Analysis of GLSS barriers in HEIs by using Grey relational analysis

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ABSTRACT

The purpose of this paper is to critically evaluate whether Green Lean Six Sigma (GLSS) can be a powerful business improvement methodology for improving the efficiency and effectiveness of higher education institutions (HEIs). The paper will also explore the fundamental challenges, barriers and critical success factors for the introduction and development of GLSS in the HE context. The last part of the paper is to understand the role of tools and techniques for the sustainability of this initiative for making the HEIs more efficient and effective. In this research methodology first we have to analyse GLSS barriers in higher education institutions then we apply grey relational analysis on these barriers with the help of literature review. The paper presents the challenges and barriers to be encountered during the introduction of GLSS in the higher education sector, most useful tools and techniques for process improvement problems, success factors which are essential for the implementation and sustainability of GLSS. This is a very theoretical paper based on the existing literature and authors' experiences in the HE sector. The proposed GLSS leadership framework is based upon leadership, statistical thinking, continuous change and improvement. This model is based upon service and the concepts of adaptive, rather than technical work, of leaders in higher education. This paper makes an attempt to remove the myth that GLSS is confined to manufacturing. It also demonstrates, through relevant existing literature and authors' experiences, that GLSS is equally applicable to public sector organisations and in particular HEIs.

Keywords: *Lean, Six Sigma, Green, Higher education institutions.*

INTRODUCTION

Higher education institutions have an great impact on today's society. It plays very important role in every sector for its growth and continuous improvement by using knowledge related to respective sector with the guidance of leader of that sector. It also helps in growth of economy by the help of various principles. Higher education institutions will help not only students, teachers, employees, etc. but it helps all the citizens who want to growth in their area with the help of research, knowledge and technology (Weisbrod et al., 2008). Six Sigma is an effective tool which reduces variations in their respective sectors. With Six Sigma, Lean is also an powerful business factor which will reduce waste or non value added activities. In earlier era Lean was not integrated with Six Sigma but in current scenario we will combine both of them to achieve our goals in any field (Antony et al.2012). The combination of lean and Six Sigma will provide superior improvement in manufacturing, medical, social and many other societies. The word 'Green' represent environment friendly process. Many researchers combine green, lean and Six Sigma (GLSS) in respective manners to achieve goals which are environment friendly, having minimum waste and by using best method of

application. The implementation of GLSS in higher education institutions is at very small level but in manufacturing sector it is applied at wide range (Sunder, 2016a; Antony et al., 2012). There are many difficulties in application of GLSS at each and every state in higher education institutions but we have to focus on minimize that difficulties by using different tools and techniques such as grey relational analysis (GRA), etc. In the USA, higher education holds three major social missions: teaching, researching and public service (Weisbrod et al., 2008). The teaching mission is achieved by providing higher education opportunities to all young people (Weisbrod et al., 2008). Research universities are the cornerstones that contribute to the second social mission (Weisbrod et al., 2008). The third social mission has two components: increasing individuals' personal earning power and empowering individuals to contribute to society (Weisbrod et al., 2008). There are many organizational and economic shifts which causes changes and challenges in higher education institutions. Globalization, which is based on the market driven principle, generates more challenges than opportunities for HEIs, especially for HEIs in developing countries (Yang, 2003). The new forms of higher education, including massive open online courses, distance learning and artificial intelligence have been changing higher education and create both challenges and opportunities. Beside those global factors, HEIs also face their regional and local challenges. Africa, a continent with more than300 universities, has difficulties to establish general principles and solutions because of the immense diversity of HEIs and the contexts within these HEIs operate (Teferra and Altbach, 2004). For example, in Yemen, there is no standard measure to evaluate higher education quality (Muthanna and Karaman, 2014). In China, the mass higher education system faces challenges with fair distribution of equality and opportunities (Wang, 2011). In the USA, the previous two decades have seen a decline in support for higher education from its traditional sources of funding and an increased call for more accountability of public funding. Concurrently, the financial model undergirding HEIs does not support their abilities to carry out their teaching missions (Denneen, 2014).

In order to address this leadership bottleneck in the HEIs, there needs to be an entrepreneurial culture amongst the leaders and top-level management. HEIs are struggling to reach long-term goals. Green Lean Six Sigma (GLSS) is a powerful methodology for enhancing customer satisfaction and improving bottom line results (Antony et al., 2012).Since its inception in manufacturing industry. GLSS has been widely adopted in a variety of industries today including services, healthcare and banking to reduces waste and improve operational efficiency (Kim 2010). In the HEI environment, there are considerable operational wastes in human resources, finance, administration and other activities. There are major opportunities for HEI to eliminate waste, meet budget requirements, and meet ultimate goals (Antony et al., 2017). Recently, HEIs have started adopting the GLSS methodology. Although a number of manufacturing and service organizations are utilizing the power of this integrated methodology, it has been clear through the authors' research that the higher education institutions (HEIs) are far behind in the introduction and development of this process excellence methodology.
Figure 1 shows basic model of GLSS.

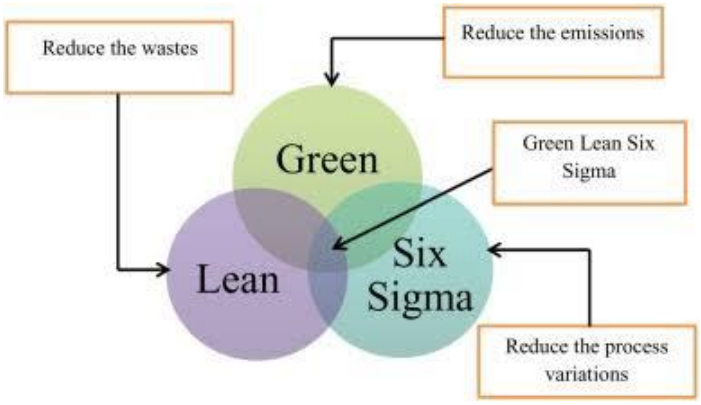


Figure 1 Basic model of GLSS

Literature review:

Lean Manufacturing: The term lean manufacturing is derived from Toyota operating model in 1930 "The Toyota Way". John Krafik introduced term Lean and it is defined by James Womack and Daniel Jones. Some research papers in recent years are as:

Panwar et al. (2015) in their study helped in providing the methods for adopting the methods of lean manufacturing and the future scope of research. They also provided the identification of the strategies for adopting the methods of lean manufacturing in the industry.

Sanders (2016) in their research work had found out that the industry 4.0 has the suitable answers in order to overcome the lean manufacturing barriers whose potential solution principles can be proves the hypothesis that the industry 4.0 is very much capable of implementing the principles of lean manufacturing.

Jasti (2016) in his study conducted a survey based on the empirical method in order to find the scope of implementation of lean manufacturing in the Indian Manufacturing organization. With the opinions of experts from the various organizations he was able to find out the various drivers and barriers for the implementation of lean manufacturing in Indian manufacturing organization.

André et al. (2017) in their work focused on purposing the conceptual methods in order to integrate into the Value Stream Mapping (VSM) tool to assess the manufacturing process through the analysis of the assessment models of the sustainability & sustainability indicators in the period of 2009-2014.

Bai et al. (2018) in their work and findings facilitates the identification of the locus of investments in order to select the better lean manufacturing practices.

Pagliosa et al. (2019) in their research work specified the relationship between lean manufacturing and industry 4.0 (I4.0) in order to differentiate the effects of relationships at all stages of flow and to analyse the effect of these relationships on the operational performance.

Yadav et al. (2020) in their research, studied the existing lean manufacturing methods and pointed out the drivers of lean manufacturing of the emerging economics.

Antony et al. (2021) in their research, studied about different tools, techniques and principles of lean manufacturing to enhance productivity.

Johan and Soediantono (2022) have done literature review on the benefits and performance of an industry after application of lean concept.

Six Sigma: It was first introduced by Bill Smith (an American engineer) while working in Motorola. In six sigma the product formed is almost 99.99966% defect free.

Conger (2014) in his paper had described and explained the use of the various six sigma concepts in order to improve the

deficient process. Combining the concepts of six sigma with lean techniques will add an edging value to the process improvement projects.

Jacobs et al. (2015) in his research developed a hypothesis which had focused on the advantages of the late acceptance and the factors affecting the ability of the manufacturing organisation to get the benefit from the six sigma. In his work, he came up with the empirical result showing that the late acceptors had gained the higher performance than the late acceptors.

Uluskan et al. (2016) had combined the quality management theory with the six sigma application and used a path analysis in his work for evaluating the research hypothesis. The result derived from his work showed that the six sigma directly influences the performance of the organisation.

Santana et al. (2016) obtained the data from the 149 respondents from Brazil & Argentina and found out that there is a major and significant impact on the performance of the project and the management of the project in the organisations of the industry and service sectors.

Kuen et al. (2019) in their paper pointed out the indicators of the six sigma of the process yields and the levels of quality in order to form a complete green supplier fuzzy selection mode.

Gupta et al. (2020) in their research pointed out the quality of finished product which is somewhat lower as that of expectations which is improved by the application of six sigma approach.

Shah et al. (2021) in their research focused on the six sigma approach in higher education institutions.

Widodo &Soediantono (2022) has applied six sigma approach in defense industry.

Green Manufacturing: Green manufacturing is an environment friendly process in any sector. It helps in achieving both social and economic goals by different techniques.

Govindan et al. (2015) had identified 12 drivers with the help of literature and experts opinion. The study can be helpful for the firms in initiating for fast and smooth application of the green manufacturing.

Kia et al. (2016) had done the study on the scheduling of problems which arises during the implementation of green manufacturing in the industries. Their major focus is to reduce the consumption of energy and the cleaning cost of environment by establishing the regular schedules that can in-turn reduce the total completion time.

Verma et al. (2016) had done the energy value stream mapping a tool to develop the green manufacturing. It deals with the developing a method allows to do the quick, easy & comprehensive analysis of energy and the material flow during the manufacturing process.

Seth et al. (2018) had identified the drivers of green manufacturing for both small, medium and large scale industries in terms of the Indian manufacturing process, where they established the relationship between the drivers of green manufacturing and also offered a comparative pictures of green manufacturing similarities and dissimilarities. They had also laid emphasis on where to prioritize the focus for the implementation of green manufacturing.

Waheed et al. (2020) had studied the impacts of practices of green manufacturing on the basis of 2 streams viz. Pollution prevention practice & product stewardship practices with an aim of focusing on the how the manufacturing organizations can engage the stakeholders within the organization by the incorporation of green practices.

Logesh and Balaji (2021) studied the implementation of green technology combined with lean and six sigma approach in electrical manufacturing industry.

Singh and Deepak (2022) in their research focused on implementation of green concept in Indian manufacturing industries by considering different parameters.

Green Lean Six Sigma: It is the environment friendly approach in which we focuses on method improvement, process improvement and try to minimize waste by using different tools and techniques of green lean six sigma such that environment is not affected by their application. There are many benefits of GLSS approach it reduces time, improve productivity and eco friendly.

Kumar et. Al. (2016) in their found barriers that can affect the implementation of GLS to improve the product and process

parameters in the manufacturing industry through ISM approach.

Cherrafi et. Al. (2017) in their framework had tried to merge the three major concepts of any manufacturing industry across the globe viz. green manufacturing, lean manufacturing & six sigma to form a new concept of GLS so as to attain the economic, social and environmental sustainability.

Pandey et. Al. (2018) in their work identified the enablers of GLS that can help the manufacturing organization for the effective environmental organization and attaining the customer requirement.

Yadav (2019) in his framework had identified 15 barriers that can hinder the implementation of GLS in the manufacturing industry and how each of the concept of GLS viz., Green, Lean, Six Sigma can act as the catalyst for each other and can help in removing the demerits of each other.

Hussaina et. Al. (2019) in their work concluded that how the purposed GLS concept can help in improvising the construction process, productivity, quality, cycle time, sustainability etc. in the construction sectors.

Singh et. Al. (2019) in their work had identified 12 enablers which can help the manufacturing organizations to initiate a systematic way for the implementation of GLS process. Their study was based on the ISM approach.

Michael et. Al. (2019) in their study had defined the framework for the implementation of GLS within the organization to achieve the green objectives based upon five dimensions of the environmental performance.

Gaikwad et. Al. (2020) in their research focused on the problem that emerges during the GLS implementation process & also showed how the people/management who act as the initiator any process in the manufacturing industry can play the major role in its implementation.

Singh et al. (2020) in their work identified 7 enablers for the adoption and implementation of GLS using Best Worst Method where they laid their emphasis on the small-scale industries of India.

Yadav et.al (2021) in their work identified 16 barriers that can affect implementation of GLS concept in the manufacturing organizations and then they prioritize their removal by using BWM.

Rathi et al. (2022) in their research has studied different tools and techniques related to lean manufacturing and six sigma, and tried to analyze different barriers.

Grey relational analysis: GRA was developed by Deng. It analyze the indefinite relations between members of system. This can be used in the problems of multi criteria decision making systems. In this method we have to indicate minimum and maximum values in given data. With the help of these values we will calculate normalized values, which are used in calculation of deviation sequence. After calculating deviation sequence grey relational coefficients are determined which are used to calculate grey relational grade. Grey relational grade is used to rank the barriers. Lowest rank means most important barrier and higher rank means least important barrier.

Identification of GLSS barriers:

S.No	Barriers	References
1	Difficulty in linking GLSS to institutions	Sunder 2011, Antony 2012, Lu et al. 2017
2	Focus of customer	Sunder 2011, Antony 2012, Lu et al. 2017

3	Commitment of management and availability of resources	Sunder 2011, Antony 2012, Lu et al. 2017
4	Leadership	Sunder 2011, Antony 2012, Lu et al. 2017
5	Provide training and proper education	Monteonet al. 2020
6	To select project and prioritize barriers	Cudney et al.2012, Antony et al. 2012
7	Communication at all levels of organization effectively	Cudney et al.2012, Antony et al. 2012
8	Available resources and skills	Cudney et al.2012, Antony et al. 2012

Table 1. GLSS barrier identification

RESEARCH METHODOLOGY

The present study consists of two phase methodology. In first phase we will identify GLSS barriers in HEIs. In second phase prioritization of barriers has been doneusing GRA.

Phase 1: Identification of GLSS barriers

In this phase identification of GLSS barriers has been done from literature review. The successful adoption of green technologies depends on the measurement and analysis of various wastes that eventually depends on the effective and systematic application of GLSS. An inclusive application of GLSS depends on a few prominent factors known as barriers. Barriers to a tool or technology are those crucial characteristics that defer achieving the organization's objectives (Kaswan et al., 2020). Table 1depicts the barriers of GLSS in the HEIs environment. In this study questionnaire survey has been done to authenticate GLSS barriers through literature review. A five-point Likert scale questionnaire was formulated and experts (educational and academics personnel) (110 experts) were asked to state the importance of enlisted barriers on the scale, 1 to 5, with '1′ tallies to the weakest and '5′ as the strongest barriers of GLSS.

Phase 2: Prioritization of GLSS barriers through GRA

Steps of GRA:

Normalization or data processing has been done in first step of GRA. The responses were collected from personnel of education department against each barrier.

1. Calculate minimum and maximum value from given data. In this step we have to calculate minimum and maximum values from given data by reviewing all the values.
2. Calculate normalized value and normal decision matrix

$$Xij = \frac{(Max\ Yij - Yij)}{(Max\ Yij - Min\ Yij)} \quad (1)$$

Normalized values are calculated from above formula where, Xij is the normalized value, Max Yij is the maximum value

from sequence, Min Yij is the minimum value from sequence and Yij is the current value.

3. Calculate deviation sequence

$$Xij = Max\ Yij - Yij \quad (2)$$

Xij is the deviation sequence, Max Yij is maximum value in deviation sequence and Yij is the current value in deviation sequence.

4. Calculate grey relational coefficients

$$Xij = \frac{Min\ Yij + €^* Max\ Yij}{Yij + €^* Max\ Yij} \quad (3)$$

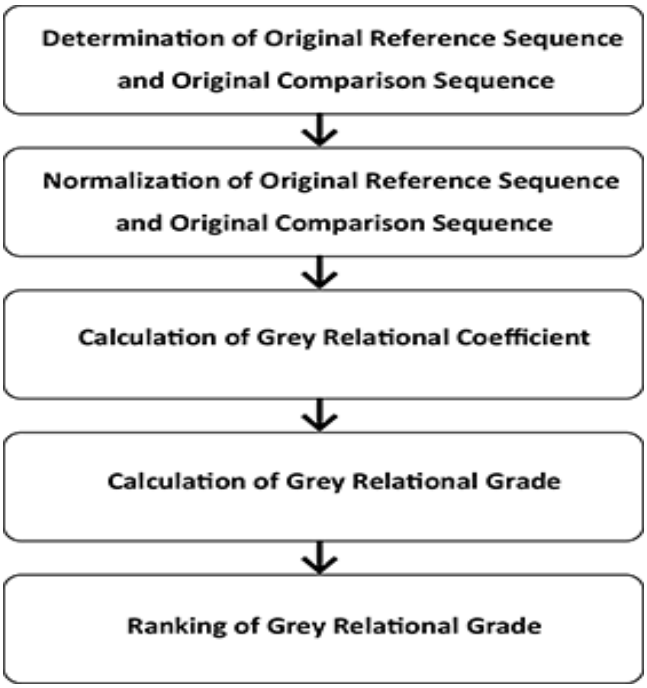
Min Yij is the minimum value from grey relational coefficients, Max Yij is the maximum value from grey relational coefficients, Yij is the current value and € is taken as 0.5.

5. Calculate grey relational grade

$$\frac{\text{Sum of all parameters}}{\text{No. of parameters}} \quad (4)$$

In grey relational grade we take sum of all the parameters and divide them by the number of parameters.

6. Ranking the alternatives on basis of gray relational value.



DISCUSSION

The following tips may be useful while selecting potential GLSS projects in the context of HE sector:

1. Projects must be aligned with critical business and customer issues. This may be referred to as the voice of the business and the voice of the customer.
2. Projects must be feasible to execute from a resource and data standpoint.
3. Project objectives must be clear to everyone involved in the project.
4. Ensure that projects can be completed within four to six months.
5. Ensure that a tollgate review must be performed at every stage of the Six Sigma methodology by the GLSS deployment champion for ensuring a smooth running of the projects.
6. Select those projects which have the ability to show measurable improvements in the delivery of quality associated with education, operational costs and timeliness

parameters.

CONCLUSION

Although GLSS as a powerful business process improvement strategy has been around for over ten years, its applications in the context of HEIs are still in their embryonic stages. The authors have found that there is a clear misconception across many public sector organizations that LSS is only applied to manufacturing companies and it cannot be transferred to HE sector. In our experience, this is not the case as we firmly believe that both Lean and Six Sigma have a role to play in university processes for improving the efficiency and effectiveness. This paper presents the challenges and barriers, success factors and the most appropriate tools and techniques for the successful introduction and deployment of GLSS in the context of HE sector.

LIMITATIONS

All research is naturally limited. In this paper, only two HEIs are considered for investigation. Further validation is therefore required before we can whole-heartedly support the GLSS approach for HEIs. This paper provides useful exploratory evidence on GLSS endeavors in pure HEI services, but further research is needed to support our findings in primary and high-school levels of education. Further, a common process and a common GLSS Master Black belt consultants were used in the study. While this allowed for cross-comparison for academic purposes within this paper, the many different approaches adopted by different GLSS proponents require examination to determine if one-best-way exists for GLSS adoption in HEIs or if different methodologies may offer benefits. However, overall we remain positive about the benefits on offer from GLSS deployment in HEIs.

FUTURE OUTLOOK

HEIs are in fierce competition. Globalization, technology development and continuously increased financial burdens force HEIs to reduce operational waste and improve efficiency. The best practice to achieve that goal is to apply GLSS methodology. Lean management determines the problems that occur in process flow. The delays in processes and common waste can be identified and eliminated. For value adding processes, Six Sigma methodology targets various problems that produce intensive errors or defects. Implementing GLSS methodology provides HEIs with a foreseeable opportunity to enhance quality performance. Current leadership models in HEIs need review. The traditional leadership models in HEIs respond slowly to the rapidly changing educational environments. Moreover, the problems occurred and created under the current leadership models cannot be solved at the same level of leadership. Some HEI leaders have tried to adopt private sector management principles. The case studies would be GLSS projects in HEI where the purpose of the work is to examine and justify the refined model in a practical way and make further refinements.

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