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DMAIC METHODOLOGY APPLICATION FOR THE CONTINUOUS IMPROVEMENT OF ONLINE VOCATIONAL EDUCATION DURING COVID-19 PERIOD

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Abstract

Due to COVID-19 scenario vocational education migrated to online platform completely for the continuity of learning process and this affected the effectiveness of achieving relevant skills competency by the learners as the hands-on practice, machine or real-world scenario-based learning part is missing. A continuous improvement is required in this case and DMAIC methodology under Six Sigma concept is proposed in this paper as a framework for ensuring the quality delivery of online vocational education. The findings from the study stressed the importance of using advanced technology, e-learning apps to facilitate an effective online education.

Keywords: Online education, DMAIC, Six sigma, vocational education, E-learning, Distance learning anyway, Technology based education

INTRODUCTION

Covid-19 scenario forced the vocational education sector to adapt online learning in a short span of time and they were not ready to embrace this quick transition. There was not enough preparation and background information for the successful deployment of online education was not available. The main challenge is to maintain the same level of quality of lesson delivery using classroom and labs also in the online mode of delivery. Vocational education based on outcome-based learning and the learner understanding judged by the achievement of set of skills listed by each course. In other words, at the end of each course learner will be competent in certain skills. As an example, upon the completion of the CAD course learner achieves competency in designing skill of 2D and 3D engineering component modelling. So, the vocational teaching and learning process extensively based on classroom, workshop, lab, industry set up along with hands on experience activities. For learning welding, electrical installation, machine tool operations learners need to be in the front of equipment or present in the workshop to practice the skills Online mode of lesson delivery limited the teaching boundary as most of the equipment, tools not accessible from the home and the absence of practical activities. This generated a big gap in delivering skills to learners and not all skill sets cannot be covered in the entire teaching and learning process. This drawback affects the effectiveness of the teaching and learning process thus in turn reduce the overall quality. DMAIC methodology is proposed in this paper with the objective of providing a framework to assess the existing online education process effectiveness to identify the areas of improvement and assurance of quality through continuous improvement.

LITERATURE REVIEW

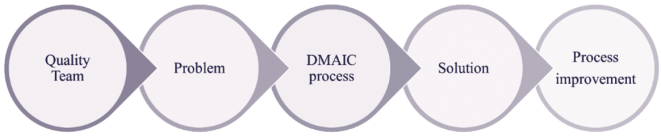
Limited studies were carried out regarding the implementation of DMAIC tool for the education sector quality improvement especially Vocation education sector and online education. A detailed study by Glykas, Michael and Bailey et al. (2015) presented what quality, in general, means and some of the main concepts associated with its implementation and assurance in the field of Vocational Education and Training. One of the recent student studies (Nandika Sampath et al. 2020) to explore the influence of implementation of quality management practices on operational performance of TVET institutions in Sri Lanka revealed the importance of quality management performance as the employee involvement and continuous Improvement verified strong and significant relationship on operational performance. A DMAIC application to establish a procedure to form a teaching feedback system proposed by Kun-Tzu Yu & Ren-Gen Ueng (2012) measured the degrees of satisfaction and importance using proposed quality indicators. In addition to DMAIC, an expanded Importance-Performance Analysis (IPA) method and TEAM diagram is applied for providing a graphical representation of teaching attributes relationship and to identify the attributes that failed to meet the institution attributes. Ho, S. L., Xie, M., & Goh, T. N. (2006) studied the feasibility of applying six sigma in higher education and discussed the challenges in integrating DMAIC in existing curriculum. The study revealed the Six Sigma DMAIC methodology fits in nicely for optimizing transactional processes in facilities support and services, as well as faculties. Also stressed the importance of understanding DMAIC methodology and education in statistical quality engineering are important for Six Sigma project success. Another study was conducted using the DMAIC methodology (Sastri, Pathanjali and Narayana, J. Lakshmi-2019) in the Outcome based Education (OBE) to improve the performance of students and improve the teaching and learning process. As Vocational Education involves outcome-based education the study is relevant DMAIC methodology can be used to improve the outcome of the teaching-learning process along with teaching enhancement with quality tools. This study considered DMAIC as continuous improvement iterative process model for ongoing quality model. Effective implementation of DMAIC in academic program design and curriculum development evaluated in the

case study at Central Michigan University (Holmes, Jenicke, & Kumar, 2005). In related to academic assessment process DMAIC methodology can be applied through a structured lean improvement event (Bargerstock, A. S., & Richards, S. R. 2015) that resulted in reduced cycle time by two-thirds, removed frustrating non-value-added activity steps, discovered additional customer value, and boosted compliance rates significantly. Related to implementing the lean principles for distance education process improvement x(Pedersen, K. L., Ziegler, M. J., & Holt, L. D. 2015) suggesting the long-term success by adopting a train-the-trainer approach that involved a cross-functional team of division employees. It is evident that there is a lack of papers proposing a framework or study of application of how DMAIC is used to improve the quality of online or distance education processes. This paper presents a framework that applying the classic five-step DMAIC Lean Six Sigma procedure for continuous process improvement of teaching and learning process.

DMAIC METHODOLOGY

DMAIC is an acronym that stands for Define, Measure, Analyze, Improve and Control and it is a data driven method used to systematically improve the process. The main goal of this approach is to increase the quality of a product or service by focusing on optimizing the process that produces the output.

Figure 1: DMAIC approach



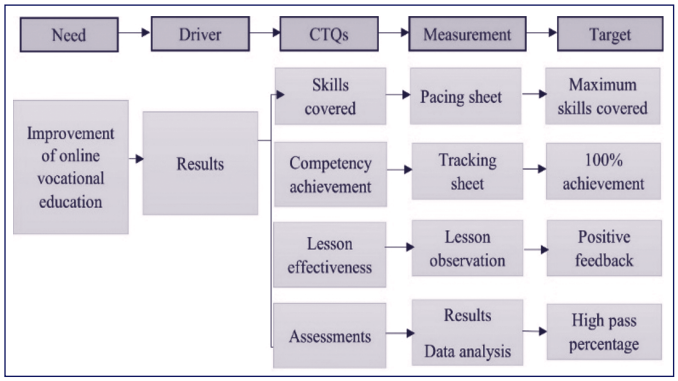
DMAIC is an improvement method through which we can find out what the customers needed and statistically examine or measure the existing process to find out the extent at which the improvement required in the define stage. The findings will be further analyzed to determine how significant the current drawbacks are. The improvement strategy will be determined based on the analysis to improve the process and confirm it through statistics. Controlling measures will be put in action to sustain the improvement and the entire process can be cycled again to ensure the continuous improvement. Basic quality tools such as flow chart, cause and effect diagram, pareto chart, control charts support the various phases in DMAIC method for the measurement, evaluation and validation of findings.

APPLICATION OF DMAIC METHODOLOGY VOCATIONAL ONLINE EDUCATION CONTINUOUS IMPROVEMENT

For the framework generation and DMAIC methodology application a scenario of an online vocational education process of Mechanical Engineering Level 3 Diploma course is considered. Welding Technology, CAD, Metal workshop Basics and Technical drawing courses are taught through online mode during the COVID-19 transition period and learners need to achieve the competency in relevant skills through continuous formative and summative assessments. Lessons delivered through online completely and learners provided with iPad to support the online learning process.

I. Define- In the define phase a detailed study of existing system or process need to be done to highlight the need and scope of areas of improvement by listening to the voice of customers represented mainly by students and teachers. The main objective needs to be continuous improvement of existing online system along with increase in the satisfaction of teachers, students and parents and quality improvement of existing online delivery mode. For achieving this objective CTQs (Critical to quality characteristics) need to be identified through brainstorming sessions, survey and interviews among various stakeholders. The identified CTQs can be represented as Critical to Quality tree diagram.

Figure 2: Critical to Quality Tree diagram



II. Measure- Various data collection tools can be applied during this phase such as observations, interviews and surveys. In this scenario survey tool is applied to collect the data from the students and faculty about the existing process and to identify the improvement opportunities. Survey was designed to collect data about the various problems faced by students and faculties while using online learning platforms for Mechanical Engineering courses. This activity is placed under VOC (Voice of customers) as faculties and students can be considered as internal and external customers. Effectiveness of teaching and learning measured from the survey responses along with lesson observation feedback. A wide range of e-learning apps and online teaching tools used for the existing process; so, data collection focused on the effectiveness of current strategies and find any gaps that limiting the competency achievement rate. Engaging students is a challenge during the online lessons and E-learning apps lesson activity reports aid the measurement of engagement effectiveness. These baseline measurements will be used as the standards against which the team will measure their success in the 'Improve' phase.

III. Analyze- The high response rate from the survey and the data from lesson feedbacks, lesson engagement reports indicate the results validity that can be used as the basis for the improvement plan. The major advantages that are identified during the measure phase are:

- Online education facilitates the use of simulation apps to make the learning more interactive and interesting. For example, students can use Tinker CAD for 3D modelling,

circuit design and simulation game app for lathe machine operation.

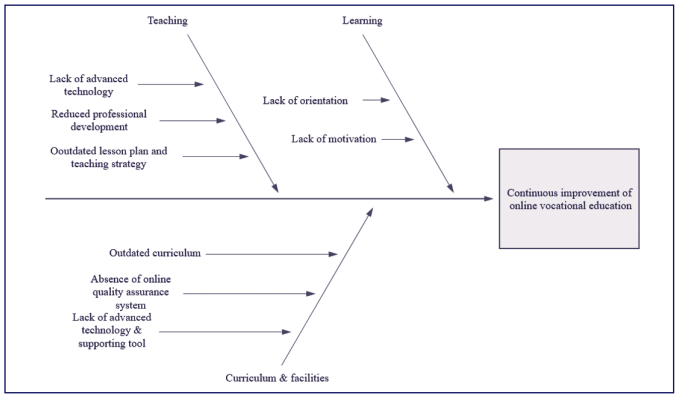
- Demonstration of standard operating procedures of machines can be provided through the videos available in video sharing platforms.
- Assessment activities simplified as auto-grading and flexibility in question sequencing along with task differentiation opportunity.
- Recording and evidencing the learners work through E-portfolio apps.
- Easy sharing of resources through cloud services and opportunity for collaboration with teamwork.
- Extensive use of technology by faculties evident in lesson observations.
- Technology skills of students and faculties improved and started trying new technologies.

Opportunities for improvement and the reasons for the gap in competency achievement rate identified from the analysis of data as follow as:

- Application of Augmented reality and Virtual reality technology to enhance the teaching, learning process of technical concepts. Some of the competency skills like metal working that requires workshop practice need to be carry out online using virtual lab applications.
- Continuous professional development of faculties and orientation for students required for preparing them for the use of new technology.
- Curriculum development strategy need to be updated with two plans- both online and offline learning. This will help to adjust the competency skills requirement list and motivate the students with positivity.
- Regular quality assurance through inspections, observation and outcome analysis.
- Involvement of industry partners to provide online certifications and courses as extra support.
- Lesson plan template modification to accommodate the sudden changes and blended learning opportunities.
- Student centered lessons for promote innovation and creativity among learners.
- To sustain the extracurricular activities promotion of online clubs are necessary.
- A centralized resource portal for accessing all technical books, journals, catalogues etc.
- Development of DIY kits or drawing instrument kits for providing to students for practice technical skills at home.
- Standardize the process and formulate a monitoring team to make sure everything on track to sustain the continuous improvement.

The collected data were also used to identify the factors that influence the quality online vocational education and summarized in the cause-and-effect diagram.

Figure 3: Cause and Effect diagram



III. Improve- In this phase, the focus is on removing the problems identified and implementing solutions for the continuous improvement. The improvement can be measured against the data collected during the measure phase. One of the challenge is not all the effective solutions not easy and practical to implement so the management need to do a deep assessment and brainstorming to identify the optimum practical solution for the implementation. The improvement will happen in all the sectors by considering all the stakeholder feedback. PDCA (Plan-Do-Check-Act) approach supports this phase by allowing to systematically study the possible solutions, evaluate the results and select the ones that have a higher chance of success.

IV. Control- In the final phase of the DMAIC method, the focus falls on sustaining the improvements and measure the success continuously. A monitoring plan along with a response plan devised to act upon if there is a drop in the process performance. The improved processes need to be documented and standardized for the continuous improvement.

CONCLUSION

Covid-19 days shifted vocational education to online mode and all the institutions working hard to deploy the online education in most effective and quality way. A need of quality assurance or continuous process improvement is evolved and DMAIC methodology from six sigma concept can be considered as the best choice. The DMAIC framework proposed in this paper suggested each phase with activities and tools that aims to achieve the end goal of quality assurance, continuous process improvement and customer/ stakeholder satisfaction. This framework can apply to any level of education system who working towards the online education delivery.

ABBREVIATIONS

COVID-19: Coronavirus Disease 2019
DMAIC: Design-Measure-Analysis-Improve-Control
VOC: Voice of customer
CTS: Critical to satisfaction characteristics
PDCA- Plan-Do-Check-Act
CAD: Computer-Aided Design

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