Project Report

Optimization of Outpatient Clinic Processes through simulation

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## **Introduction**

In the dynamic landscape of healthcare operations management, the pursuit of efficiency and patient satisfaction is paramount. Within this context, outpatient clinics play a vital role in providing timely and effective care to patients. This project focuses on optimizing the operational processes of an outpatient clinic through the utilization of simulation modelling. By harnessing the power of SIMUL8 software, we aim to delve deep into the intricate workings of a specific outpatient clinic, identify areas for improvement, and propose strategies for enhancing overall performance.

The chosen outpatient clinic serves as a microcosm of the broader challenges facing healthcare facilities today. With a diverse patient population and a range of medical needs, the clinic grapples with common issues such as prolonged patient wait times, resource underutilization, and administrative bottlenecks. By conducting a comprehensive analysis of its operations, we seek to uncover insights that can drive tangible enhancements in clinic efficiency and patient satisfaction.

This introduction sets the stage for the exploration that follows, outlining the objectives of the project and the methodology employed. Through simulation modelling, we endeavour to simulate the clinic's processes, from patient registration to checkout, and uncover opportunities for streamlining workflows and optimizing resource allocation. By the end of this report, we aim to equip clinic stakeholders with actionable recommendations grounded in data-driven analysis, paving the way for a more efficient, responsive, and patient-centred outpatient clinic environment.

## **Methodology**

### **Phase I: Current Process Analysis**

In this phase, the focus was on comprehensively analysing the current operational processes within the outpatient clinic. The following steps were undertaken:

#### **Clinic Process overview:**

The simulation model development involved replicating the sequential flow of activities within the outpatient clinic. Each stage of the patient journey was carefully mapped out and incorporated into the simulation model:

* **Patient Registration:** Patients entered the virtual clinic and proceeded to register with the patient registrar. This stage captured the initial interaction between patients and clinic staff, simulating the process of collecting necessary information and registering patients into the clinic system.
* **Examination Waiting Area:** Returning patients were directed straight to the exam waiting area, while new patients were provided with additional paperwork to complete. This stage simulated the differentiation between returning and new patients, replicating the distribution of paperwork and patient routing accordingly.
* **Nurse Interview:** Once available, the nurse conducted a preliminary interview with the patient. This stage represented the interaction between patients and nursing staff, simulating the process of gathering preliminary information and assessing patient needs before the MD examination.
* **MD Examination:** Patients underwent examination by the MD to assess their medical condition. This stage captured the core of the clinic's operations, simulating the interaction between patients and medical staff, including the examination process and medical diagnosis.
* **EKG/Lab (if required):** Some patients required additional tests such as EKG or Lab work, which were conducted by the nurse. This stage represented ancillary services provided within the clinic, simulating the process of conducting diagnostic tests and gathering additional medical information as needed.
* **Finance Desk:** Finally, patients stopped by the finance desk for any necessary payments and to schedule follow-up appointments. This stage captured the administrative aspect of the patient journey, simulating the process of handling financial transactions and scheduling future appointments.

#### **Simulation Model Development:**

The clinic's workflow was meticulously modelled using SIMUL8 software. This involved replicating each stage of the patient journey, from registration to examination and checkout, in a virtual environment. The simulation model allowed for the visualization and simulation of patient flow through the clinic's processes.

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Figure 1: The Simulation Model for Phase 1

#### **Data Collection and Parameterization:**

Data on process times and patient arrivals were collected to parameterize the simulation model accurately. This included information on the time taken for patient registration, nurse interviews, MD examinations, and other key activities within the clinic. Probability distributions, such as exponential and lognormal distributions, were assigned to capture the variability inherent in these processes.

* **Simulation Parameters:**

|  |  |  |
| --- | --- | --- |
| **Data Element** | **Process Time** | **Probability/Distribution** |
| Patient Interarrival Time | 5 minutes | Exponential (5) |
| Registration | 6 minutes | Lognormal (6, 1.25) |
| New Patient Percentage | -- | 32% |
| New Patient Paperwork | 5 minutes | Lognormal (5, 2.5) |
| Nurse Interview | 10 minutes | Lognormal (10, 3.75) |
| MD Exam | 20 minutes | Triangular (10, 20, 35) |
| EKG/Lab Percentage | -- | 25% |
| EKG/Lab | 22 minutes | Triangular (10, 22, 35) |
| Check out | 2 minutes | Lognormal (2, 0.5) |

Table 1: Simulation Parameters

### **Key Performance Indicator (KPI) Analysis:**

Once the simulation model was constructed and parameterized, key performance indicators (KPIs) such as patient wait times and resource utilization rates were analysed. By running the simulation model under various scenarios, insights into clinic performance were gained, highlighting areas of inefficiency and potential improvement.

### **Identification of Bottlenecks and Inefficiencies:**

Through the analysis of simulation results, bottlenecks and inefficiencies in the current clinic processes were identified. Common areas of concern, such as prolonged patient wait times or underutilization of key resources, were scrutinized to pinpoint root causes and opportunities for enhancement.

## **Phase II: Financial Analysis and Resource Optimization**

In Phase II, the financial analysis and resource optimization efforts were expanded to accommodate additional resources, including doctors, nurses, registrars, and bookkeepers, to support the introduction of multiple checkout points and extended clinic hours. A computer diagram of a network

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Figure 2: The Simulation model for Phase II

The following steps were undertaken:

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The financial data underwent a thorough evaluation to gauge revenue streams, costs, and overall profitability. This involved analysing revenue sources from various services and examining both direct and indirect costs associated with clinic operations.

Figure 3: Financial Input Summary

### **A screenshot of a computer Description automatically generatedShift Allocation and Extended Hours Integration:**

With the addition of multiple checkout points, shift allocation was optimized to ensure efficient staffing across morning and afternoon shifts. Morning shifts were allocated additional resources to handle increased patient flow during peak hours, while afternoon shifts were adjusted accordingly.

Figure 4: Shift allocation properties

### **Income Statement Generation:**

Utilizing the simulation model and financial data inputs, income statements were generated to assess the clinic's financial performance. These statements provided a detailed breakdown of revenue sources, including consultation fees, ancillary services (such as EKG or lab tests), and other income streams. Additionally, the income statements outlined the clinic's operating expenses, including staffing costs, facility maintenance, and other overhead expenses, to determine the clinic's profitability.

### **Effectiveness of Multiple Checkout Points:**

The introduction of multiple checkout points, tailored to patients' specific needs (e.g., doctor consultations only or EKG/lab visits), improved overall clinic efficiency and patient satisfaction. By streamlining the checkout process and reducing wait times, patients experienced a smoother flow through the clinic, leading to higher levels of patient satisfaction and improved clinic performance.

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Figure 5: Flow Chart of Phase II

### **Resource Allocation Optimization:**

Resource allocation, including staffing levels, room utilization, and now, shift scheduling, was optimized to enhance clinic efficiency and profitability. By simulating different resource allocation scenarios, we aimed to strike the optimal balance between resource utilization and patient demand, minimizing idle time and maximizing throughput.

## **Findings**

### **Phase I Findings**

* **Patient Wait Times**: The analysis revealed that the expected time a patient must wait before the examination begins is approximately 2.9 hours. This extended wait time underscores potential inefficiencies in the clinic's process flow, particularly at the registration and patient intake stages.

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Figure 6: The Average Queuing Time

= 45.07 + 0.00 + 129.47

= 174.54 minutes

= 174.54 /60 hrs (For conversion to hours)

= 2.909 hours.

* **Overall Clinic Time**: The average time a patient spends in the clinic is 211.72 minutes which is approximately 3.52 hours. This finding suggests opportunities for improvement in reducing patient wait times and streamlining service delivery processes to enhance overall clinic efficiency and patient satisfaction.

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Figure 7: Overall clinic time.

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  Description automatically generated**Staffing Insufficiency**: Only 5% of patients complete their visit in 1 hour or less, indicating that the clinic's staffing may not be sufficient to meet patient demand efficiently. This insight, obtained through simulation modelling, highlights the need for further analysis and potential adjustments to staffing levels to improve clinic performance and reduce patient wait times.

Figure 8: End block properties

### **Phase II Findings:**

* **Average Time in Clinic:** Patients needing lab work spend approximately 1.95 hours in the clinic, while patients only visiting the doctor spend around 2.6 hours. These findings highlight variations in patient visit durations based on the services required, indicating potential areas for targeted process optimization to minimize overall clinic time.

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Figure 9: Result Manager Window - Phase II

* **Optimal Resource Allocation**: Through simulation modelling and financial analysis, the optimal resource allocation was determined to be 1 Registrar, 2 Nurses, 3 Doctors, and 1 Bookkeeper. This resource allocation configuration maximizes clinic efficiency and patient throughput while ensuring optimal utilization of available resources.
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  Description automatically generated**Financial Performance Insights**: Income statement reports generated through simulation modelling provided comprehensive insights into the clinic's financial performance. These reports detailed revenue sources, including consultation fees, ancillary services, and other income streams, as well as operating expenses such as staffing costs.

Figure 10: Financial Performance Insights

## **Recommendations**

* **Streamline Patient Registration Process**: Implement automated registration systems or self-service kiosks to expedite the registration process and reduce patient wait times. This can help alleviate congestion at the registration desk and improve overall clinic efficiency.
* **Optimize Staffing Levels**: Based on the findings from Phase I and Phase II, consider adjusting staffing levels, particularly during peak hours, to better match patient demand. This may involve increasing the number of registrars, nurses, or doctors available during busy periods to minimize patient wait times and improve service delivery.
* **Implement Appointment Scheduling System**: Introduce an appointment scheduling system to better manage patient flow and reduce wait times. By scheduling appointments for specific time slots, the clinic can optimize resource utilization and ensure a smoother patient experience.

## **Conclusion**

In conclusion, the findings from the simulation modelling and analysis conducted in this project have provided valuable insights into the operations of the outpatient clinic and identified opportunities for improvement. Through the simulation of current processes and evaluation of key performance indicators, inefficiencies in patient wait times, resource utilization, and clinic workflow were identified. Additionally, the financial analysis shed light on revenue generation opportunities and cost reduction strategies to enhance clinic profitability and sustainability.

By leveraging simulation modelling and data-driven analysis, we have developed recommendations to optimize clinic performance, including streamlining patient registration processes, adjusting staffing levels and implementing appointment scheduling systems. These recommendations aim to improve patient satisfaction, reduce wait times, and enhance overall clinic efficiency.

In summary, this project serves as a roadmap for enhancing the outpatient clinic's operations and improving patient outcomes. By implementing the recommendations outlined in this report and embracing a culture of innovation and continuous improvement, the clinic can position itself for sustained growth and success in the dynamic healthcare landscape.

## **References**

Taj, S. and Mousavidin, E. (2015) ‘Using discrete event visual simulation to teach process modelling in MBA operations management courses’, Int. J. Simulation and Process Modelling, Vol. 10, No. 1