites

The table 1.5 gives a measure of contribution of each variable to the model. T-Value of University blocks Educational site is 1.189 and the significance is .237 and the probability is greater than 0.05. Thus the University blocks Educational site is not influencing in the prediction of overall blended learning in educational sector. T-Value of satisfaction e-learning is 0.804 and the significance is 0.423 and the probability is greater than 0.05. Thus the satisfaction e-learning is not influencing in the prediction of overall blended learning in educational sector. T-Value of helps Assignment is 4.107 and the significance is 0.000 and the probability is greater than 0.05. Thus the helps Assignment is influencing in the prediction of overall blended learning in educational sector.

T-Value of Academic Performance is -1.115 & significance is 0.267 and the probability is greater than 0.05. Thus the Academic Performance is not influencing in the prediction of overall blended learning in educational sector. T-Value of satisfaction Internal Assessment is -0.418 & significance is 0.677. Thus the satisfaction Internal Assessment is not influencing in the prediction of overall blended learning in educational sector. T-Value of Internet role skill development is 3.169 & significance is 0.002 and the probability is greater than 0.05. Thus the Internet role skill development is influencing in the prediction of overall blended learning in educational sector.

A Case Study has been taken from a well reputed University which is located in south India. Through this study it is proven that Internet has a positive relationship with student's performance. This case study depicts the fact of internet in their performance. In order to enhance the students' performance the quality of Internet is increased by adopting Six Sigma approach. Six Sigma Methodology which is discussed early is carried out in this case study. For this Questionnaire has been collected from 119 samples from students (customer) in a random sampling manner.

9. Pre-Define Phase

AFFINITY DIAGRAM

Table 1.7 Affinity Diagram

TECHNOLOGY	SERVICES	INFRASTRUCTURE
• High Speed Internet	• University Policy	• University Environment
• Stable Speed Internet	• Networking Staffs	• Transmitter Area
• Router/	• Services	
• Customer Computer	• Timely Maintenance	
• Firewall	• Timing	
• Virus		

RIE ANALYSIS

Table 1.8 RIE Analysis

TECHNOLOGY					SERVICES					INFRASTRUCTURE				
	R (0-10)	I (0-10)	E (0-5)	R+I/E		R	I	E	R+I/E		R	I	E	R+I/E
High Speed Internet	8	8.3	3.3	4.94	University Policy	7	8.2	3.5	4.48	University Environment	7.8	7.2	4.3	3.48
Stable Speed Internet	7.3	7.7	3.1	4.84	Network Staffs	5.1	6.7	2.9	4.06	Transmitter Area	7.1	7	4.1	3.43
Router/	5.7	7.3	3.6	3.61	Services	5.1	5	3.4	2.97					
Customer Computer	4.5	2	4.6	1.41	Maintenance	7.1	6	3.7	3.54					
Firewall	5	5.4	2.7	3.85										
RIE	18.65				RIE	15.05				RIE	6.91			

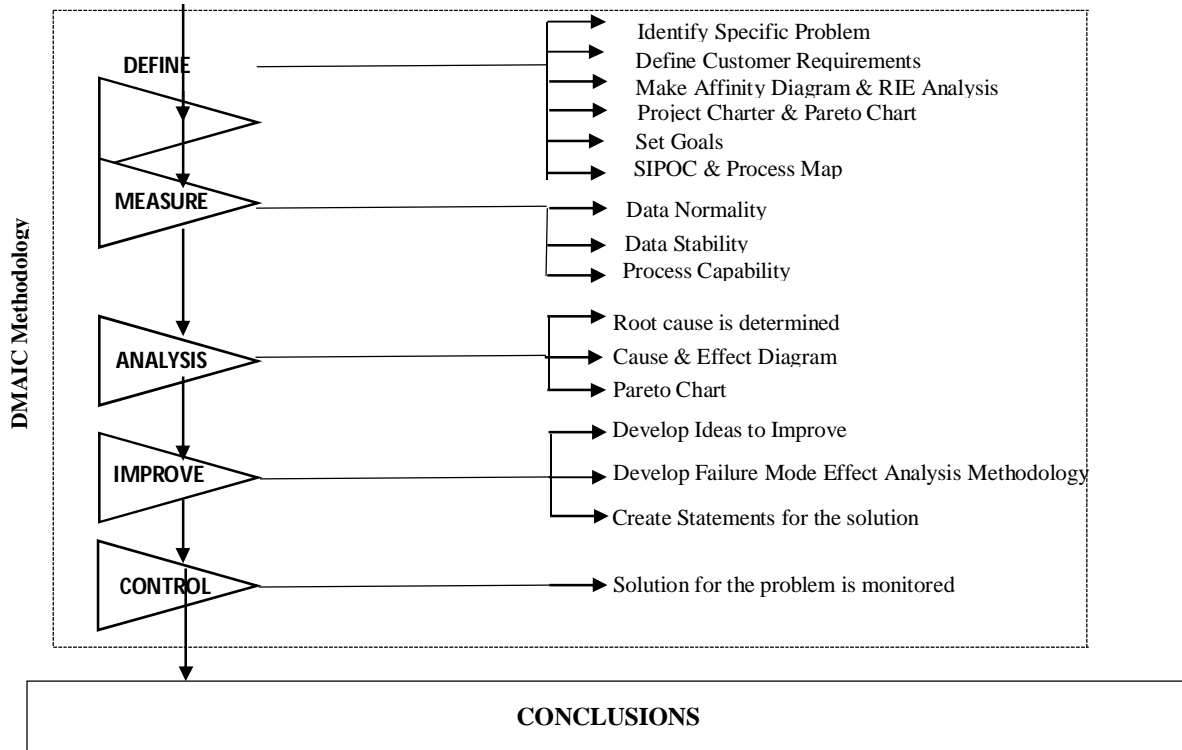
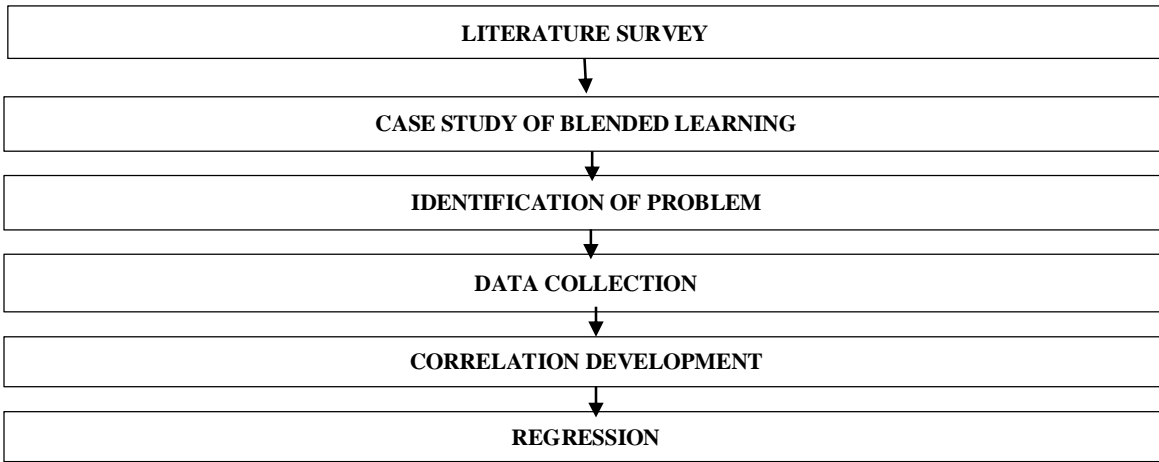
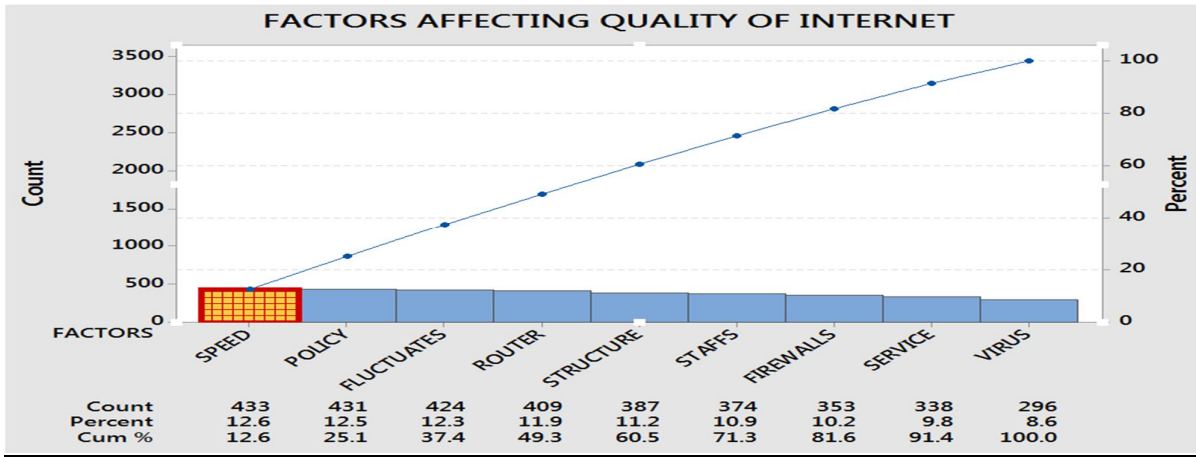


Figure 1.6 Flow Diagram of Methodology adopted

Table 1.9 Factors Affecting Internet



10. Define Phase

This phase defines the goals and boundaries of an improvement study in terms of customer requirements or business requirements and the process delivering these requirements (Porter 2001).

The team which is assigned for Six Sigma in Table 1 has thoroughly studied those data which is obtained from the Questionnaire. The six sigma team has prepared a project charter which is shown in Table 1.11. Other main activities in this phase are SIPOC and Process Mapping.

Table 1.10 Six Sigma team structure in Internet providing Educational Sector

Champion	Vice Chancellor/Principal/Registrar (Identify and scope the six sigma project)
Master Black Belt	Director of Computer Technology Center (Trains and coaches Black belts and Green belts)
Black Belt	Network Engineers (Apply Breakthrough strategy to specific projects)
Green Belt	Technicians (Supports Black belt by participating in the projects)
Team Members	Student (Carries out instructions for Data Collection)

Table 1.11 shows the objective of the project. Identifies the needs of the main stakeholders of this project. A clear description in terms of problem and the importance of solving the problem and the goals of the project.

Table 1.11 Project Charter

VOC	Customer Requirements	CTQ
Quality Internet	Good Service, Good Infrastructure, Good Student Performance (Grading, Skill Improvement)	Internet Speed Delay, Jitter
Process Importance	Process Problem	Project Goals
Student Performance is controlled by Internet which is a facilitator for e-learning. It aims to increase the Quality of Internet.	The speed of Internet is not sufficient for the use of e-learning purpose and their by the student performance is decreasing.	To Increase Quality of University Internet From 1.33 sigma level to 2 sigma level and to increase student's performance.

SIPOC Diagram which is used in Six Sigma Methodology. In this case, it is prepared by carefully observing the supplier, input, process, output and customer for attaining to increase Quality of Internet.

SIPOC

University Internet

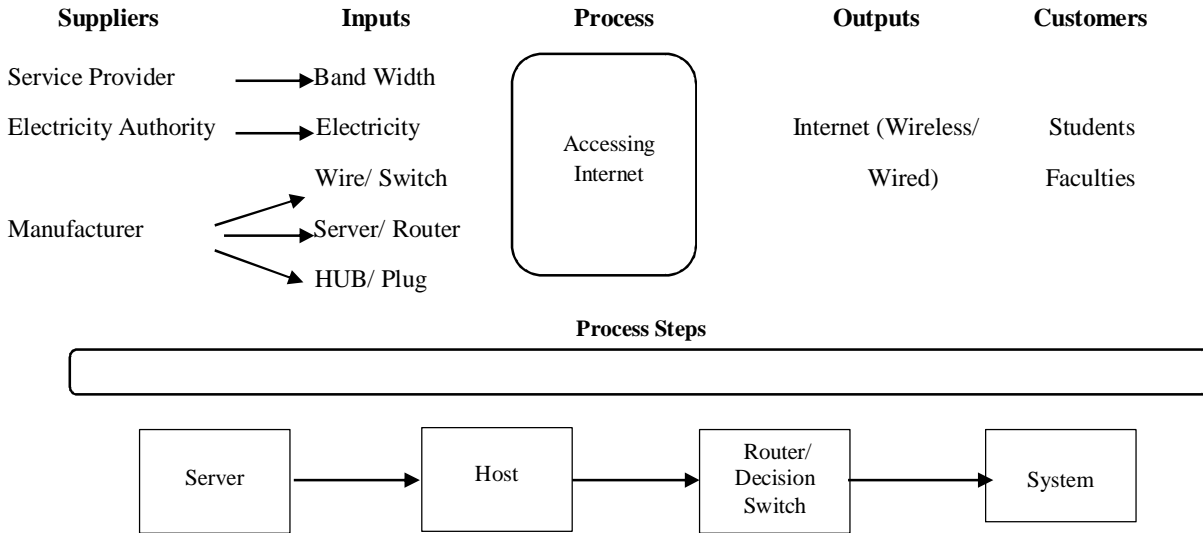
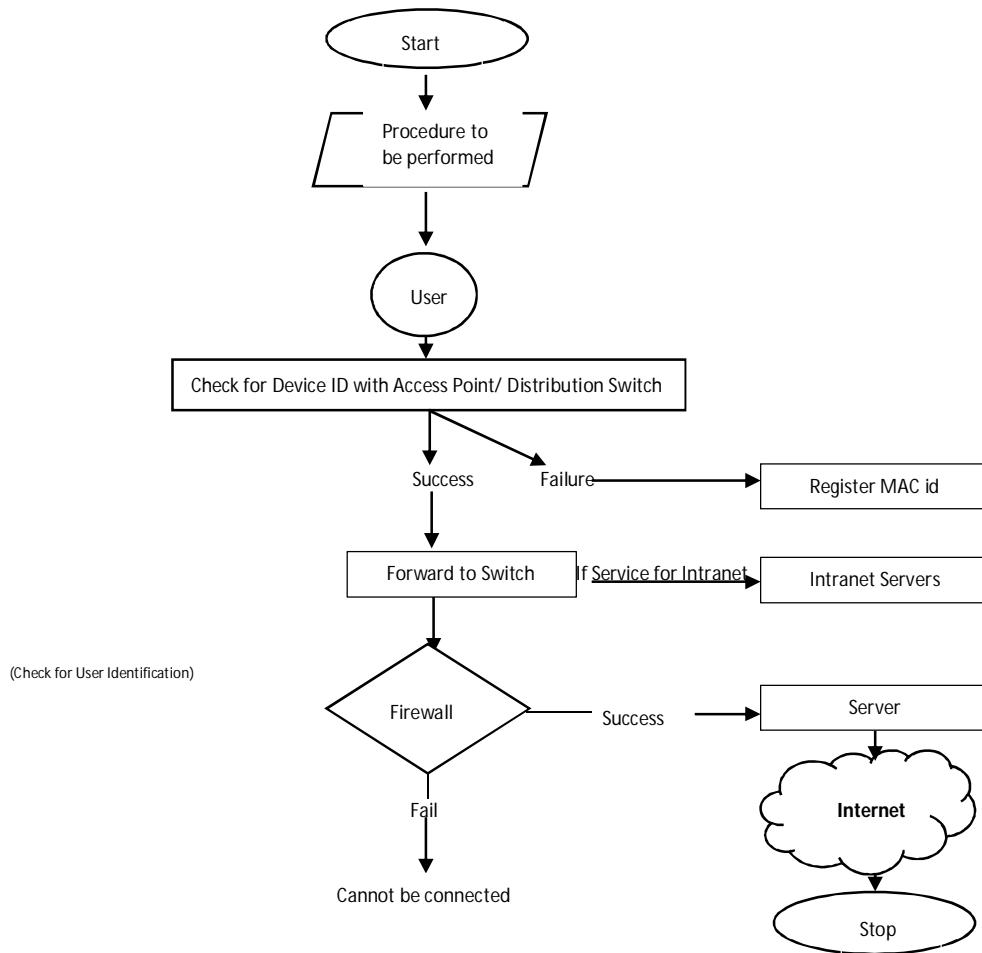


Figure 1.12 SIPOC Diagram

11. Process Map



12. Measure Phase

The Internet speed data is subjected to normality test to check out whether the data collected from a normally distributed process or not. The Normality of data can be found out by Histogram.

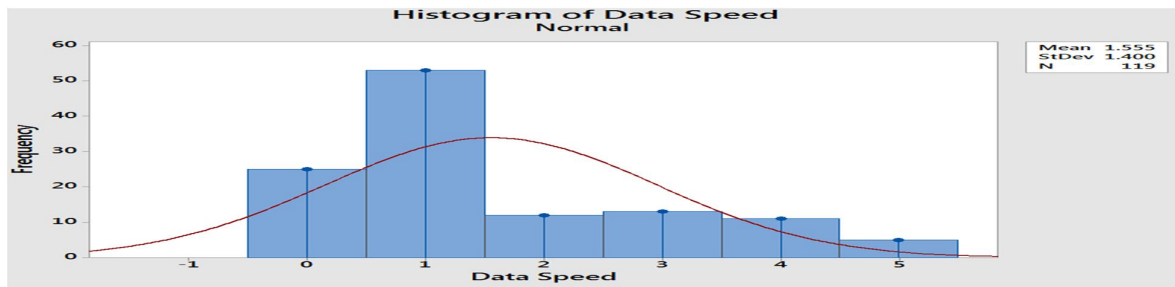


Figure 1.13 Normality

$$Z = \frac{\bar{X} - \mu_0}{\frac{\sigma}{\sqrt{n}}} = \frac{1.555 - 1.645}{.125} = 0.000.$$

Interpretation: The z-test value is less than 1.645, so Ho is accepted, i.e, the data does not follow normal distribution.

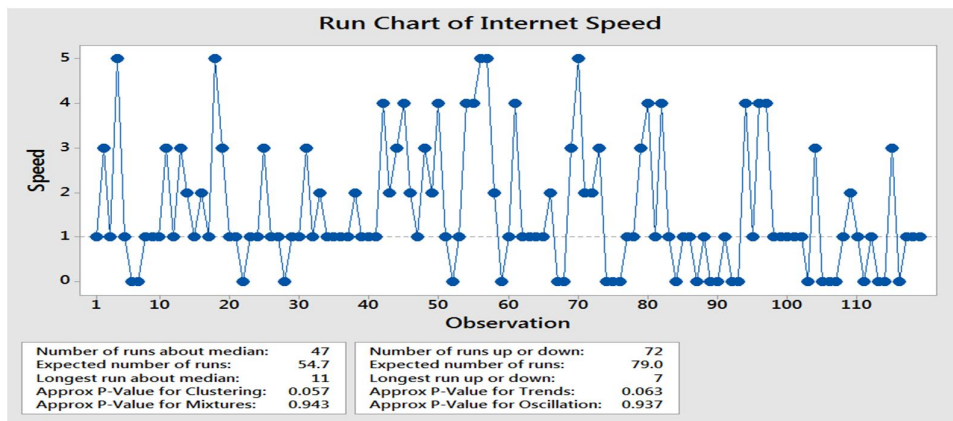


Figure 1.14 Stability

Interpretation: The stability of the data can be found out by Run Chart. Variation will exist in all process. These variation will be common variation or special variation. Special variation makes the problem for the customer. The common variation won't affect customers. The p-values shown in the chart i.e, Clustering (0.057), Mixtures (0.943), Trends (0.063), Oscillation (0.937) are more than significance level of 0.05, which indicates that there are no special causes of variation in data.

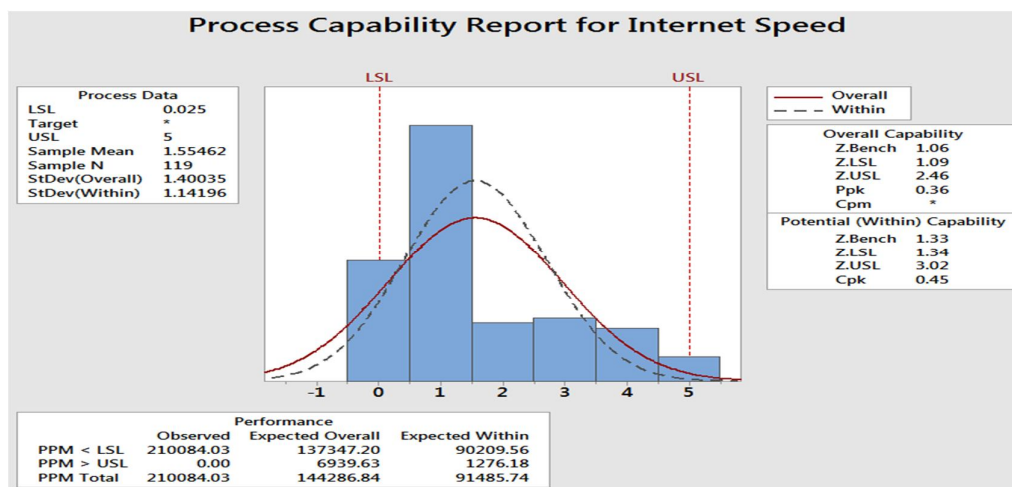


Figure 1.15 Process Capability

Interpretation: Process Capability is the ability of the process to meet the design specifications for a service or a product. Process Capability Index (Cpk), is an index that measures the potential for a process to generate defective outputs relative to either upper (USL) or lower specifications (LSL). From the result shown in figure 1.15, the Z-bench sigma value of the Internet Speed was found to be 1.33 and the DPMO level is found to be 90209.56.

13. Analysis Phase

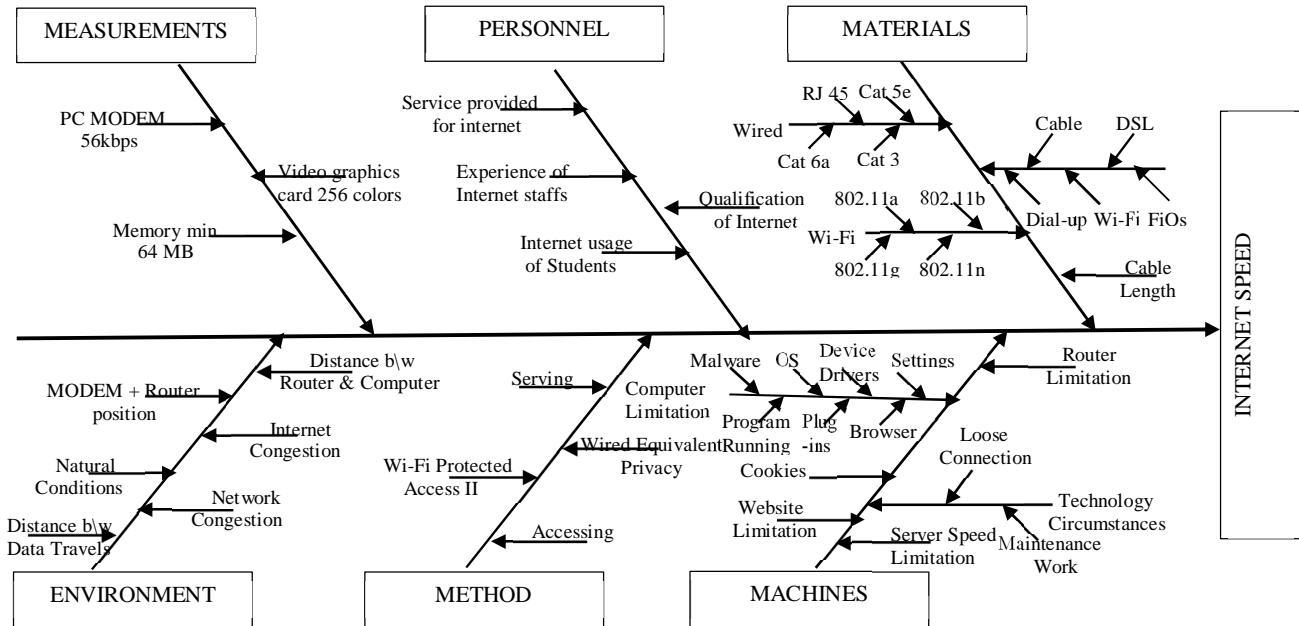


Figure 1.16 Fish Bone Diagram

Interpretation: From the figure 1.16, the main causes behind the problem of internet connectivity is showed. The problems are categorized according to their mode of occurrence.

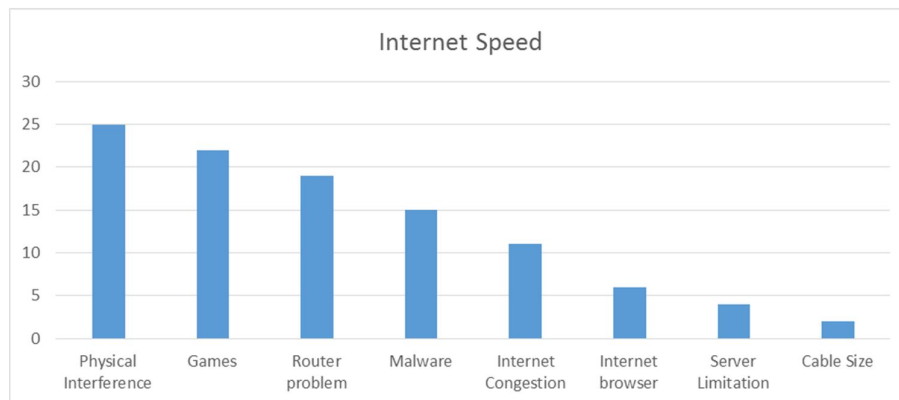


Figure 1.17 Problem in Internet speed

Interpretation: From the figure 1.17, it is proved that the main problem behind the internet speed is physical interference. 80% of the problem can be reduced by 20 % of cause. By reducing physical interference, the problem of internet speed can be minimized to a great extent.

14. Improve and Control

Failure Mode and Effect Analysis (FMEA) is a methodology for analyzing the potential reliability problems in the process and to take necessary actions to overcome these issues. It is a bottom-up approach. It is used to identify the potential failure modes of the parts of components, determining their effect on the operation of manufacturing a product or service, and identify actions to mitigate these failures. This is mainly done by brainstorming.

The QS9000 standards put forward a new technique for FMEA based on **Risk Priority Number (RPN)**. This is a quantitative technique. It plays a major role in identifying the risk and action plan for reducing the risk. The risk priority number is the product of the **Severity (S)** of the effect, probability of **Occurrence (O)** and ease of **Detection (D)**.

Table 1.18 Failure Mode Effect Analysis for Provider

Mode of Failure	Components Details	Effect of Failure	S	Causes Of Failure	O	D	R	Recommended Action	Responsibility
Student Performance lacks as the Quality of Internet fails	Electrical	Slow Internet Speed	8						University Management and Computer Center Staffs
	Wired			Natural Condition	2	4	64	Shielding the Cables	
	Wi-Fi			Over Heat	1	5	40	Renew	
	ISP- Dial-up, DSL, Cable, FiOs			Shut downing for maintenance	1	1	8	Qualified Staff	
	Server Limitation			Overheating, Over computation Natural temp, No of user	4	6	192	Coolers, No. of servers	
	Internet Congestion			Overheating, More no. of users	7	8	448	More coolers	
	Router Limitation			Range limitation, Bandwidth limitation	9	8	576	Band width increase, increase users acceptance in routers	
	Loose Connections of Cables			Damage of connecting pins	2	4	64	Rubberized	
	Mechanical								
	Cable Size			Excavation	2	5	80	Proper Shielding	
	Network Congestion			More no.of Users	7	8	448	More no.of Routers	
	Distance between computer & router			Limited coverage area	9	3	216	Boost signal strength	
	Limited range			Lack proper Infrastructure	7	9	504	Energy booster, ventilation, blocking Rogue Access Points by sending traffic	

Interpretation: From the table 1.18, FMEA for provider is categorized into two namely mechanical and electrical. Details of the causes are mentioned such as Internet congestion, cable size, distance between computer and router, server limitation, limited range, loose connection etc. In the table 1.18, limited range (physical interference), network congestion, router limitation, internet connection and server problem are identified as some of major causes for the problem of internet speed in provider part.

Table 1.19 Failure Mode Effect Analysis for Accessing

Mode of Failure	Components Details	Effect of Failure	S	Causes of Failure	O	D	R	Recommended Action	Responsibility
Student Performance lacks as the Quality of Internet fails	Electrical	Slow Internet Speed	8						Students
	OS			No Port	2	1	16	Upgrade	
	Internet browser			Time delay in Downloading data	7	6	336	Use suitable browser	
	Plug-ins			No videos can be played, compatibility	6	3	114	Install required software	
	Program running			Time delay	2	4	64	Close website not in use	
	Signal Receiver			Overheating	2	3	48	Use lap on well-ventilated area	
	Cookies			Automatic	6	5	240	Delete all unused cookies	
	Modem			Overheating, Physical damage	6	4	192	High Efficient Modem	
	Playing games			over heating	9	8	576	New firewall	
	Device Drivers			File corruption	4	5	160	Proper usage of drivers, Update	
	Malware			Files delete	8	4	256	Antivirus	

Interpretation: From the table 1.19, in FMEA for accessing, details of the causes are mentioned such as Internet browser, malware or virus, playing games, cookies, program running, device drivers, modem etc. In the table 1.19, playing games, internet browser, cookies, malware and modem are identified as some of major causes for the problem of internet speed in accessing part.

15. Conclusion

Now a day all the service or manufacturing sector are trying to implement Six Sigma in their concern. Internet is a facilitator of E- Learning (Blended Learning) and the student's performance has a positive relation with Internet. Application of Six Sigma methodology in this study is to improve the medium of learning i.e. Internet Connectivity through a set of procedures in an effective way. The main root cause for the internet connectivity is found out in this study. The solutions to minimize the causes are suggested.

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