International Journal of Novel Researches in Science, Technology & Engineering
Vol. 8 No. 1 March, 2025
ISSN 2141 825X
www.oasisinternationaljournal.org

A LEAN-DRIVEN EXPERIMENTAL APPROACH TO REDUCING PATIENT WAIT TIME IN A UNIVERSITY HEALTHCARE SETTING

by

Raji Abdulfatai Adisa

Department of Mechanical Engineering,

Institute of Technology,

Kwara State Polytechnic, Ilorin, Kwara State- Nigeria.

Abstract

This study focuses on enhancing the efficiency of health care services within the university clinic by amalgamating Lean Manufacturing principles with the Design of Experiments (DoE) methodology. The principles of lean manufacturing are employed to discern and eradicate non-value-added activities, thereby fostering operational efficiency, patient satisfaction and optimal resource utilization. The investigation adopts a methodical framework that encompasses extensive data collection through surveys, interviews and observational studies, succeeded by data analysis to delineate current workflows and pinpoint inefficiencies. The DoE technique is implemented to assess factors influencing clinic operations thus facilitating the formulation of effective optimization strategies. Two determinants affecting Patient wait time, namely Patient load and doctor's availability were chosen for the experimental design. These strategies encompass the reduction of patient wait times and the enhancement of staff productivity. The application of lean tools such as Value Stream Mapping (VSM) and the Yamazumi chart aids in the visualization and assessment of proposed enhancements. Findings indicate that the integration of DoE with Lean principles significantly diminishes Patient Wait Time in the clinic and elevates overall service delivery. A future-state Value Stream Map delineates optimized workflows, underscoring the practical advantages of the research methodology applied within the clinic. This study offers valuable insights for stakeholders and contributes to the expansive application of lean principles combined with DoE in analogous healthcare environments thereby promoting continuous advancement in clinic operations.

Keywords: Lean Driven Experiment, Patient Wait Time & University Health Care

Introduction

Healthcare service providers around the world are generally being faced with challenges in delivering efficient services due to increase demand, limited resources and complex operations (Abu *et al.,* 2019). Many organizations have adopted the implementation of Lean techniques to streamline the processes and improve efficiency of the organization. Healthcare should be free of mistakes, because simple mistakes can have severe consequences including fatalities and possibly death (Akmal *et al.,* 2020).

Healthcare quality improvement needs a systematic technique and framework that includes patients, service providers and the entire system as key players. Lean thinking assists manufacturing and service sector to add value by the process of removal of waste and promotion of important, value-added activities (Abu *et al.,* 2021). Waste in the system includes any unnecessary material movement, excessive inventory, unnecessary movement of employee or machine, patient wait times, over processing, overproduction and defects (Agrell and Dahl., 2021).

In order to address these challenges, integration of Design of Experiment (DoE) together with Lean manufacturing techniques is proposed to optimize university clinic processes (Alesso *et al.,* 2019). Combining DoE with Lean tools will enable the analysis and optimizing the factors that affecting the service delivery such as resource allocation, patient flow and service quality (Al-Balushi *et al.,* 2014).

Research have shown that applying Lean tools systematically in healthcare can lead to significant improvements including reduced patient wait times, promotion of process efficiency and improvement in staff effectiveness (Alalawin *et al.,* 2022). This approach enhances clinic operations contributing to better patient.

Research Methodology

This research methodology explains the method used for the conduct of the study. It elaborates clearly the process and explains each phase of the study. It commences with a general research methodology flow and then followed by explanation of each of the stages of the phases involved in carrying out this study.

The methodology of this study is divided into three phases which are connected in 13 steps in all and finally compilation of the report. Generally, a comprehensive methodology was utilized in this research. This comprises of review of existing literature, collection of data and analysis, lean manufacturing principles, design of experiment DoE and compilation of final report.

Data Collection

The methods of data collection for this study include the survey questionnaire for patients who are students that have used the clinic one time or the other and semi-structured interview with staffs who are involved in the clinic consultation processes. It involved the staff medical officer, Nurse and registration officer during the site visit.

Survey Questionnaire

In order to gather quantitative data including current outpatient and consultation processes, lean manufacturing principle (Outpatient waste & process improvement), consultation efficiency of the clinic, lean based improvements in outpatients' consultation in the clinic and a survey questionnaire was created and electronically disseminated. An extensive variety of responses were obtained from the survey, distributed to patients who are students only who have used the clinic one time or the other. This made it possible to represent viewpoints from students who the major users of the clinic.

An essential instrument in the data collection process was the survey questionnaire which

made it possible to collect information systematically on a range of lean initiatives in the outpatient consultation processes. To guarantee that this data collection method is effective, a number of important considerations were considered.

Questionnaire Development: The survey's questions have been carefully developed to meet the particular goals of the study and collect relevant data. The questionnaire consisted of five sections totalling 17 questions. Each intended to derive relevant data to the study's goals. The questions were carefully prepared to encourage respondents to offer thorough and candid feedback enhancing the accuracy of the collected information.

Pilot Testing: The survey questionnaire was subjected to a pilot testing phase in order to evaluate its efficacy and pinpoint any possible areas for improvement. A sample of the questionnaire was distributed to a particular group of students for their input and assessment. The results of this preliminary testing were insightful and helped to improve the final version of the questionnaire. There is a noteworthy feedback point that was raised during the pilot testing phase was worth mentioning:

All questions to be made compulsory: An important observation made during the pilot test raised questions regarding the need to make all the questions compulsory as some respondents may want to skip some questions which may make the data collection uncompleted. Based on the suggestion, the questionnaire was modified. This attempt is to improve the quality of data collection by making all the questions mandatory.

Wide-ranging Coverage: The questionnaire was designed to give an all-encompassing perspective of the students including those who are visiting the clinic for the first time and those who have been using the clinic more than twenty- four months.

Sections of the Survey: These sections addressed the current outpatient and consultation processes, lean manufacturing principle (Outpatient waste & process improvement), consultation efficiency of the clinic and lean based improvements in outpatients' consultation in the clinic. This well-organized framework made it easier to collect data in an organized manner.

Distribution of the Survey: The survey was distributed electronically. The questionnaire was distributed through different students WhatsApp group including some university international students' group. This made it possible to collect data widely and effectively. In order to obtain a comprehensive understanding of lean practices within the clinic, the research reached out to all staff members involved in consultation processes, including Medical Officer, Nurse and registration officer.

Quantitative Data: This consists of multiple-choice questions, Likert scales and short answer responses were used in the survey to gather opinions of students, recommendations and experiences with lean manufacturing principle. The quantitative data served as the foundation for the statistical analysis and numerical evaluation.

Semi-Structured Interview

In order to have more in-depth knowledge of the clinic's operational procedures and viewpoints, semi-structured interviews were conducted with the same major staff involved in the consultation process. The medical officer was questioned during these sessions. The responses of these interviews demonstrated a thorough understanding of the clinic peak season, the main issue, and the strategy and plan to overcome the problem.

The assistant nurse at the counter takes vital science-blood pressure, temperature and so on. About the challenges contribute to delay the nurse said language barrier between some staff and students. As some staff do not understand English while some students also do not understand the local language. More so there are instances of system or network issue of university wifi which affect the whole process in the clinic whenever this happened.

The registration officer stated that the patient spent less than 15 minutes at the counter, when asked about the current appointment scheduling and those delays attributed to issues during registration. The registration officer said delay could only occur if there is server problem from university digital. On lean principle for time reduction, the registration officer said filling of forms by patient often cause delay in moving the patient for consultation and that some patient needs more explanation on the filling of forms and process flow. The registration officer therefore suggested that for their work to be more efficient they should shift from usual filling of hard copy forms to paperless with the use of electronic online for the filling of the forms.

Patients' period of using the Clinic

Figure 1 shows Patient period of using the clinic from the respondents. The respondents in Figure 1 are a combination of long-term users and recent users as well as first time students with most respondents using the clinic for more than 12 months. This indicates different users' experiences, from well-acquainted students to new students.

Data Analysis

Based on the questionnaire responses for the project on optimizing university Clinic's healthcare efficiency through DoE (Design of Experiment) and Lean Manufacturing Principles, the analysis of the responses is given below.

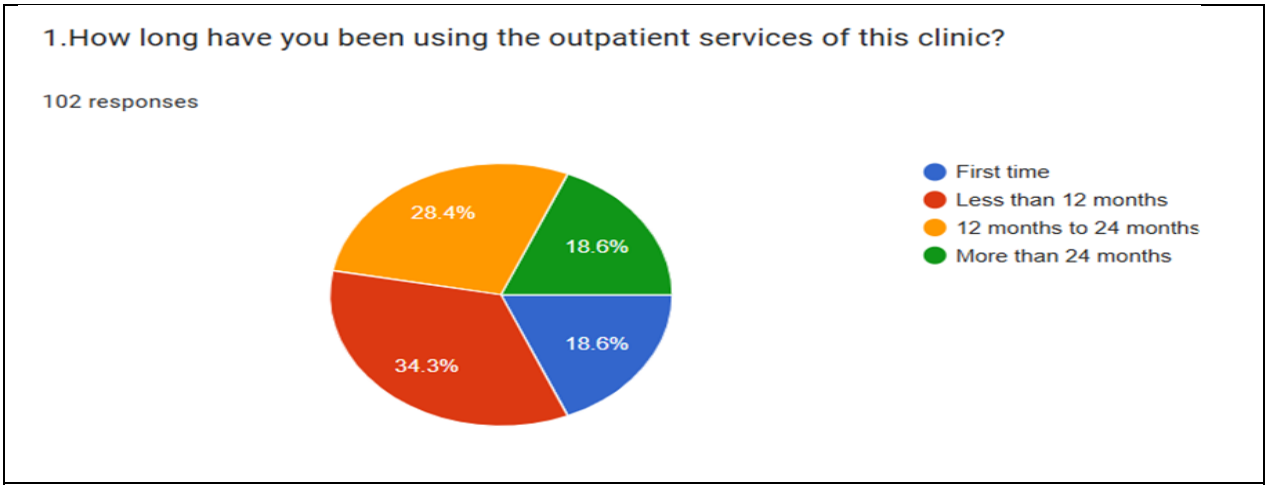

Figure 1: Survey Questionnaire Results-Patient Period of Using the Clinic

Survey Questionnaire Results- Efficiency Rating of the Registration Process

Figure 2 shows the efficiency rating of the outpatient consultation registration by the respondents. It was observed from figure 2 that there are overwhelming positive responses, with 56.9% rating as efficient while 22.5 % rating as very efficient. Only a very insignificant number rate the clinic as very inefficient and inefficient. This suggests that registration is generally effective but may still have areas to optimize as 15.7% are neutral.

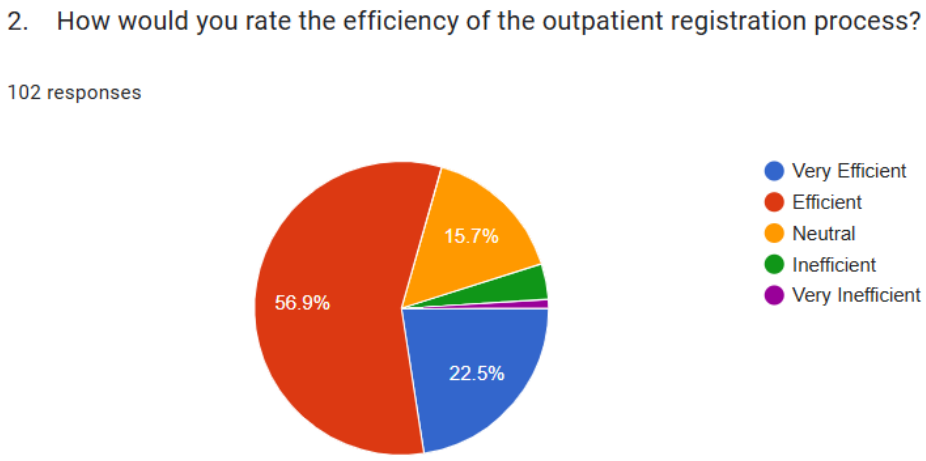

Figure 2: Survey Questionnaire Results on Efficiency Rating of the Registration Process

Figure 3 shows how often delays are experienced in outpatient consultation services. From Figure 3, it was observed that delays are minimal with 37.3% rarely and 31.4% never experienced delays in the clinic. This implies that overall scheduling may be somehow satisfactory; however, some patients 26.5% experience occasional delays suggesting room for further improvement.

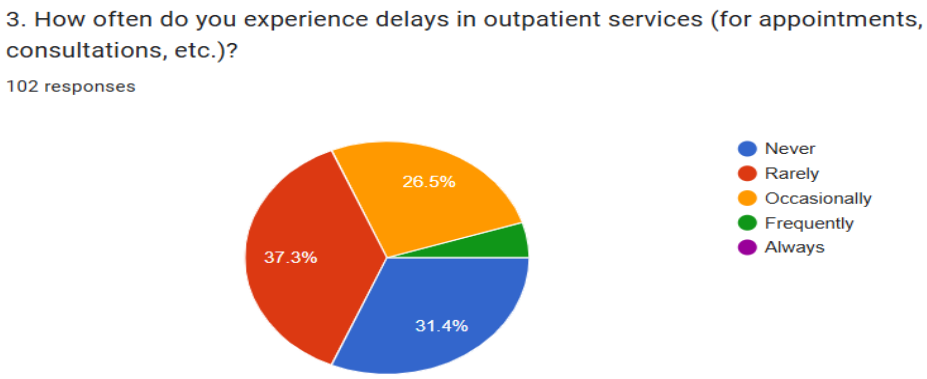

Figure 3: Survey Questionnaire Results on Experience Delays in Outpatient Services

Figure 4 shows the results of the consultation flow perception. The responses from figure 4 show that majority of the respondents (96.1%) feel the consultation flow is smooth; however, 42.2% report minor issues. This positive outlook highlights strengths in flow but also an indication that certain areas may need improvements in order to minimize minor issues.

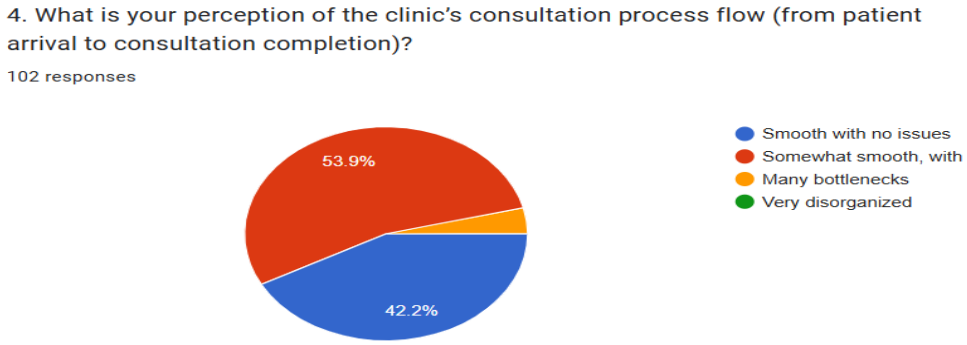

Figure 4: Survey Questionnaire Results on Consultation Flow Perception

Figure 5 show the results of scheduling system of the outpatient consultation appointments satisfaction. From figure 5, it can be observed that the process of scheduling is widely viewed as being positive with 79.4% either satisfied or very satisfied with the scheduling system. Although 17.6% respondents are neutral, and very few respondents dissatisfied, this shows there may be hidden inefficiencies or user experience concerns, indicating need for continuous improvement.

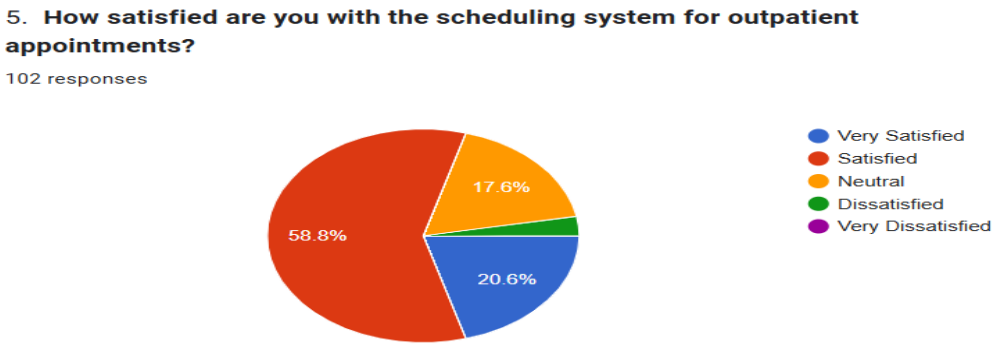

Figure 5: Survey Questionnaire Results on Scheduling System of the Outpatient Consultation Appointments

The results of identified waste and communication between the personnel are shown in Figure 6. Observation from figure 6 identifies the biggest source of waste as patient waiting time (73.5%) followed by unnecessary patient movement (11.8%). This feedback from the respondent's underlines that waiting time is a major area for Lean interventions while movement inefficiencies may also need to be addressed.

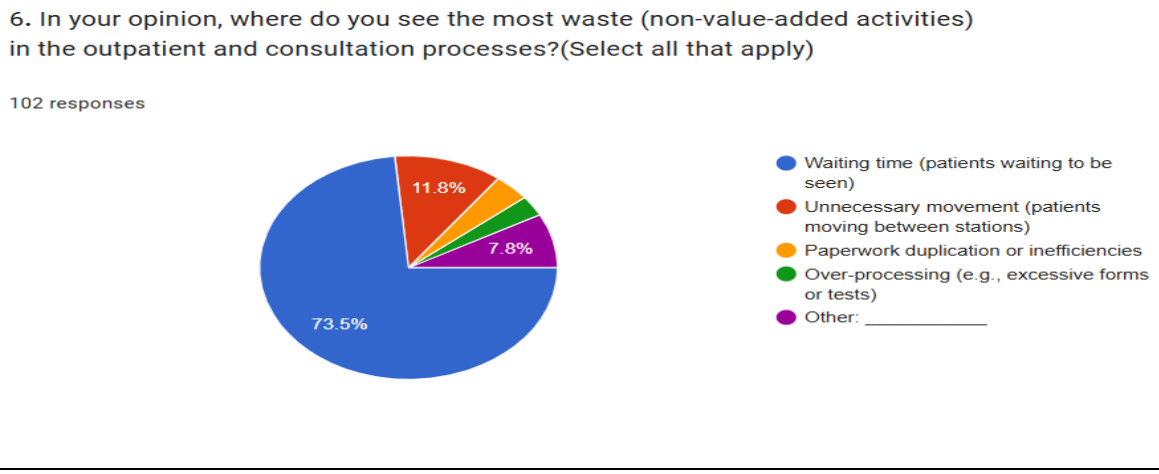

Figure 6: Survey Questionnaire Results on Identification of Waste in the Process

Figure 7 exhibits that the coordination across various departments is positively rated with 74.5% of feedback from respondents indicating Good or Excellent communication in the system. This is a strong foundation for implementing cross-department Lean strategies for further improvement in information flow in the clinic.

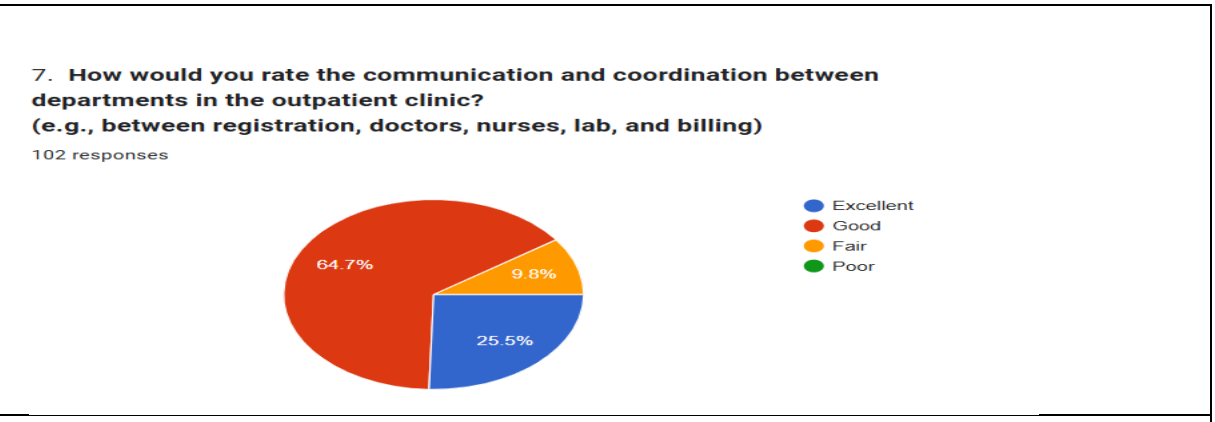

Figure 7: Survey Questionnaire Results on Communications and Coordination

Figure 8 displays that 47% of respondents believe that there are no unnecessary steps exist in the system while 22.5% answered maybe, while 30.4% answered Yes. This perception shows a different view on process waste suggesting that streamlining specific steps may benefit outpatient processes.

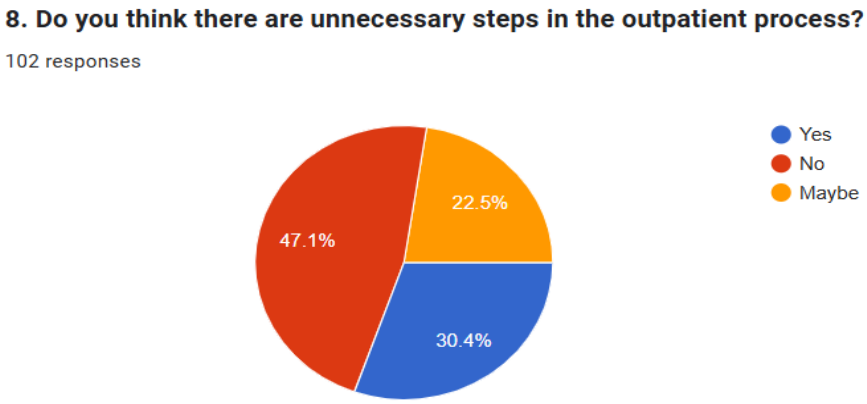

Figure 8: Survey Questionnaire Results on Perceptions of Unnecessary Steps

Figure 9 displays the Survey Questionnaire results suggestions for improvement. The top recommendations for suggestions for improvement from the feedback of the respondents are streamlined consultation process 37.3% and optimized staff allocation is 30.4%. These priorities are in alignment with Lean principles indicating a focus on reducing non-value-added tasks and improving workforce efficiency.

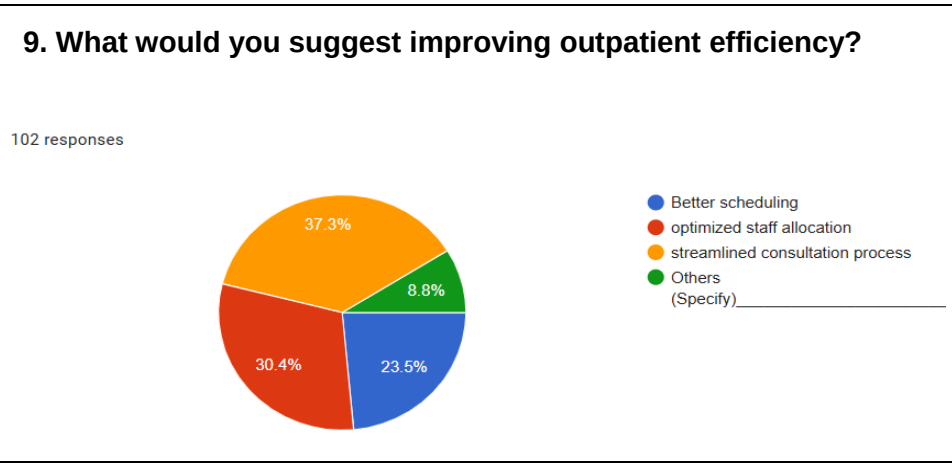

Figure 9: Survey Questionnaire Results on Suggestions for Improvements

The consultation experience from the feedback of the respondents as seen in Figure 10 is largely positive with 62.7% rating as “good” and 22.5% rating as “Excellent”. This implies that the core experience is strong. However, there is still a gap for improvement as some patients rated it “Fair” or “Poor”.

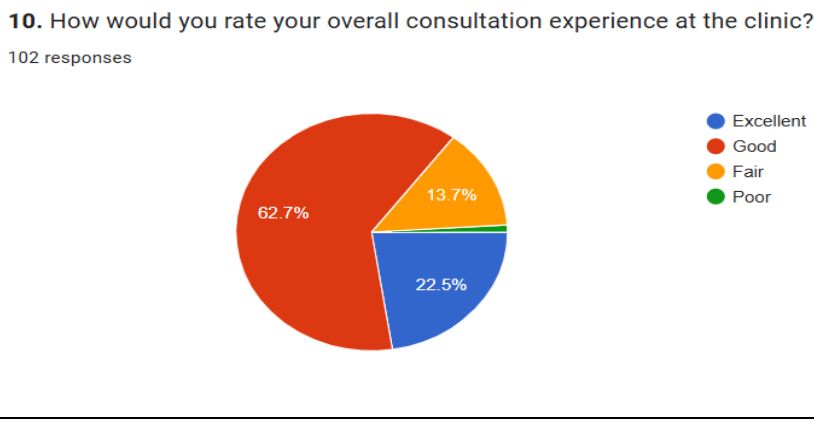

Figure 10: Survey Questionnaire Results on Overall Consultation Experience

Figure 11 shows the outcomes of the Wait time for consultation unit. From Figure 11 according to feedback, most respondents wait between 20-40 minutes. 56.9% of the respondents and 25.5% wait 40-60 minutes. This suggests that reducing waiting times could promote patient satisfaction and improve the efficiency of the clinic service especially for those who feel 20-40 minutes is too long.

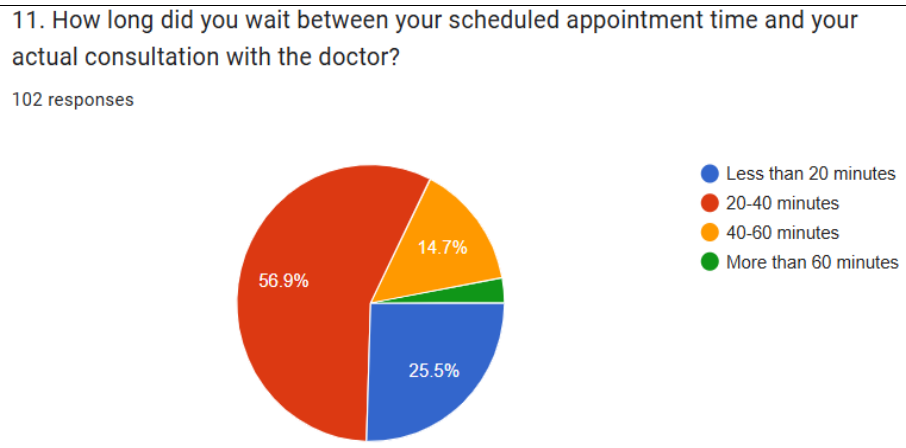

Figure 11:Survey Questionnaire Results on Wait Time for Consultation

In figure 12, the results of the Staff communication and responsiveness are displayed. The feedback of the respondents as observed in Figure 12 is generally favorable with 84.3% rating communication as "Good" to "Excellent." This strong communication base indicates that further process improvements could be built on this positive interaction among staff of the clinic.

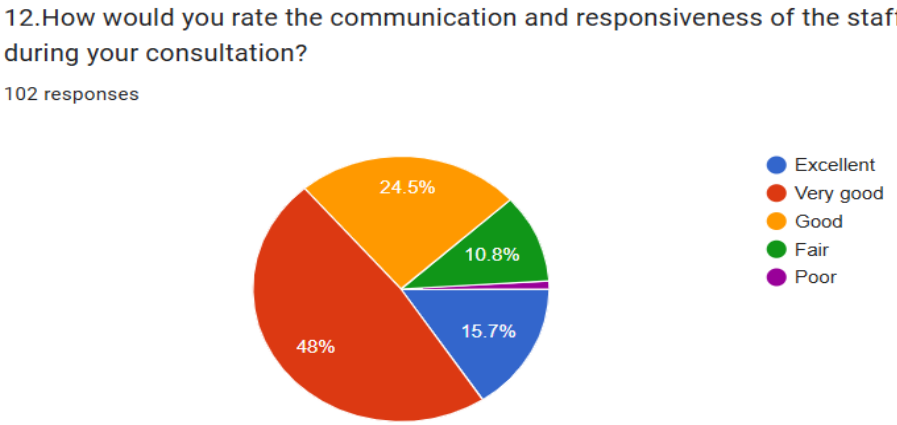

Figure 12: Survey Questionnaire Results on the Staff Communication and Responsiveness

From Figure 13, the majority of the respondents that is 61.8% find the consultation process as smooth and efficient but 31.4% responded "Maybe" suggesting that some patients may see need for improvement in the system.

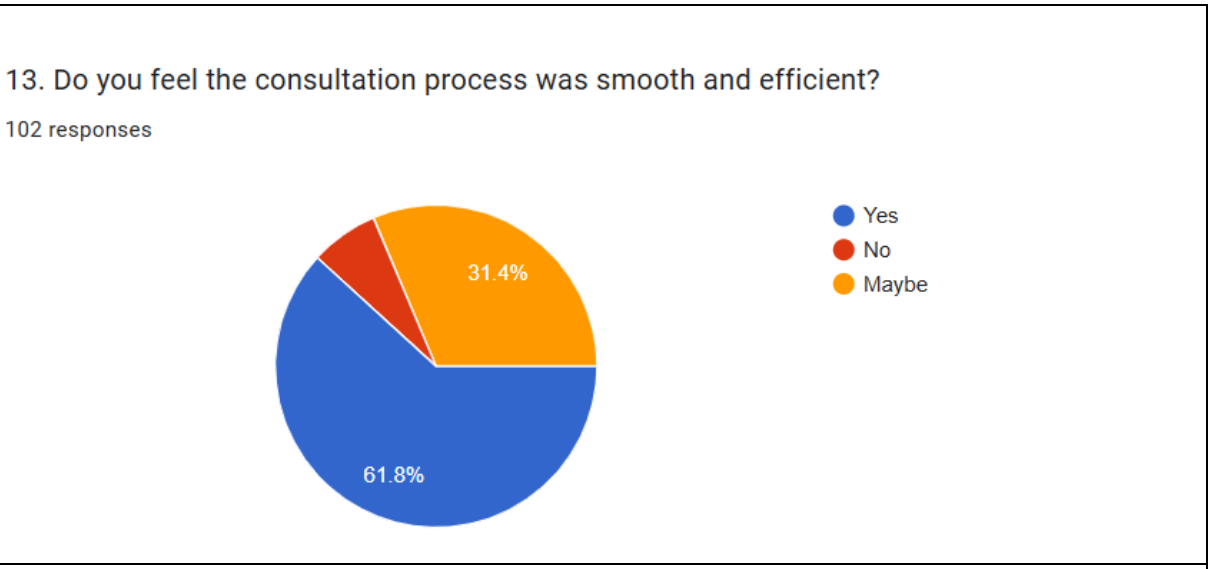

Figure 13: Survey Questionnaire Results on Smoothness of the Consultation Process

On a scale of 1-5 in figure 14, how likely are you to recommend this outpatient clinic to others? Most students would recommend the clinic as 57.9% selecting a 4 or 5 on the recommendation scale. However, 24.5% selected a neutral rating of "3". This indicates the possibilities of potential areas for improvement in order to enhance loyalty of the clinic.

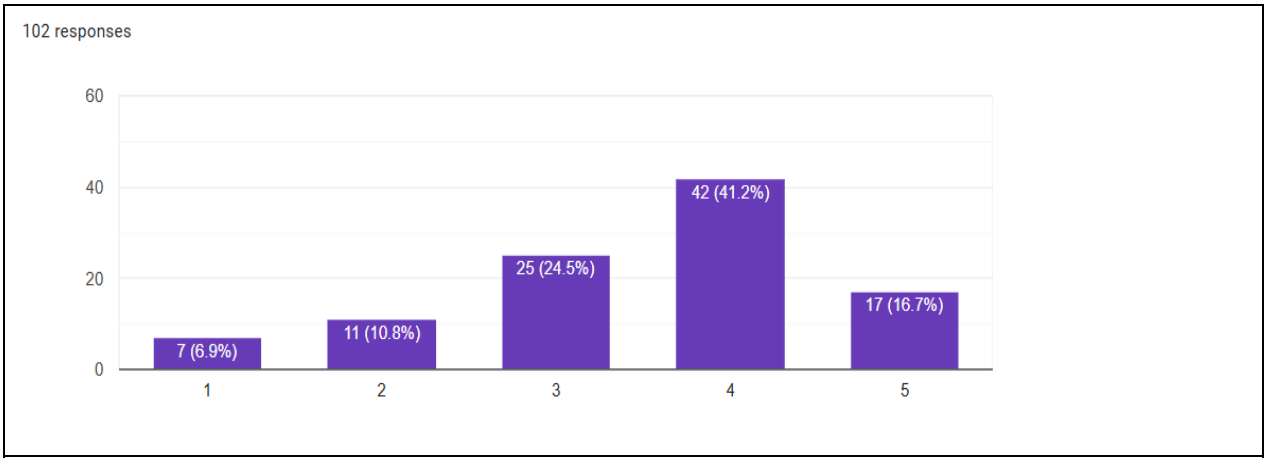

Figure 14: Survey Questionnaire Results on Likelihood to Recommend the Clinic

N.B: 1. Very unlikely 2. Unlikely 3. Neutral 4. Likely 5. Very likely

Figure 15 displayed the results of Specific Improvement Priorities. The highest percentage of response (63.7%) was to reduce patient wait times followed by streamlined registration (9.8%). This prioritization is a strong indication of Lean's potential impact by integrating with DoE.

.

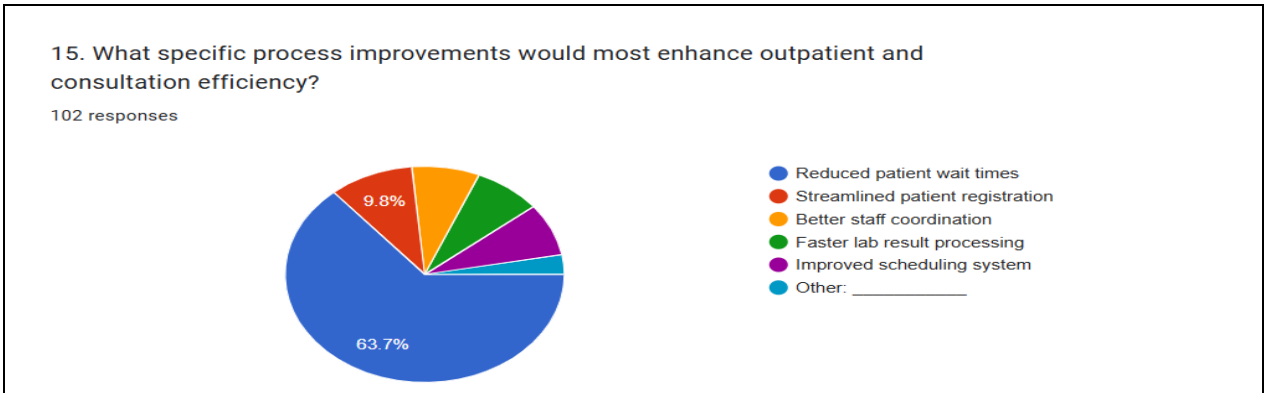

Figure 15: Survey Questionnaire Results on Specific Improvement Priorities

Figure 16 shows that many respondents anticipate "reduced waiting time" as 59.8% selected "reduced wait time" and 24.5% selected "more efficient patient flow" from Lean implementation. This aligns well with Lean's emphasis on reducing waste and improving process flow, validating the project's objectives. The responses for question 16 of "If Lean principles were applied to outpatient processes (e.g., eliminating waste, improving flow), what improvements do you expect?" are as follows:

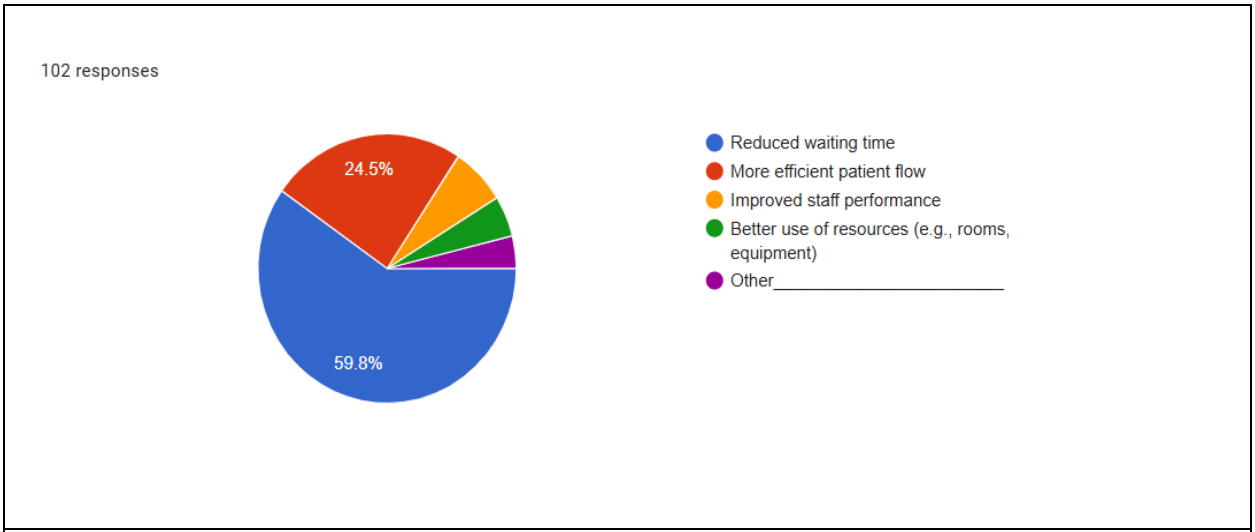

Figure 16: Survey Questionnaire Results on Expected Improvement from Lean Principles

Conclusion and Recommendations

Overall, this analysis of the questionnaire responses highlights that university Clinic already has a good foundation in patient experience and communication. However, application of Design of Experiment using Lean Manufacturing Principles such as reducing patient wait times, streamlining patient flow could optimize clinic operations. The Design of Experiment (DOE) approach can be employed to test improvements systematically ensuring efficient and targeted improvements across the clinic's processes.

The analysis showed that the university Clinic, however, offers satisfactory services. There is significant room for improvement in reducing PWT and promoting operational efficiency. Integrating lean principles with Design of Experiment and staff optimization can effectively address extended PWT. Implementing these recommendations can lead to a more balanced workflow, reduced PWT and overall improved satisfaction. This study serves as a framework for similar healthcare institutions aiming to improve outpatient consultation services through lean manufacturing principles and design of experiments.

References

Abu, F., Gholami, H., Mat Saman, M. Z., Zakuan, N., & Streimikiene, D. (2019). The implementation of lean manufacturing in the furniture industry: A review and analysis on the motives, barriers, challenges, and the applications. *Journal of Cleaner Production, 234*,660-680. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.06.279

Abu, F., Gholami, H., Saman, M. Z. M., Zakuan, N., Streimikiene, D., & Kyriakopoulos, G. L. (2021). An SEM Approach for the Barrier Analysis in Lean Implementation in Manufacturing Industries. *Sustainability*, *13*(4). https://doi.org/10.3390/su13041978

Agrell, C., & Dahl, K. R. (2021). Sequential Bayesian optimal experimental design for structural reliability analysis. *Statistics and Computing*, *31*(3). https://doi.org/10.1007/s11222-021-10000-2

Akmal, A., Greatbanks, R., & Foote, J. (2020). Lean thinking in healthcare - Findings from a systematic literature network and bibliometric analysis. *Health Policy*, *124*(6), 615-627. https://doi.org/10.1016/j.healthpol.2020.04.008

Al-Balushi, S., Sohal, A. S., Singh, P. J., Al Hajri, A., Al Farsi, Y. M., & Al Abri, R. (2014). *Agronomy Journal*, *111*(6), 2724-2735.

Readiness factors for lean implementation in healthcare settings--a literature review. *J Health Organ Manag*, *28*(2), 135-153. https://doi.org/10.1108/JHOM-04-2013-0083

Alalawin, A., Qamar, A. M., AlAlaween, W. H., Bentahar, Y., Al-Halaybeh, T., Al-Jundi, S., & Tanash, M. (2022). Aligning key performance indicators with lean management in the service sector: A case study for a Jordanian telecommunication company. *Cogent Engineering*,9(1). https://doi.org/10.1080/23311916.2022.2124940

Alesso, C. A., Cipriotti, P. A., Bollero, G. A., & Martin, N. F. (2019). Experimental Designs and Estimation Methods for On-Farm Research: A Simulation Study of Corn Yields at Field Scale. https://doi.org/10.2134/agronj2019.03.0142