Educational Administration: Theory and Practice
2024,30(5),3428-3439
ISSN:2148-2403
https://kuey.net/

Research Article

Optimizing E-Resource Utilization In Business School Libraries: A Lean Six Sigma Approach

Dr. Anand Sasikumar[1*] Dr. Sunil MV[2]

[1*]Assistant Professor – Operations SDM Institute for Management Development (SDMIMD), Mysore, INDIA anand@sdmimd.ac.in
[2]Assistant Professor – Systems and General Management SDM Institute for Management Development (SDMIMD), Mysore, INDIA sunilmv@sdmimd.ac.in

Citation: Dr. Anand Sasikumar Dr. Sunil MV et. al (2024), Optimizing E-Resource Utilization In Business School Libraries: A Lean Six Sigma Approach *Educational Administration: Theory And Practice*, *30*(5), 3428 - 3439
Doi: 10.53555/kuey.v30i5.3468

ARTICLE INFO

ABSTRACT

The main objective of the paper is to identify the causes for lower usage of online resources and to suggest steps for improving the overall utilization of online resources in a centralized library of a private business school based in South India. The paper intends to demonstrate how Lean Six Sigma tools can be adopted to improve the online usage of resources. The college management is concerned with non-utilization of online library resources and fall in the reading frequency of students. The management has contacted one of the authors, who is pursuing his research in the area of library sciences, to address the problem. Lean Six Sigma methodology (LSS) was employed, and the main issue was gauged by the DMAIC methodology. The methodology was coupled with AHP method to prioritize the causes for lower utilization of online resources. The name of the institution is disguised for confidentiality purposes and the paper provides some crucial insights in the adoption of Lean Six sigma in a private business school setting.

Keywords: Lean Six sigma, Business school, Library, online usage

1.0 Introduction

In today's competitive world, organizations aim to improve the quality of their processes and products through continuous improvements. The Lean manufacturing concept, which originated from the Toyota Production System, is a continuous improvement technique that focuses on doing more with less. Similarly, the Six Sigma approach focuses on reducing variations in the process and has shown dramatic improvement in the process. Both concepts are integrated into the Lean Six Sigma (LSS) methodology, which is widely used in manufacturing and service sectors. Researchers have made substantial contributions to various service sectors, including banking and financial services, hospitality services, airlines, information and technology services, and healthcare. Studies have proven that LSS is an effective tool and has overcome the barriers of Lean and Six Sigma when applied separately. The application of LSS in Higher Education Institutions (HEIs) is a topic that is gaining interest, and there are a couple of studies that have explored the possibility of its application in HEIs.

Sundar and Mahalingam (2017) applied multiple case-study methods to explore the implementation of LSS in two selected university colleges. The study focused on improving the utilization of the central library and increasing customer satisfaction in the university computer center.

The present study aims to adopt the Lean Six Sigma concept in a stand-alone institute that offers postgraduate degree programs in management. The institute is a premier business school based in South India.

2.0 Lean Six Sigma in Higher Education

The higher education system consists of post-secondary, tertiary and higher education and is the phase of learning that is prevalent in colleges and universities (Sundar and Mahalingam, 2018). Higher education also includes a host of institutions like business schools, vocational schools, engineering colleges and career colleges which award professional certifications or academic degrees (Sundar, 2014). The greatest challenge of higher education today is ensuring quality, which has been further strengthened by the growing pressure from the

stakeholders and the highly competitive environment that is prevalent today. It has become inevitable for higher educational institutions (HEIs) to implement quality enhancement technologies to deliver value to students which are novel and innovative. Many manufacturing and service organizations have applied the concept of Lean Six Sigma methodology, it has been pointed out by researchers that there is enough scope for its application in Higher education (Antony et al., 2018; Sundar and Mahalingam, 2018).

The concept of Six Sigma focuses on improving customer satisfaction by driving remarkable improvements in the process with sustainable consequences (Bin, 2015). LSS is the amalgamation of Lean and Six Sigma concepts which often results in significant and rapid improvements in performance rather than using them separately (Sheridian, 2000; George, 2003). Mukhopadhyay, 2017 has highlighted that the concept of Six Sigma can solve complex problems in the education system and the philosophy of lean can lessen the waste in the process. The concept of lean has been applied to a number of HEIs in the USA and UK. A few examples of such applications are St. Andrews University (Scotland), Cardiff University (Wales), Coventry University (England), University of Portsmouth (England), Central Connecticut State University (USA), Bowling Green State University (USA), MIT (USA), and Oklahoma State University (USA) (Antony et al., 2018).

A few HEI institutions which have adopted the concept of Lean Six Sigma approach is the King Abdullah University of Science and Technology based in Saudi Arabia (Svensson et al., 2015). This section briefly presents some of the key findings of the literature on Lean Six Sigma in the higher education sector. A Lean Six Sigma framework has been designed to improve the quality of higher education (Kanakana et al., 2015). The study considered different types of costs related with nonadherence to system requirements in higher education. Studies have shown that LSS when applied within university settings can significantly improve curriculum delivery, business, admission process, research and enrollment management (Hess and Benjamin, 2015). Antony et.al, (2018) have shown the application of LSS projects across administration, finance, human resources, information and technology and library services. A real-time case study was explained by Sundar and Mahalingam (2015), which applied the LSS framework in a university library to improve the library process thereby reducing the average search time of books. But from literature it is evident that though a few institutions have incorporated Lean with Six sigma for augmenting the value and the efficacy of their process(Antony et al.,2018) and there is still a lot of scope for the implementation of Lean Six Sigma in the higher education sector. It has been observed there is a dearth of literature with respect to the adoption of the LSS framework for the effective utilization of online resources. It is with this background the current study has been initiated in a centralized library of a private business school based in South India.

3.0 Research Methodology

The management team of Business School was interested in improving the effective utilization of online resources in the library. The study is conducted in the main library of the business school. The building, which has 3 floors, contains close to 15265 volumes of books and 58 academic journals. The institution has 360 students (post graduate students in management), 20 faculty members and 6 research scholars. A series of discussions were held with heads of various academic departments, and it was decided to hire an external person who is doing a research study on the feasibility of applying continuous improvement techniques in improving the effective utilization of library management systems. It was felt that Lean Six sigma concept is an appropriate technique which can be applied to solve present crisis.

The first stage of LSS methodology includes the analysis of the system which is under study that is the library. A DMAIC approach is suggested, which addresses the main issues face by the library and attains the relevant statistics required for improvement in the system. A Lean Six Sigma approach was created on the basis of statistics, Lean, Six sigma related concepts and the methods proposed by Furterer and Elshennawy (2005), Kumar et al. (2006), Thomas et al. (2008), Vinod et al. (2011) and Guerrero et al. (2017), Sasikumar et al.(2023) (Figure 1).The study was conducted in the business school due to the necessity for improvement in the utilization of online resources in the library.

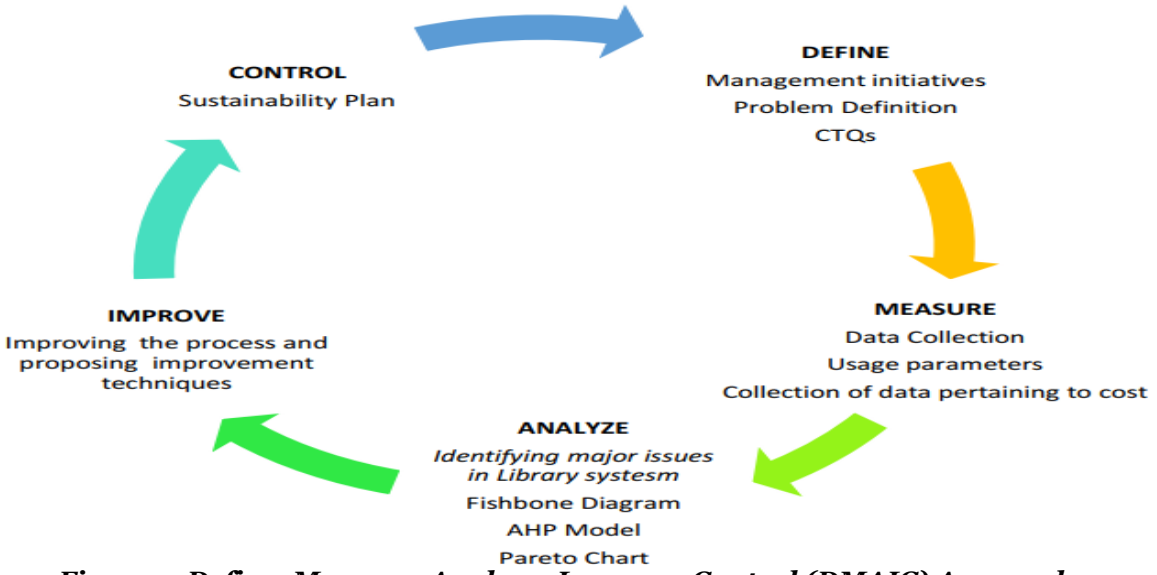


Figure 1: Define, Measure, Analyze, Improve, Control (DMAIC) Approach (Source: Author Creative)

3.1 Define phase: The main aim of this phase is to identify the critical issues leading to lower utilization of library resources. The management of the business school looked at the various opportunities and prospects for improvement.

3.1.1 Management Initiatives

The director of the institute convened a meeting with the various academic heads which included professors, associate professors, and assistant professors. The purpose of the meeting is to suggest techniques to improve the current practices and thereby improving the online usage of resources. The management was aware of practice of Lean six sigma and its success in higher education. The implications of Lean Six sigma program and its impact on the current system was discussed. The team members were of the opinion, that they should ahead with implementing the Lean Six Sigma program, since it was a proven and tested concept. It was decided to be in touch one of the alumni of the institution who is doing research in library sciences to address the problem.

3.1.2 Problem Definition

The researcher and his team had interacted with academic and library staff to unravel issues faced by them with respect to online resources. Based on their feedback, it was understood that the proper utilization of the library will be only achieved by applying the LSS concept. As mentioned earlier in the paper, LSS is a proven concept for continuous improvement in manufacturing and service industries. During the discussions, it was found that the faculty heads were concerned with the fall in non-utilization of online library resources and fall in the reading frequency of students. Based on the above feedback it was decided by the research team to use an appropriate CTQ to measure the utilization parameters into more quantifiable terms.

Online utilization has been defined as a measure of

- ***CTQ-1:*** Average usage of subscribed database.
- ***CTQ-2:*** Average utilization of money spent on databases.

The library has subscribed to four categories of databases namely a) Capitaline b) EBSCO c) Harvard cases (HBS) d) non-Harvard cases (Non-HBS). The usage statistics for the year 20222023 are presented in table 1.

Table 1: Usage of HBS vs. Non-HBS

	HBS cases	**Non-HBS cases**	**Usage**
Apr-June 2022	40	5	45
Jul-Sep 2022	46	18	64
Oct-Dec 2022	32	15	47
Jan-Mar 2023	8	7	15
		Total	171

	Capitaline	EBSCO	Usage
Apr-June 2022	65	69	134
Jul-Sep 2022	391	70	461
Oct-Dec 2022	46	616	662
Jan-Mar 2023	261	50	311

3.2 Measure Phase

In this phase, the usage rate of the subscribed data based was defined as Usage rate = Usage/ No of users
Based on the feedback of the academic heads and the library staff, they apply 80-20 rule for gauging the effective utilization of the online resources. The target view/ readings are calculated based on the following formula.
Target views/readings = 20%× no of students and faculty members × no of days in a month = (0.2×380× 30) = 2280 views/readings

The average views/readings of the respective databases are presented in table 2.

Table 2: Average views/readings

Capitaline	EBSCO	HBS/Non-HBS Cases
64	67	14

The total effective online utilization is measured as the sum of the average views/readings of the respective databases. The number of views/ readings equals 145, which is far behind the target set by the management. Therefore, on average 25 students account for the total readings/views.
This indicates a tremendous scope for improvement. The subscription rate for the databases in rupees are presented in table 3.

Table 3: Subscription rate for 1 year

	Subscription rate in Rs/year
EBSCO	279752
CAPITALINE	191400
HBS	940569

The Total amount which is spent equals to Rs 1411721 and the approximately Rs 3175 is spent per user per year and Rs 310 is spent for a user per month. Based on the usage statistics the effective utilization of money spent is calculated as follows:

Effective utilization of money spent in a year = Number of users × average money spent for a user×12 = 25×310×12= Rs 89161. Therefore, there is huge loss in terms of monetary value due to low utilization of online resources.

3.3 Analyze phase

At this phase, the main causes of lower utilization of online resources were identified with the help of repeated interactions and brainstorming sessions with various academic heads and library staff of the institution. The experience of the respondents ranged from 5 to 15 years. Tha main causes were depicted with the help of a cause-and-effect diagram. An Analytic Hierarchy Process (AHP) method is a multicriteria decision analysis method which was used for ranking the criticality of the causes. The cause-and-effect diagram is extensively used in problem solving and quality control in numerous industries. The cause-and-effect diagram aids in detecting the basic causes of defects or issues and provides a visual representation of the possible causes and their interrelationships (Bhat and Shetty,2021).

3.3.1 Cause and Effect Diagram

A cause-and-effect diagram or the fishbone diagram was constructed to analyse the core causes of reasons pertaining to low usage of subscribed database in process (Figure 2). This would give a better idea for detecting the areas for the improvement in the library system.

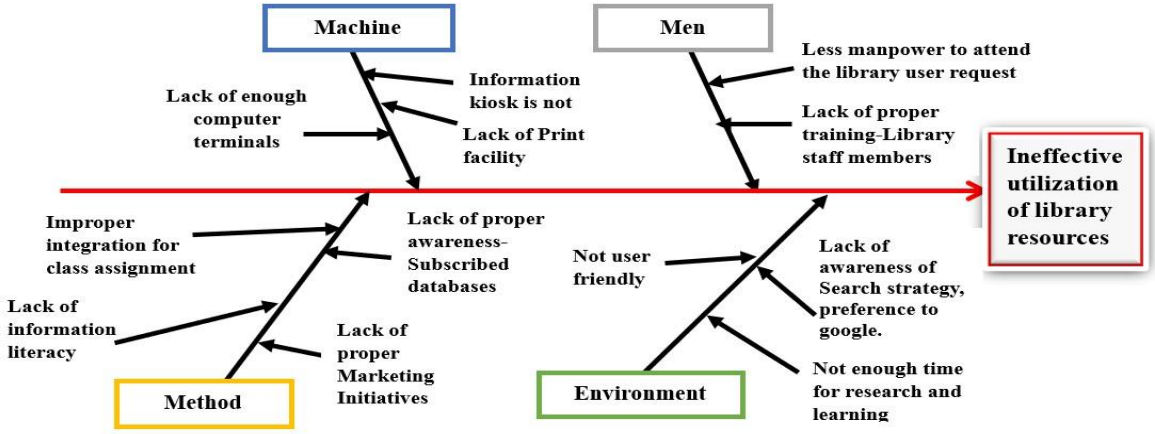


Figure 2: Cause and effect diagram (Fish Diagram) of factors leading to ineffective utilization of library resources

The diagram is categorised into five headings namely: a) Men b) Method c) Environment e) Machine for identifying the critical issues pertaining to low usage of online resources. It has been seen that there was a lack of proper training among the library members with respect to the effective utilization of library resources and there was no proper manpower training to attend the user request. There were not enough computer terminals and printing facilities to facilitate the usage of online resources. There was a general opinion among the academic heads and library staff that a proper information kiosk could solve these problems to a certain extent. The feedback from the respondents also highlighted that students were of the opinion that there was the system was not user-friendly and did not have enough time for research and training. Therefore, they preferred using search engines like Google to complete their assignments and research. Also, the academic heads felt that the library team should engage in more marketing activities by highlighting what are new or the state-of-the-art information pertaining to research and education.

3.3.2 Analytic Hierarchy Process

An appropriate MCDM technique was used to categorise the factors based on its importance. Analytic Hierarchy Process (AHP) is a popular MCDM technique which makes use of pairwise comparisons and depend on the judgement of experts to derive priority scales (Saaty,2008). A group of Six people were identified for this process, two academicians in the rank of Professor and an Associate Professor and three people from the library science department of prominent business schools based in Karnataka, India. the respondents had an average experience of more than 14 years. The research team arranged a face-to-face discussion with them and the questionnaire were distributed. The questionnaire considers a rating scale from 1 to 9, for 1 being the equal importance or influence and 9 being extreme importance or influence (Table 5). The AHP technique adopts the pairwise comparison of factors with respect to the objective(in this case, ineffective utilization of library resources).

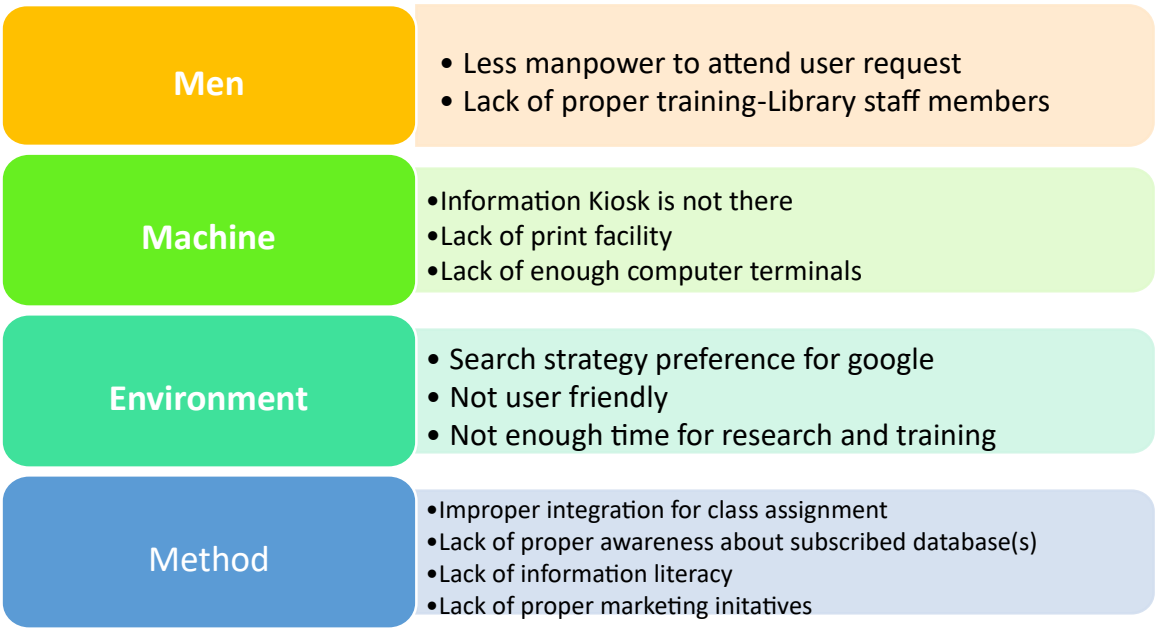
The AHP model is created based on the following steps illustrated by Saaty, 2008 and Paneerselvam, 2012.

Step1: Define the aim: The aim of the study is to rank the reasons pertaining to ineffective utilization of library electronic resources. manufacturing process.
Step 2: Organizing parts into factors, dimensions, alternatives, etc.: The main criteria considered are Men, Machine, Environment, and Method. The sub-criteria are finalized based on results from the fishbone diagram. The criteria and sub-criteria are presented in Table 4.

Table 4: Factors and Dimensions of the AHP model

Men	Less manpower to attend user requests, Lack of proper training staff members.
Method	Improper integration for class assignments, lack of proper awareness databases, lack of information literacy, and lack of proper marketing initiatives.
Machine	Information kiosk is not there, lack of print facility, lack of enough computer terminals.
Environment	Search strategy preference for google, Not user friendly, Not enough time for research and training.

Prioritizing critical factors which are responsible for ineffective utilization of library resources



Intensity of Importance	Description	Explanation
1	Equal Importance	Both the criteria/activities contribute equally to the objective.
3	Moderate importance	Experience and judgement slightly favour one criterion/activity over another.
5	Strong importance	Experience and judgement strongly favour one criterion/activity over another.
7	Very strong importance	Experience and judgement very strongly favour one criterion/activity over another.
9	Extreme importance	The evidence favouring one criteria/activity over another is of the highest possible order of affirmation.
2,4,6,8	For compromise between the above values	Sometimes one needs to interpolate a compromise judgement numerically because there is no good word to describe it.

Steps 3,4: Make pairwise comparisons of elements in each group. In this stage a pairwise comparison of criteria (Men, Machine Environment, Method) with objective (Infective utilization of library resources) is conducted. The results are shown in Table 6. This is followed by computing the normalized weights (Table 7) and the consistency ratio (CR).

Table 6: Pairwise comparison of criteria with respect to the objective

Objective	Men	Machine	Environment	Method
Men	1	0.5	0.5	1
Machine	2	1	2.0	2
Environment	2	0.5	1.0	3
Method	1	0.5	0.3	1
Total	6	2.5	3.8	7

Table 7: Normalized Weights (Pairwise comparison of criteria with respect to the objective)

Objective	Men	Machine	Environment	Method	PV
Men	0.17	0.20	0.13	0.14	0.16
Machine	0.33	0.40	0.52	0.29	0.39
Environment	0.33	0.20	0.26	0.43	0.31
Method	0.17	0.20	0.09	0.14	0.15
Total	1	1	1	1	

The consistency ratio (CR) is used to reliability of the values achieved by pairwise comparison. The judgements made by the experts who were part of the survey were checked for consistency. The consistency ratios (CR) of the comparison matrices are computed using the following formula
CI= (λ_{max} – n)/(n-1)
Where CI = consistency index λ_{max} is the principal eigenvalue
n = the order of the matrix or the number of criteria considered
If CI =0, means expert's judgement satisfy consistency
If CI > 0, means the experts have conflicting judgements
If CI ≤ 0.1, means there is reasonable level of consistency (Boateng,2014)
CR = CI/RI
RI is the random consistency index is computed based on the number of criteria selected for pairwise comparison.

Table 8: Random Consistency Index

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

When CR ≤ 0.1(10 %), it indicates the expert's judgment will satisfy consistency. In case if CR values are greater than 10 %, then the judgements made by the experts are reviewed again.
The principal eigenvalue λ_{max} for the criteria is computed by the following formula
$\lambda max = \sum nj=1TjPVj$
Where n = Number of criteria
Tj = Total of the relative importance values in the column corresponding PVj = Priority index of the j^{th} criterion in the priority vector of the criteria.

Hence the CR values for the pairwise comparison of criteria with respect to the objective is illustrated below.

Table 9: Consistency Ratio for pairwise comparison of criteria with respect to the objective

λmax	4.14
Consistency Index (CI)	0.05
Random Consistency Index (RI)	0.90
Consistency ratio (CR)	0.05

It can be that CR values is 0.05(5%) which is less than 0.1(10 %). Hence the values are accepted. Similarly, the pairwise comparison, computation of priority vectors and consistency ratios are computed for sub-criteria w.r.t each criterion (Table 10 to Table 20).

Table 10: Pairwise comparison of sub criteria with respect to the criteria(Men) Criteria: Men

Men	Less manpower to attend user request	Lack of proper training to Library staff members
Less manpower to attend user request	1	0.2
Lack of proper trainingLibrary staff members	5	1
Total	6	1.2

Table 11: Priority Vector (Pairwise comparison of sub criteria with respect to the criteria (Men))

Men	Less manpower to attend user request	Lack of proper trainingLibrary staff members	PV
Less manpower to attend user request	0.17	0.17	0.17
Lack of proper trainingLibrary staff members	0.83	0.83	0.83

CR values are not applicable if the number of sub-criteria is less than 3.

Criteria: Machine

Table 12: Pairwise comparison of sub criteria with respect to the criteria (Machinery)

Machine	Information kiosk is not there,	lack of print facility	lack of enough computer terminals
Information kiosk is not there	1.00	5	3
Lack of print facility	0.20	1	0.33333
Lack of enough computer terminals	0.33	3	1
Total	1.53333	9.0	4.3

Table 13: Priority Vector (Pairwise comparison of sub criteria with respect to the criteria (Machine))

Machinery	Information kiosk is not there	lack of print facility	lack of enough computer terminals	PV
Information kiosk is not there	0.65	0.56	0.69	0.63
Lack of print facility	0.13	0.11	0.08	0.11
Lack of enough computer terminals	0.22	0.33	0.23	0.26

Table 14: Consistency Ratio for pairwise comparison of sub-criteria with respect to the criteria (Machine)

λmax	3.05536
Consistency Index (CI)	0.02768
Random Consistency Index (RI)	0.58
Consistency ratio (CR)	0.04773

The CR values are less than 10 %, so we can infer these judgments are consistent.

Criteria: Environment Table 15: Pairwise comparison of sub criteria with respect to the criteria (Environment)

Environment	Search strategy preference for google	Not user friendly,	Not enough time for research and training
Search strategy preference for google	1.00	3	3
Not user friendly	0.33	1	0.5
Not enough time for research and training	0.33	2	1
Total	1.67	6.0	4.5

Table 16: Priority Vector (Pairwise comparison of sub criteria with respect to the criteria (Environment))

Environment	Search strategy preference for Google	Not user friendly,	Not enough time for research and training	PV
Search strategy preference for google	0.60	0.50	0.67	0.59
Not user friendly	0.20	0.17	0.11	0.16
Not enough time for research and training	0.20	0.33	0.22	0.25

Table 17: Consistency Ratio for pairwise comparison of sub-criteria with respect to the criteria (Environment)

λmax	3.07037
Consistency Index (CI)	0.03519
Random Consistency Index (RI)	0.58
Consistency ratio (CR)	0.06066

The CR values are less than 10 %, so we can infer these judgments are consistent.

Criteria: Method

Table 18: Pairwise comparison of sub criteria with respect to the criteria (Method)

Method	Improper integration for class assignment	Improper integration for class assignment	Improper integration for class assignment	Improper integration for class assignment
Improper integration for class assignment	1.00	0.33	0.33	0.25
Lack of proper awareness - Subscribed databases	3.00	1.00	0.50	0.33
Lack of information literacy	3.00	2.00	1.00	0.33
Lack of proper marketing initiatives	4.00	3.00	3.00	1.00
Total	11.00	6.33	4.83	1.92

Table 19: Priority Vector (Pairwise comparison of sub criteria with respect to the criteria (Method))

Method	Improper integration for class assignment	Improper integration for class assignment	Improper integration for class assignment	Improper integration for class assignment	PV
Improper integration for class assignment	0.09	0.05	0.07	0.13	0.07
Lack of proper awareness - Subscribed databases	0.27	0.16	0.10	0.17	0.18
Lack of information literacy	0.27	0.32	0.21	0.17	0.27
Lack of proper marketing initiatives	0.36	0.47	0.62	0.52	0.49

Table 20: Consistency Ratio for pairwise comparison of sub-criteria with respect to the criteria (Method)

λmax	4.12
Consistency Index (CI)	0.04
Random Consistency Index (RI)	0.90
Consistency ratio (CR)	0.04

The CR values are less than 10 %, so we can infer these judgments are consistent.

Step 5: This Step involves the computation of the final ranking.

Table 21: Final Ranking of Criteria/Sub-Criteria

Criteria	Weights	Sub-criteria	Normalized weights of Subcriteria
Men	0.16	Less manpower to attend user request,	0.03
		Lack of proper training-Library staff members	0.13
Machine	0.39	Information kiosk is not there,	0.25
		Lack of print facility	0.04
		Lack of enough computer terminals	0.10
Environment	0.31	Search strategy preference for Google,	0.18
		Not user friendly	0.05
		Not enough time for research and training	0.08
Method	0.15	Improper integration for class assignment	0.01
		Lack of proper awareness-Subscribed databases	0.03
		Lack of information literacy	0.04
		Lack of proper marketing initiatives	0.07

3.3.3 Pareto Chart

Pareto Chart The normalized weights of the sub-cause served as input for the construction of Pareto chart (Figure 3). The chart depicts the descending order of sub-criteria based on the normalized weights of each sub-criteria.

Pareto charts applies the 80-20 rule to identify the sub-criteria which are the main reasons for Ineffective utilization of library resources. It can be inferred from figure 3 ,while applying the 80 % rule , the ineffective utilization of library resources is due to following sub-causes

a) Information kiosk is not there.
b) Search strategy preference for google.
c) Lack of proper training-Library staff members
d) lack of enough computer terminals
e) Not enough time for research and training

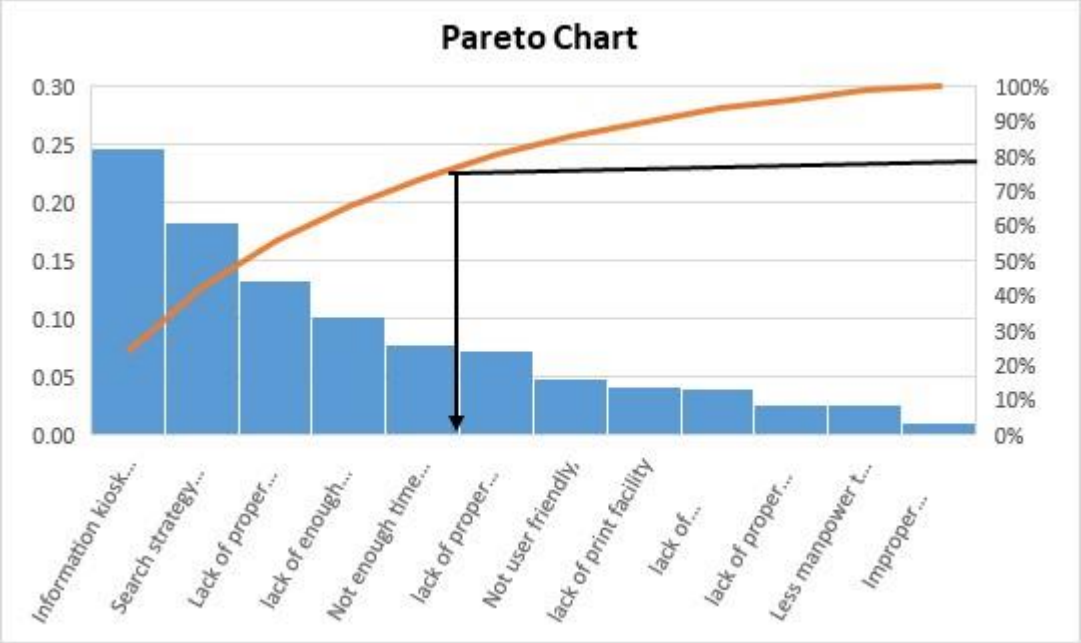


Figure 3: Pareto Chart for the B-School Library E-Resource Utilization

3.4 Improvement Phase:

- **Enhanced Training Programs:** Develop comprehensive training programs for library staff to ensure they are proficient in assisting users with accessing and utilizing online resources effectively. This includes training on database navigation, search strategies, and troubleshooting common issues.
- **Increase Access Points:** Install additional computer terminals and provide adequate printing facilities within the library premises to accommodate the needs of students and faculty members. This will facilitate easier access to online resources and encourage their utilization.
- **Information Kiosk Implementation:** Introduce an information kiosk within the library premises to provide users with quick access to guidance on utilizing online resources effectively. The kiosk can offer tutorials, tips, and FAQs to assist users in navigating databases and conducting research efficiently.
- **User-Friendly Interface:** Collaborate with database providers to ensure that the interface of subscribed databases is user-friendly and intuitive. Improving the interface will enhance the overall user experience and encourage greater utilization of online resources.
- **Marketing Initiatives:** Implement marketing initiatives to raise awareness among students and faculty members about the availability and benefits of online resources. This can include promoting new or relevant content, highlighting database features, and showcasing successful case studies of resource utilization.

3.5 Control Phase:

- **Usage Monitoring System:** Implement a usage monitoring system to track and analyze the utilization of online resources in real-time. This system can generate reports on usage patterns, identify trends, and monitor the effectiveness of implemented improvements.
- **User Accountability:** Implement user authentication mechanisms for accessing online resources to track individual usage and ensure accountability. This will help in identifying high and low users, understanding usage patterns, and tailoring support and training efforts accordingly.
- **Regular Audits:** Conduct regular audits of online resource utilization to assess the effectiveness of implemented improvements and identify any emerging issues or areas for further enhancement. These audits can inform ongoing optimization efforts and ensure continuous improvement.
- **Feedback Mechanisms:** Establish feedback mechanisms for users to provide input on their experience with online resources and suggest areas for improvement. This feedback can be valuable in identifying user needs, addressing challenges, and refining services accordingly.

4.0 Conclusions:

The application of Lean Six Sigma methodology has provided valuable insights into the factors influencing the effective utilization of online resources in the business school library. Through a structured approach encompassing problem identification, analysis, and prioritization, key issues have been identified, and targeted improvements have been recommended.

By addressing critical areas such as staff training, access points, interface design, and awareness initiatives, the library can enhance the utilization of online resources and better meet the needs of its users. Additionally, implementing control measures such as usage monitoring, user accountability, regular audits, and feedback mechanisms will facilitate ongoing optimization and ensure continuous improvement in resource utilization.

Overall, the study underscores the importance of applying quality improvement techniques in library management to optimize resource utilization, enhance user satisfaction, and support the academic mission of the institution. By embracing a culture of continuous improvement and innovation, the library can effectively meet the evolving needs of its stakeholders and contribute to the success of the business school community.

References

1. Antony, J. (2017). Lean Six Sigma for higher education. *International Journal of Productivity and Performance Management*.
2. Antony, J., Ghadge, A., Ashby, S. A., & Cudney, E. A. (2018). Lean Six Sigma journey in a UK higher education institute: a case study. *International Journal of Quality & Reliability Management*, *35*(2), 510-526.
3. Bhat, A., & Shetty, S. (2021). A Review of Quality Control Techniques and Tools in Tyre Manufacturing. Journal of Industrial Engineering International, 17(1), 53-67.
4. https://doi.org/10.1007/s40092-020-00402-x
5. Bin, Y. (2015). Using Six Sigma Methodology to improve the performance of the Shipment Test.
6. George, M. L. (2003). Lean six sigma for service in Turkey by using structural equation modeling", Journal of Applied Statistics, Vol. 43 No. 4, pp. 738-753.
7. Hess, J. D., & Benjamin, B. A. (2015). Applying Lean Six Sigma within the university: opportunities for process improvement and cultural change. *International Journal of Lean Six Sigma*, *6*(3), 249-262.
8. Kanakana, G. M., Van Wyk, B., & Pretorius, J. H. C. (2015, August). Framework assessment for costs of poor quality in higher education processes. In *2015 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1133-1136). IEEE.
9. Kuvvetli, Ü., Firuzan, A.R., Alpaykut, S. and Gerger, A. (2016), "Determining six sigma success factors
10. LeMahieu, P. G., Nordstrum, L. E., & Cudney, E. A. (2017). Six Sigma in education. *Quality Assurance in Education*.
11. Panneerselvam, R. (2012). Production and Operations Management. PHI Learning Pvt. Limited, New Delhi.
12. Prasad, S., Khanduja, D. and Sharma, S.K. (2016), "An empirical study on applicability of lean and green practices in the foundry industry", Journal of Manufacturing Technology Management, Vol. 27 No. 3, pp. 408-426.
13. Sasikumar, A., Acharya, P., Nair, M., & Ghafar, A. (2023). Applying lean Six Sigma for waste reduction in a bias tyre manufacturing environment. *Cogent Business & Management*, *10*(2), 2228551.
14. Sheridan, J. H. (2000). 'LEAN SIGMA'SYNERGY. *Industry Week/IW*, *249*(17), 81-82.
15. Sunder M, V., & Antony, J. (2018). A conceptual Lean Six Sigma framework for quality excellence in higher education institutions. *International Journal of Quality & Reliability Management*, *35*(4), 857-874.
16. Sunder M, V., & Mahalingam, S. (2018). An empirical investigation of implementing lean six sigma in higher education institutions. *International Journal of Quality & Reliability Management*, *35*(10), 2157-2180.
17. Sunder, M. V. (2014). Quality excellence in higher education system through Six Sigma: student team engagement model. *International Journal of Six Sigma and Competitive Advantage*, *8*(3-4), 247-256.
18. Svensson, C., Antony, J., Ba-Essa, M., Bakhsh, M., & Albliwi, S. (2015). A Lean Six Sigma program in higher education. *International Journal of Quality & Reliability Management*, *32*(9), 951969.