INSE 6210

Total Quality Methodologies in Engineering

Project Report – Fall 2021

"Improving Online Education Quality for higher education institutions Using DMAIC Principles."

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EXECUTIVE SUMMARY

Online education, which utilizes distance-learning modules, has become an integral part of current education system today. This is mainly due to the growing number of university courses offered online, and the effect of the COVID-19 pandemic on the educational institution's method of delivery. This project examines current support services available to online graduate students and presents a quality improvement methodology to be implemented in educational institutions.

Employing Six Sigma to examine online learning for graduate students highlights both the strengths of these services and the areas that require improvement. This paper concludes that Six Sigma is one of the most suitable analytical approach to improve quality aspects for online students, instigating consistent performance through DMAIC methodologies. This project will examine current support services available to online students and presents a quality improvement methodology to be implemented in educational institutions. Using DMAIC Principals to identify quality challenges as online students are facing, analyze the current state of available tools and services. And expound guidelines for quality improvement support plan.

INTRODUCTION

For many years, the traditional classroom setup has been employed in universities as the main method for the delivery of instruction. This system of teaching has been changed dramatically after the pandemic. Online education is simply become one of the only solutions for higher educations to keep going by the extensive use of the Internet, smartphones, and tablets.

While online learning was the only solution for the stakeholders during universities closure, it also has introduced challenges alongside. Time management, technical glitches, lack of communication skills, sense of Isolation, and instructors lack of training. The concept of Six Sigma was introduced by Motorola in the 1980s to improve their products and maintain quality. The core of Six Sigma lies in the continuous improvement process using the DMAIC (Define, Measure, Analyze, Improve, and Control) method [1]. And it is one of the more recent quality improvement initiatives to gain popularity and acceptance in many industries across the globe. Its popularity has grown as major companies have adopted Six Sigma to improve quality aspects.

Figure 1: Five Stages of DMAIC

1. Quality Problem

It is no doubt that the majority of the academic advisors and instructors are professional in delivering online lectures and information's. However, there are many cases where students not satisfied with the quality of services they are receiving. In most of the educational institutions, prior training is not provided to instructors on how to conduct online classes for effective results and inferior knowledge in utilizing the connecting devices and information sharing tools with Students. In addition to that, technical glitches immediate solving is not existed in most of the conducted online courses, bringing us to our major second problem.

2. Problem Investigation Importance

DMAIC methodology if implemented will help to improve the performance of both the faculty and students, which leads to dropout's rate decreasing and increase classes efficiency, in turn, solving such an issue could have a considerable impact on students' academic performance, and overall impact on the reputation of educational institutions and providers in the long run. This project will provide an opportunity to identify root causes that affected the educational outcomes from remote teaching and improve the processes that deliver the best possible learning outcomes.

SIPOC:

SIPOC (suppliers, Inputs, Process, Outputs, Customers) plays a vital in role in distinguishing each component in the improvement process and it summarizes the inputs and outputs involved. Higher education process can be viewed to be similar to a manufacturing process. In a manufacturing process, raw materials are processed through a series of steps to produce finished products. Similarly, the higher education institutions produce intellectual graduates from incoming students through a series of steps. [2]

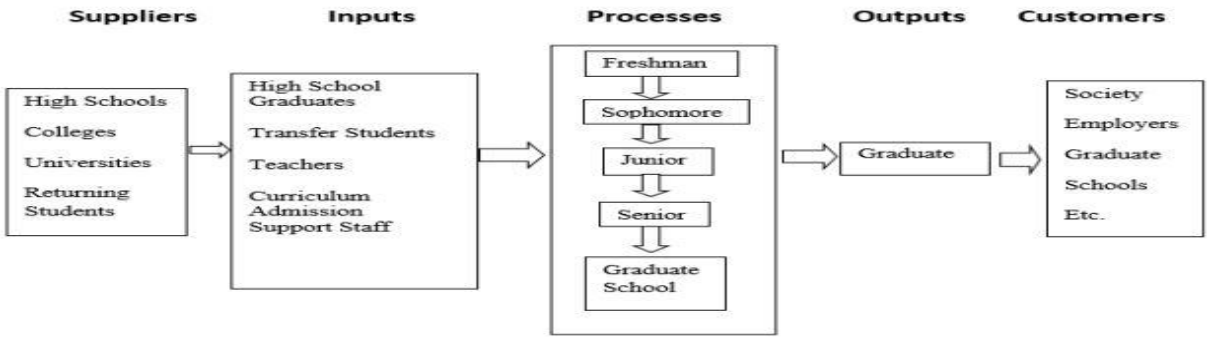


Figure 2: Six Sigma Process (SIPOC) in Higher Education

Figure 3: Process flow in a conventional manufacturing process

METHODOLOGY

For this project, we have implemented the 6 Sigma DMAIC Methodology which stands for Define, Measure, Analyze, Improve and Control. In the **Define phase**, we have created the Project Charter which is the main document that formalizes the existence of this project. Also, we have created the current process map to know how the existing process works and we have conducted an online survey to collect the Critical to Quality Characters. In the **Measure Phase**, we have collected the data from online and measured the Sigma Level, Process Capability and used some control charts to identify if the process is in control or not. In the **Analysis Phase**, we have used the Cause & Effect diagram and Root Cause Analysis Technique 5 Why to identify the causes of the problems which are to be fixed. In the **Improve phase**, we have used PDCA and provided some plans to speed up the application process and came up with an improved process map. We implemented the plan theoretically in 50 education institutions and measured the process capability & sigma level again to make sure that the process has become more capable after the Improvement. Finally, the new data has been analyzed by using control charts to check if the process has come under control or not in **Control phase**.

1. DEFINE:

1.1 Project Charter: As the first step of the DMAIC, we have developed a Project Charter.

PROJECT TITLE & Estimated Budget	
Improving Online Education Quality for higher education institutions Using DMAIC Principals.	200K CAD
PROBLEM STATEMENT	
It is to Define, Measure, Analyze, Improve and Control the main drawbacks of online education system by eliminating the main reasons of students' dropouts and the loss of millions of dollars revenue to the Education institutions. Our project mainly revolves around improving the quality of remotely education fashion being adopted by the Universities during the pandemic, using a target process of 6 Sigma to provide a quality level of at most 3.4 defects per million opportunities.	
BUSINESS CASE	
To reduce the student dropout count and help educational institutions earn high annual revenues, it is indispensable to give students a competent, convenient, and knowledgeable online educational sphere. As per the statistics based on the survey conducted with students in several universities, it is imperative to provide online instruction training to teachers to improve the overall online education quality. Since, the teachers are no longer only the instructors but also the facilitators to the students. Thus, improved student interactions, knowledge sharing in a dynamic virtual environment, better dealing with the technical glitches during the classes, would lead to seamless flow of course which would decrease the rate of dropouts. This will increase the annual revenues earned by the education sector by millions of dollars, all over the world.	
PROJECT GOAL	
The project is going to be commenced on the collected data and give the required output in satisfying students by enhancing online education quality. The goals include: • Identify the major attributes that need to be controlled in order to improve the quality of the online education. • Reduce the variability by using six sigma techniques to eliminate causes responsible for declining the quality of online education.	

TEAM MEMBERS	
Name	**Title**
Huma Maryam	Six Sigma Quality Manager
Ayman Al-Qadi	Project Manager
Ramya Gali	Quality Assurance Engineer
Mian Basit	Quality Assurance Engineer

HIGH LEVEL PROJECT TIMELINE			
Phase	**Start Date**	**Finish Date**	**Duration (In Days)**
Define	15/10/2021	25/10/2021	10
Measure	26/10/2021	08/11/2021	12
Analyze	09/11/2021	21/11/2021	12
Improve	22/11/2021	02/12/2021	12
Control	03/12/2021	06/12/2021	3

APPROVAL			
Role	**Name**	**Approval Signature**	**Date**
Project Sponsor	Zachary Patterson		08/12/2021

1.2 <u>Process Flow Map:</u> A process flow map has been created to understand how the existing process works.

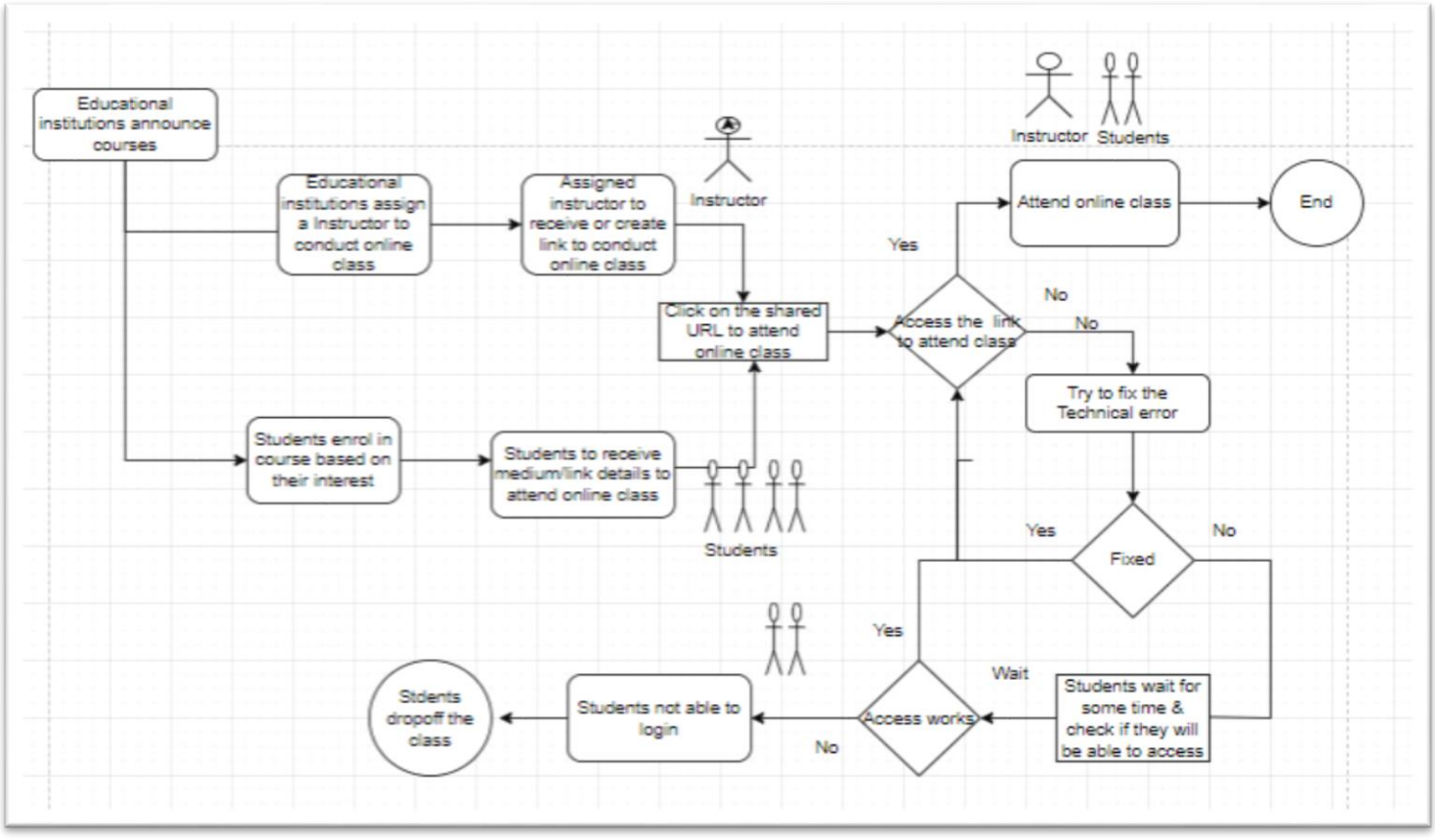


Figure 4: Online Education Process Map

1.3 Data Collection Set

We used online surveys as data collection tool, A data collection plan was created, and online surveys were conducted to gather responses from students about the online course delivery systems and to identify opportunities for improvement. The surveys targeted different students with different universities and backgrounds who used different systems in Montreal.

Students' questionnaire consisted of several question to indicate what type of disadvantages (defects) their educational online experience has, consequently, among different factors affecting quality of education process and student performance, the important ones are illustrated in the figure 5 below.

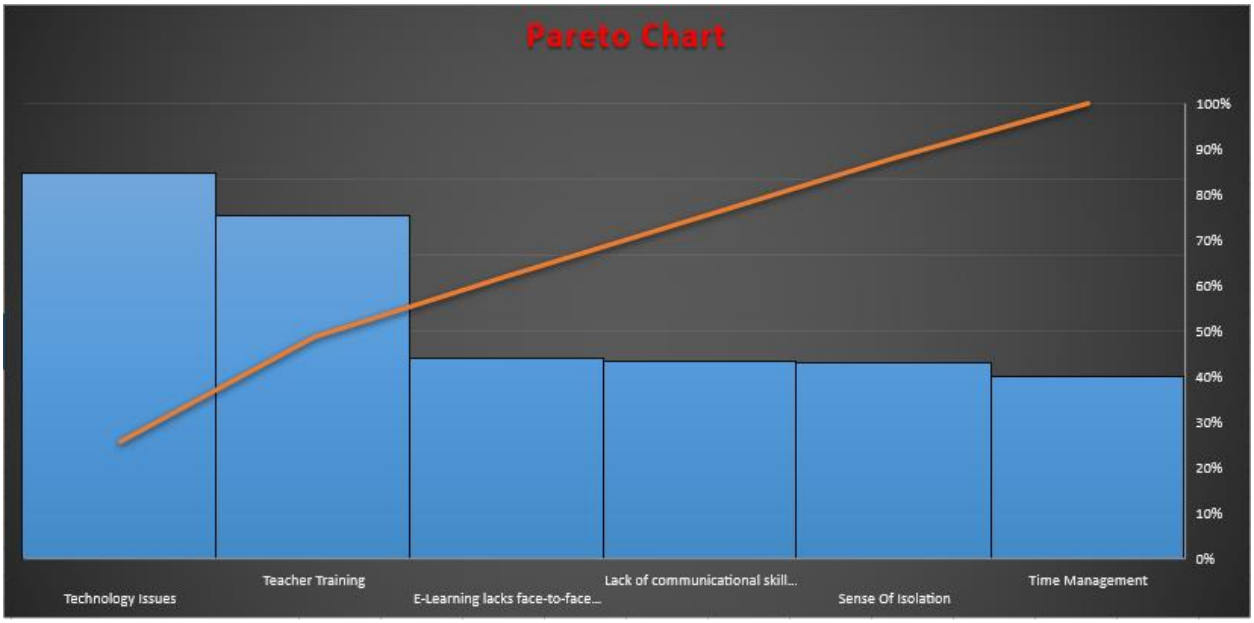


Figure 5: Pareto Chart

1.4 CTQs:

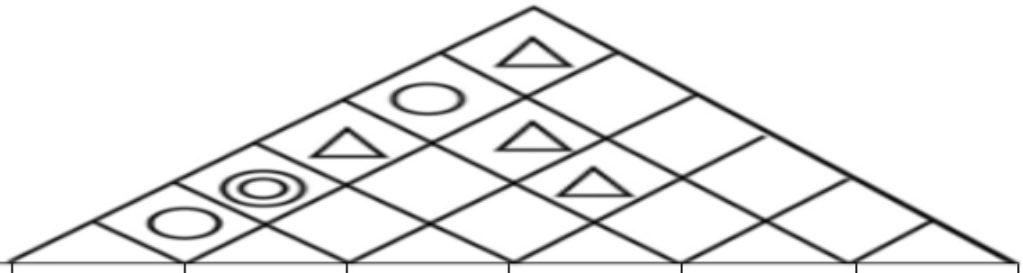
After doing proper research as well as constructing a Pareto Diagram as in Fig. 5, the following factors were agreed on that they mainly contribute to student satisfaction.

- Easy access
- Reliability
- Efficiency
- Rich Content
- Student Support
- Entrancing
- Aesthetics

2. MEASURE

2.1 QUALITY FUNCTION DEPLOYMENT

QFD is a structured method that uses the management and planning tools to identify and prioritize students' expectations quickly and effectively.



Relationship Legend Very Important: 5=© Average: 3= O Low Important: 1= Δ		Teamwork	Time Management	E-Learning communication	Up to date Technology	Feasible online classes	skill development
Easy access	5		Δ		O	©	O
Reliability	4	Δ			©		
Efficiency	3	Δ	©			O	
Rich Content	2	Δ	O	©	O	O	O
Student Support	2	Δ	O	©			
Entrancing & Aesthetics	1	©					Δ
Priority Score		16	32	20	41	40	22

Figure 6: QFD for online education.

The key requirements to deploy and their order of priority as per the House of Quality diagram shown above are as follows:

- Up to date technology
- Feasible online classes
- Time Management
- Skill development
- E-learning communication
- Teamwork

2.2 DPMO & Process Capability Calculation of Existing Process

100 students survey sample were collected, a criterion of marking their defects by 5 = strongly agree and 0 = strongly disagree.

According to student survey report, it is found that different 6 defects are found regarding 100 students on semester basis, concerning a quality major question which include an assumption any rate below 2 is a defect.

Defects per Million Opportunities were calculated to be able to assess the process Sigma Level as shown below.

DPMO= $\frac{6}{100} \times 1m = 60{,}000$ defects per million opportunities

Sigma Level = □□□□□□□nv (1-$\frac{60000}{10^6}$) + 1.5 = 3.1σ

MEAN	**3.12**	**Cp**	**0.387**
STD	**1.29**	**CpU**	**0.356589**
UTL	**4.5**	**CpL**	**0.41586**
LTL	**1.5**	**CpK**	**0.3565**

Process Capability for ''lack of prior Training to conduct online classes''

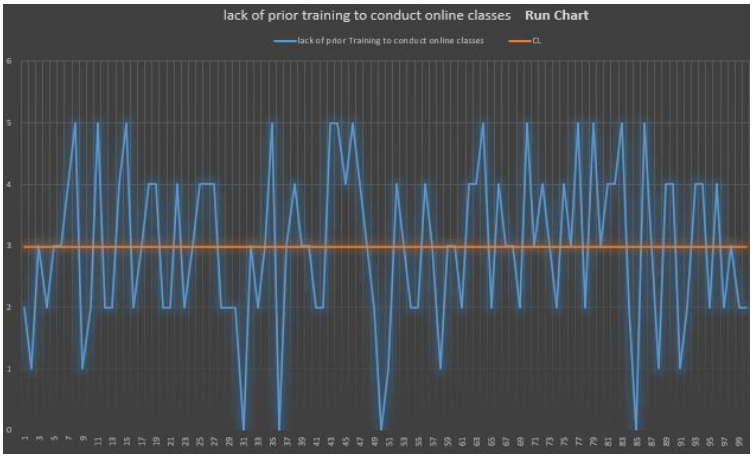
MEAN	**2.61**	**Cp**	**0.5137**
STD	**0.9733**	**CpU**	**0.64728**
UTL	**4.5**	**CpL**	**0.38**
LTL	**1.5**	**CpK**	**0.38**

Process Capability for ''technology issues''

2.3 Control Chart of Existing Process

Since the most important factors account for 80% of the problems, they were reflected in the dataset as two variables that are lack of prior training to conduct online classes, and Technology Issues.

It has been decided to focus on these variables in terms of measurement. In this phase, first the data will be visualized in Run Charts to observe the nature of the data. Then X-bar chart, R-chart are going to be introduced for both issues.



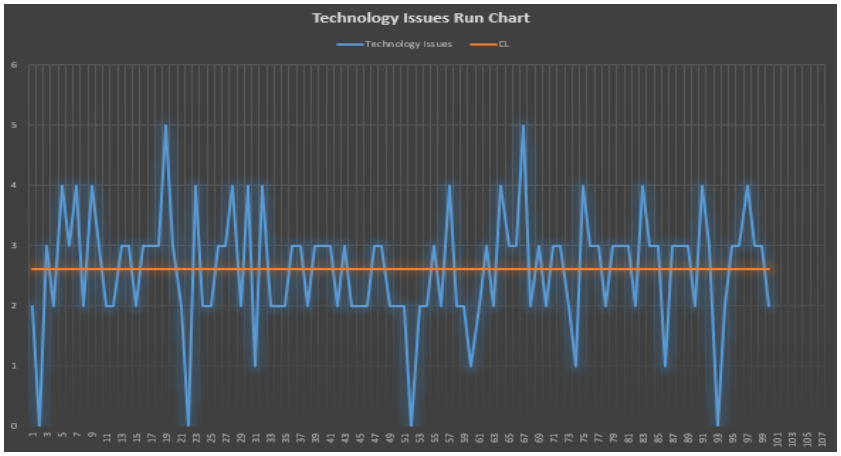
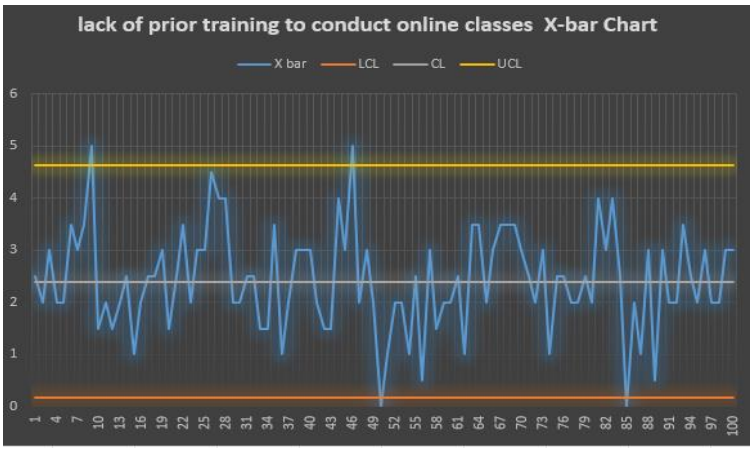


Figure 7: Run Charts for Lack of prior training to conduct online classes, and Technology Issues



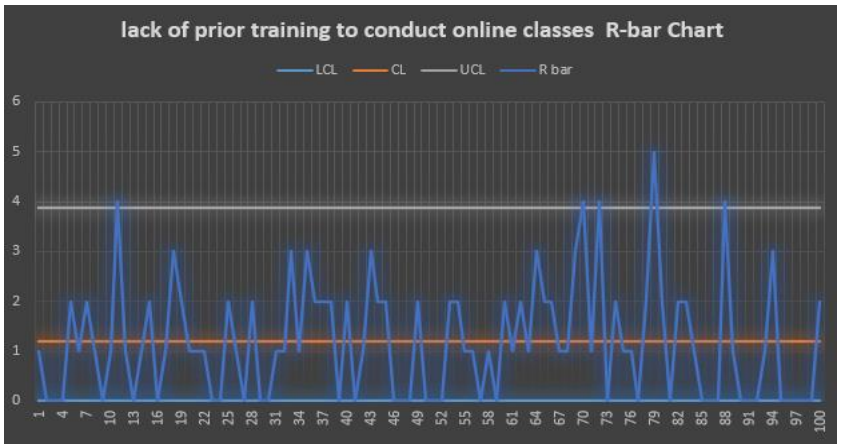
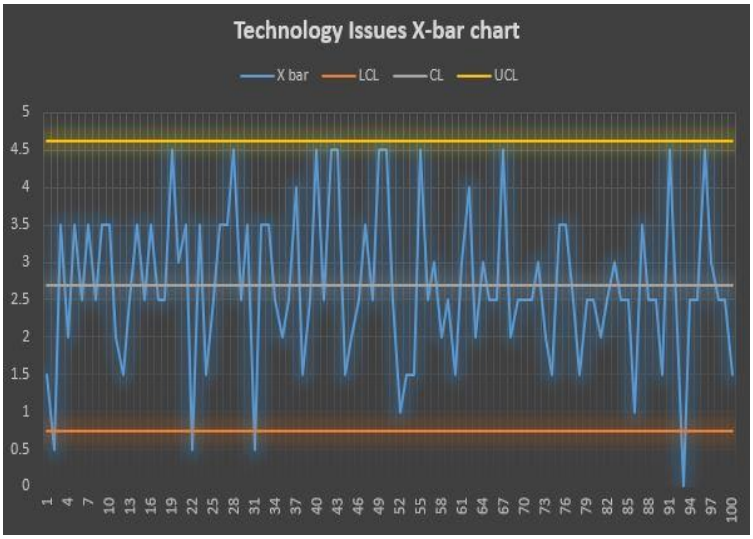


Figure 8: X-bar & R-bar Charts for Lack of prior training to conduct online classes.



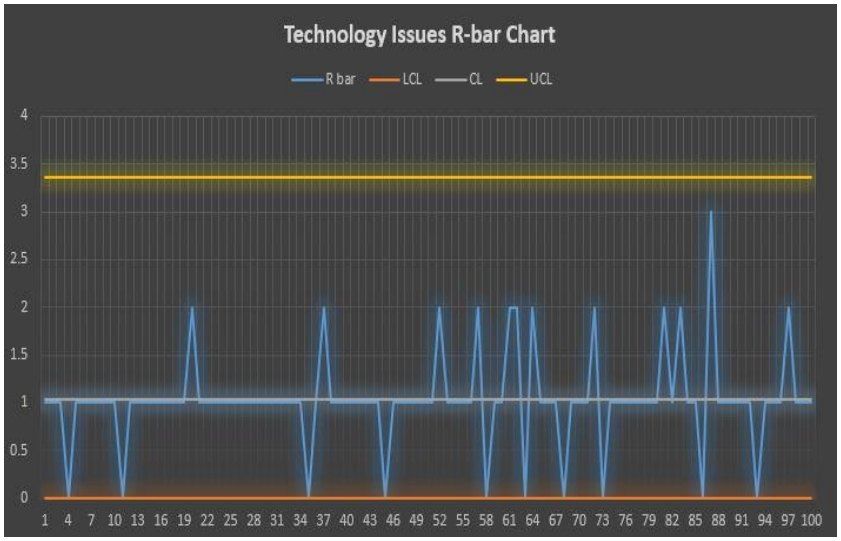


Figure 9: X-bar & R-bar Charts for Technology Issues.

3. ANALYZE

Analyze phase is the third phase of DMAIC methodology. In this phase, the data collection during the measure phase has been reviewed. The aim of data analysis to gain an understanding of why problem occurs. In our project, we are using following approaches to find out the root causes of technical glitches and instructors lack of training to which the online educational quality is not satisfying everyone.

3.1 Five Why's

The Five Whys helps identify the root cause of a problem. We have used the 5 "Why" questions which involves asking a series of questions until the root cause is eventually discovered.

Why are many students not satisfied with the online education experience?

Because the online education experience provided by instructors is not up to the mark.

Why the online education experience provided by instructors is not up to the mark?

Because of instructor's lack of prior training, less competency in the efficient use of software's which leads to an ineffective study environment.

Why instructor's lack of prior training, less competency in the efficient use of software's?

Because in most educational institutions, prior training is not provided to instructors on how to conduct online classes effectively and thus they have inferior knowledge in making best use of the software's.

Why in most educational institutions, prior training is not provided to instructors on how to conduct online classes effectively?

Because there are no good trainings designed specifically for instructors on how to conduct online classes effectively because education online is new method education.

Why there are no good trainings designed specifically for instructors on how to conduct online classes effectively apart from education online is new method education?

Because due to lack of financial funding in such a field.

Thus, the main root cause of this problem is: there are no good trainings available or designed specifically for instructors on how to conduct online classes effectively because education online is new method and financial funding in this area was not implemented.

3.2 Fishbone Diagram

The following fishbone diagrams were drawing to try to understand the source of the online education defects.

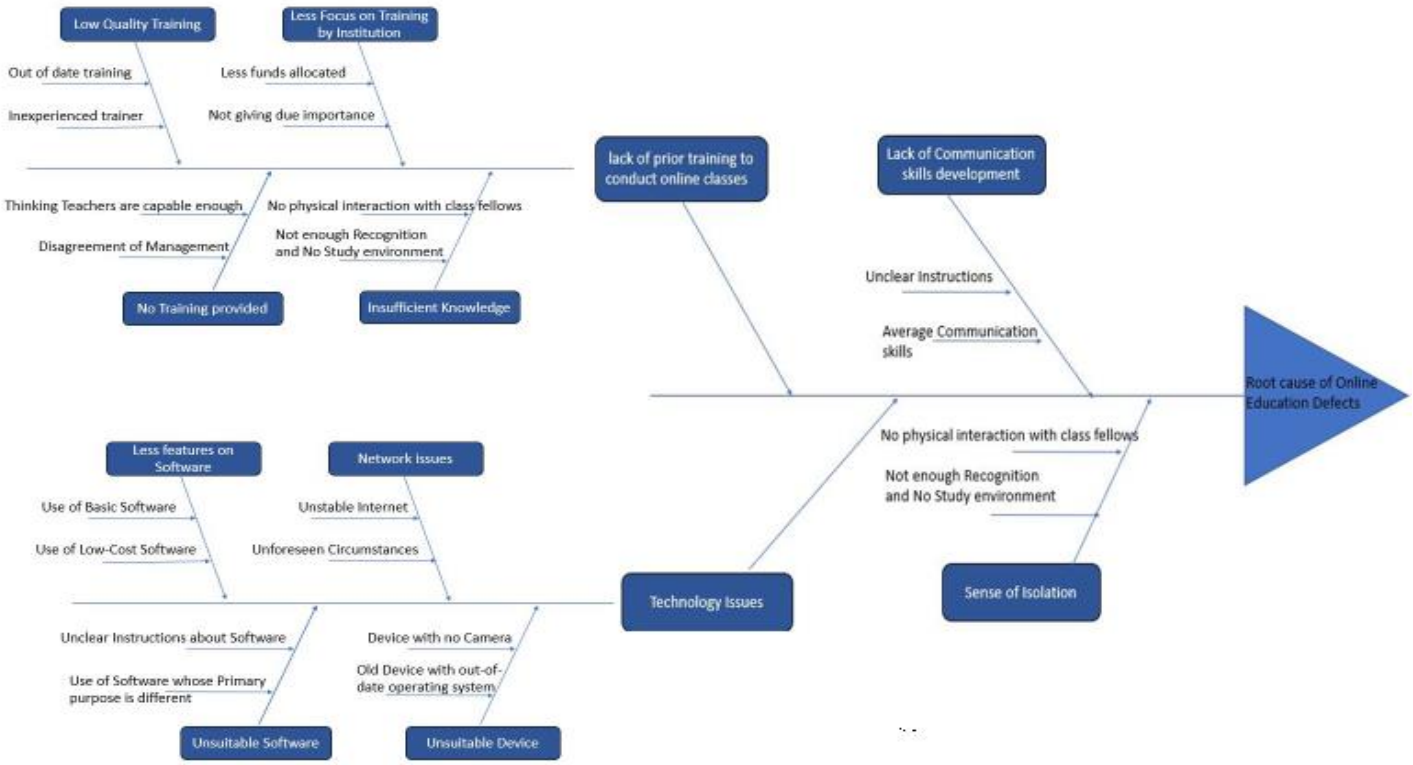


Figure 10: Fish-bone diagram for online education defects

4. IMPROVE

Improve is the critical step in the DMAIC as corrective measures as a solution is designed and implemented to improve the performance of the existing process.

4.1 PDCA

Based on the data analysis and root cause analysis, using PDCA model, a six-sigma methodology, improved the quality of online education. PDCA stands for Plan, Do, Check and Act, below is the detailed PDCA to be implemented to improve the quality of online education.

1. **PLAN:** As per root cause analysis below are the two primary reasons that are negatively impacting the

quality of online education:

1. High priority (Critical):

Lack of prior training to conduct online classes

Technical glitch/ Technology Issues

2. Medium Priority:

Sense of Isolation/ Lack of face to face to communication

Lack of communication skill

Time Management

- Objective:

Quality and experience of online education to be improved.

- Corrective Actions:

- Lack of prior training to conduct online classes

As per existing process, educational instructors are not trained to conduct online classes. As a result, many of the instructors are not aware of using the tools or media which they use to conduct online classes. Hence, they are not able to make the most of it, like setting agenda of class, sharing the information or exam conducting. If hands on training provided through some expertise in the same field the instructor can gain firsthand knowledge and best practices on how to conduct the virtual classes to capture students' attention.

- Technical glitches:

1. Instructors should be trained to address the basic technical issues which they might encounter daily
2. Handouts/Manuals should be provided to classes enrolled Students and Trainers on the first day of the class on how to fix the common issues of the technical issues if they come across
3. Educational institutes to have access to experts who can fix any issue triggered and can fix in no time

- Sense of Isolation/ Lack of face to face to communication
    1. Adding some entertainment to class, fun based quiz
    2. Having 1:1 meeting or having meetings with small group once in a while

- Having long single sessions students might lose interest:

    1. Giving 10 minutes break for every hour

    2. Having class for one or two hours instead of for long durations, sharing related information in advance, if possible, to provide material well in advance

- Time Management:

    1.Have realistic agenda that can cover in planned class

    2. Stick to agenda

    3. prior Preparation

    4.Punctuality

    5. Avoid technical issues, as this will waste time

- Lack of communication skills:

    1. Must select suitable instructors who has good communication skills

    2. Provide prior training

2. DO:

Suggested solutions:

- Training provided through some expertise to instructors on how to use all the available tools and resources to conduct the online classes.
- Instructors should be trained to address the basic technical issues which they might encounter daily
- Handouts/Manuals should be provided to classes enrolled Students and Trainers on the first day of the class on how to fix the common issues of the technical issues if they come across
- Educational institutes to have access to experts who can fix any issue triggered and can fix in no time

3. CHECK

The above suggested steps must be followed separately as well in combination and check for the best output.

4. ACT

The best of these should be chosen and implemented.

4.2 Improved Process Map:

As a part of the Improvement, we have also developed a new improved process map. After deciding on the measures and processes to be taken and others to be eliminated, an updated Process Map was created for future online educational process journey as shown in Fig.11.

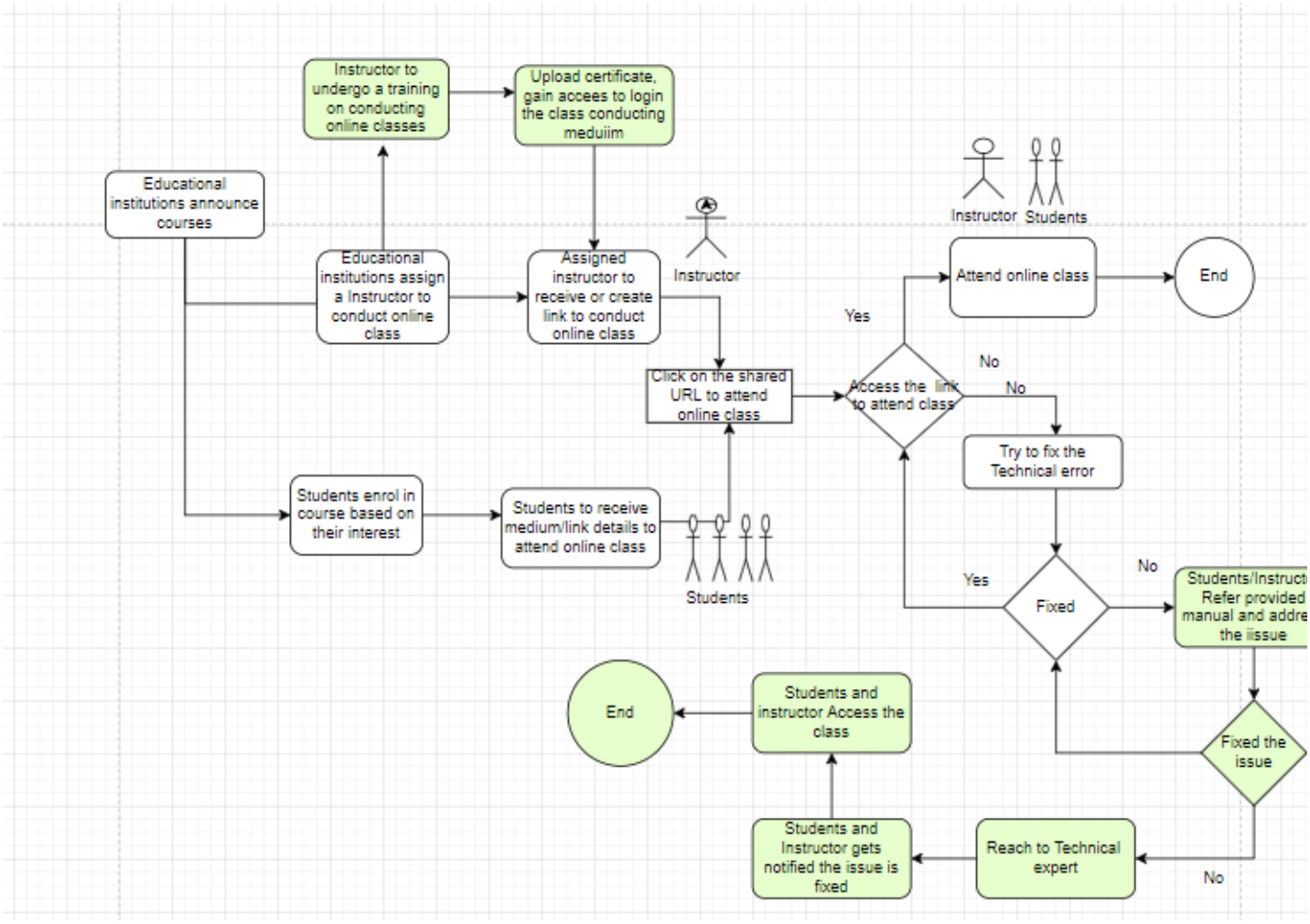


Figure 11: Improved Process Map

4.3 Implementing Poka-Yoke or Mistake Proofing:

Design the potential errors out of the process which is a most powerful form of mistake proofing to eliminate the possibility of error or defect.
The potential defects are:

1. Teacher may not login on time due to some server issues
2. Techer or students experiencing challenge to login to class login
3. Students to login at least 5miinutes early to the class to check their access. If any issue to communicate with School or Expert through toll free number
4. Post certification in training teacher should be eligible to conduct a class

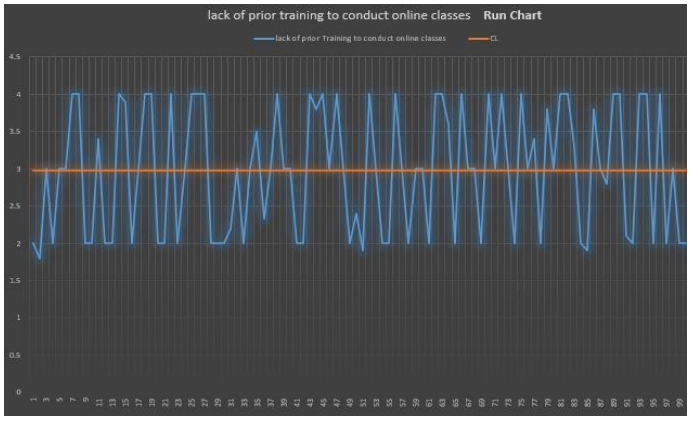
Poke-Yoke Tricks:

1. Teacher to login the link 15-mins before the class and to check if it's working as expected. If any issue, try to connect with experts to fix it.
2. To set an alarm or notification to teacher to login and check 15mins early otherwise to block the access to the class 10 minutes prior
3. To send an auto notification or reminder to students to login to the class check their access. Failure to do that and report an error at the beginning of class is deemed as Student's failure and not considered as failure or defect.
4. Without uploading the certification, access should not be granted to a teacher to conduct a class

5. Control

5.1 Improved Control Chart

After the corrective actions have been implemented, improved control charts i.e., X-bar, R, and Run-charts were created to visualize how the process became in control in Fig. 12, Fig. 13, and Fig. 14.



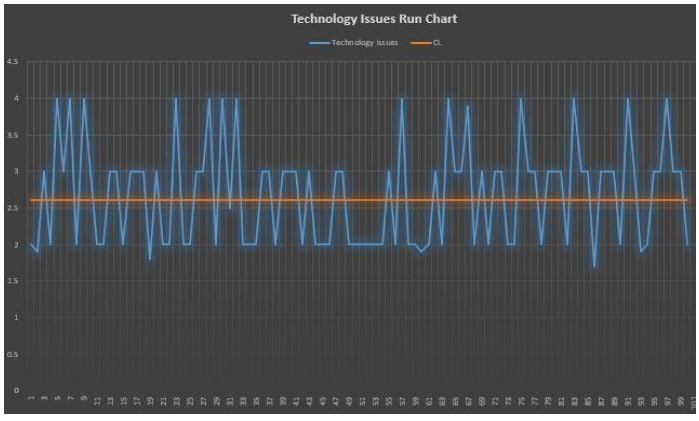
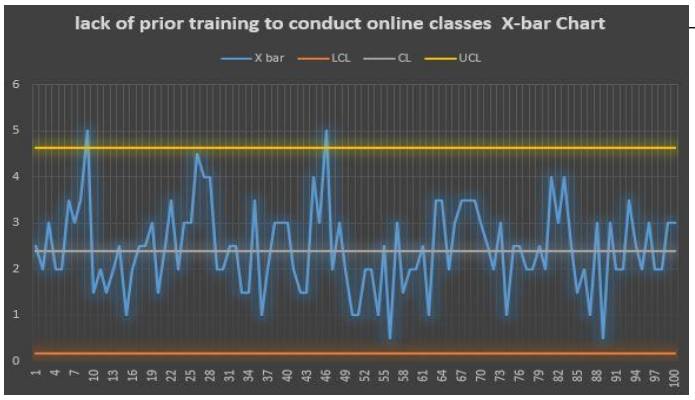


Figure 12: Improved Run Charts for Lack of prior training to conduct online classes, Technology Issues.



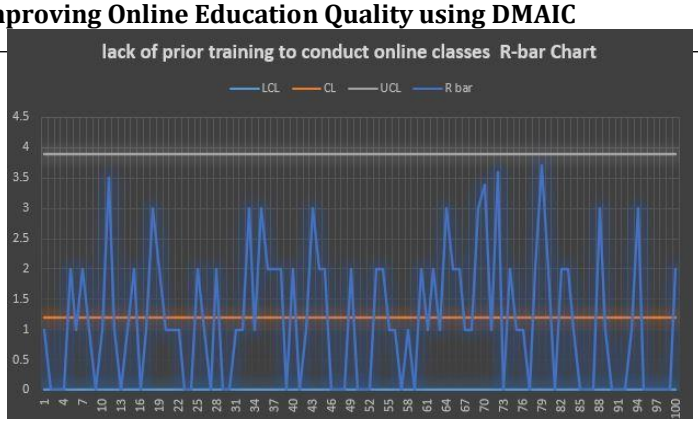
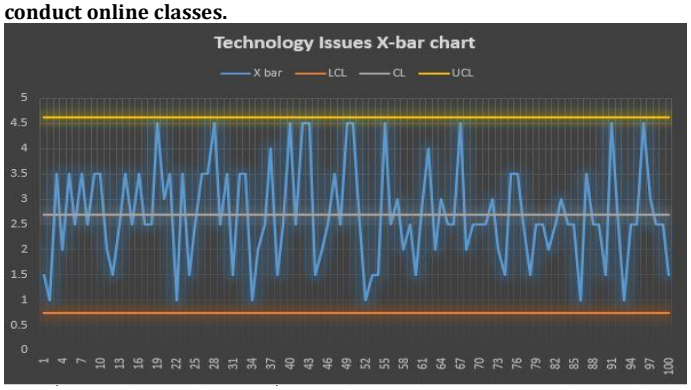


Figure 13: Improved X-bar &R-bar Charts for Lack of prior training to conduct online classes.



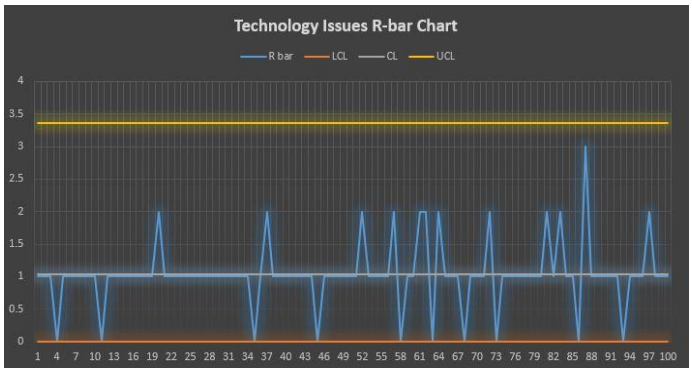


Figure 14: Improved X-bar & R-bar for Technology Issues

Our criteria of improvements on X-bar charts only assessed regarding the lower control limit line, there are no problem reaching better quality rate above 4.5 (UCL), However, the process will be affected if there are any out of control points specially under the LCL.

5.2 Improved Process Capability

In terms of Process Capability, it is shown below the improved calculations of Cpk for both main defects. Both values are improved to .92 and 1.11, which conclude that lack of prior training still needs area of improvements to be capable, however, Technology issues which was the greatest defect in this project, its Cpk process in barely capable and the process has a spread just about equal to specification width.

MEAN	3.12	**Cp**	1
STD	0.5	**CpU**	0.92
UTL	4.5	**CpL**	1.08
LTL	1.5	**CpK**	0.92

Process Capability for ''lack of prior Training to conduct online classes''

MEAN	3.2	**Cp**	1.282051
STD	0.39	**CpU**	1.111111
UTL	4.5	**CpL**	1.452991
LTL	1.5	**CpK**	1.111111

Process Capability for ''technology issues''

CONCLUSION

As a result of applying DMAIC technique in implementing Six Sigma on online educational systems, we were able to successfully improve the quality of this service by reducing the variation and the flatness of the normal distribution curve of the process. In fact, the process was found to have a 3.1 Sigma level as explained earlier in measure Phase. Below, it can be seen how Sigma level has been improved to 3.6.

Improved DPMO= $\frac{2}{100} \times 1m = 20{,}000$ defects per million opportunities

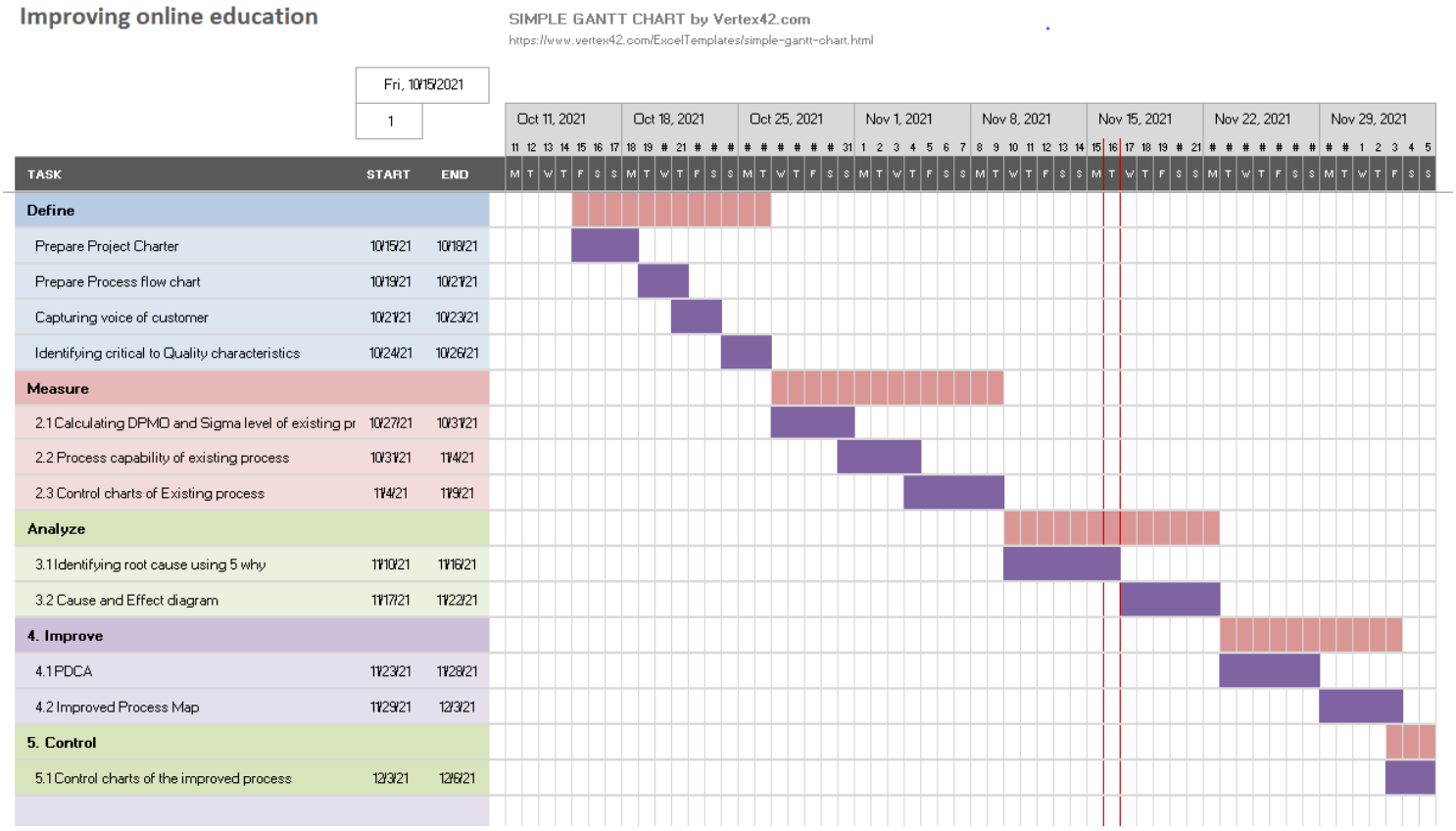
Sigma Level = □□□□□□□nv $(1-\frac{20000}{10^6})$ + 1.5 = 3.6σ

An intellectual question could simply be, why 3.6 and not 6 Sigma level? In fact, reaching a DPMO of 3.4 is not an easy task since this rate is close to perfection where only forty companies reached 6 Sigma level like 3M, Amazon, Boeing, Motorola, Caterpillar, Dell, General Electric, Ford Motors, and others. [3]

We addressed the identified problems in the delivery of student distance learning experience. We proposed the use of 6 sigma methodology, this methodology which contains various method for process improvement and the reduction of defects. We used to ascertain specific major issues for online students, analyze the current state regarding these problems, and present guidelines to the administration and faculty of the educational institutions for developing a plan to eliminate those issues. The methodology also included continuous improvement and readjustments according to the results acquired from preliminary data.

APPENDIX

Appendix 1: Actual Project Timeline



Appendix 2: Online Survey Questionnaire

a) Out of the following six identified issues, which is the major bad quality issue as per your online education experience?

1. E-Learning lacks face-to-face communication
2. Time Management
3. Sense of Isolation
4. Lack of communicational skill development
5. Technology issues
6. Teacher's lack of training to conduct online classes

b) Instructors lacks in proper training to make sure that there are proper interactions between teacher and students.

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly Agree

c) E-Learning experience was not satisfying due to time management issues occurred because of various technological issues during the classes.
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

d) Online education experience was not as expected as instructors/facilitators failed to eliminate a sense of isolation?
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

e) Online class experience was not satisfying due to lack of instructor's training to trouble shoot the technological issues occurred during the classes.
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

f) Are you satisfied with your overall online education experience?

0 1 2 3 4 5

Unsatisfied Satisfied

Appendix 4 : Part of the data collected from students.

1	Student #	Technology Issues	lack of prior Training to conduct online classes	E-Learning lacks face-to-face communication	Time Management	Sense Of Isolation	Lack of communicational skill development	Over all Quality
2	1	2	2	3	1	3	2	3
3	2	0	1	0	0	2	3	1
4	3	3	3	3	4	4	2	4
5	4	2	2	4	1	2	3	4
6	5	4	3	2	0	4	4	3
7	6	3	3	4	4	5	5	4
8	7	4	4	2	2	2	4	4
9	8	2	5	5	0	5	2	3
10	9	4	1	5	0	2	5	3
11	10	3	2	3	0	2	4	1
12	11	2	5	4	4	4	3	2
13	12	2	2	2	4	2	2	2
14	13	3	2	4	4	3	2	2
15	14	3	4	3	3	5	5	3
16	15	2	5	5	4	4	4	5
17	16	3	2	5	5	2	5	3
18	17	3	3	3	2	4	5	2
19	18	3	4	3	4	5	4	3
20	19	5	4	5	3	4	4	5
21	20	3	2	3	2	4	3	5
22	21	2	2	5	5	4	3	4
23	22	0	4	5	3	5	2	3
24	23	4	2	3	2	5	2	3
25	24	2	3	3	2	4	3	0
26	25	2	4	4	4	5	3	3
27	26	3	4	4	3	2	2	2
28	27	3	4	4	2	4	4	4
29	28	4	2	4	3	5	4	2

References

[1] Mitra, A. (2004). Six sigma educations: a critical role for academia. The TQM Magazine, 16(4), 293-302.

[2] Dr. Quamrul H. Mazumder, University of Michigan, Flint Applying Six Sigma in Higher Education Quality Improvement

[3] Pyzdek, T. “The Six Sigma Handbook”, McGraw-Hill, New York, 2003.

“List of Six Sigma Companies,” Wikipedia, 02-Mar-2020. [Online]. Available: https://en.wikipedia.org/wiki/List_of_Six_Sigma_companies. [Accessed: 02-May-2020].