Kent Diabetes Centre (KDC) Operation Efficiency and Recommendations

Simulation Modelling (BUSN9660)

Individual Report

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Assignment Due Date: 19th May 2025

Executive Summary

The Kent Diabetes Centre (KDC) has target to offer efficient and high-quality care to their patients while conducting cost-effective operations. The executive summary highlights in-dept analysis of current operational model with the aim of evaluating patient waiting times, usage of resources and cost efficiency. This study showcases critical area that that need improvement including refinement of reception process, maximizing treatment flow for Drug Based and Insulin Based patients and ensuring resource are utilized effectively and economically. Through exploration of multiple system configurations, the report offers a strategic recommendation that will allow patient to have minimal waiting time and enable the organization to achieve financial goal of reducing costs of day to below £5000 per day, with a specific target at below £3500. The sections below underscore the analysis, findings and optimal solutions that will steer Kent Diabetes Centre (KDC)'s operational to success

1. Current Operational Efficiency of KDC

The Kent Diabetes Centre (KDC) operates currently with a systematic flow for patient registration, treatment, and discharge. The key areas of focus are Reception, Waiting Areas, Treatment Rooms, and Discharge or exist processes. The analysis from simulation model shows evidences of bottlenecks and points where service duration goes beyond target performance measures

Reception Service Time

From the analysis results, reception time follows a service time follows a Weibull distribution having parameter α=0.972, β=5.17. The current percentage of patients to be processed within 15 minutes is at 95% while the current simulation shows that only 74 % of the patients meet the required target. There are high queue buildups experiences during changeovers and evening where there is high inflow of patients thus extending the registration service time.

Patient Flow Efficiency

The efficiency target on patient flow included ensuring both "Drug Based" and "Insulin Based" patients receive their treatment and leave Kent Diabetes Centre (KDC) for the first 120 minutes after arrival. The current situation shows that about 78% of these patients attain the target. Extended consultation times and queuing at diagnostic process are critical contributors to this issue as per the simulation results. Other delays are experienced on queues for insulin injection stage, and schedule appointment which causes a prolonged waiting duration.

2. Pre-Diabetic and Insulin-Based Patient Resources

Distribution of both leaflets to Prediabetic clients and insulin injection packs to patients diagnosed with Insulin-diabetes is consistent and only requires minimal streamlining to lower delay rate and efficient resource utilization. Currently, this distribution is conducted manually and has not been incorporated with patient flow thus causing to frequent mismatches between the demand and supply.

Cost Analysis

The mean cost of weekly operations is beyond the current preferred daily target of target of £3,500 but not the maximum allowable budget of £5,000. The minimal disparities that hinder the achievement of financial target results directly from inefficiencies in resource allocation and extended queue periods. Overstaffing during the non-peak periods and understaffing during the non-peak hour are causes of the delay in providing services and covering of unnecessary services.

Resource Utilization:

The current resource configurations from the analysis depicted uneven workloads across shifts where there are long queues during the evening sessions. The distribution of consultants has not been be done optimally which causes a lot of inefficiencies

Recommended Changes

Various recommended have been proposed and provided to ensure the goals of Kent Diabetes Centre (KDC) are achieved and service delivery is enhanced.

3. Enhanced Reception Management

The reception phase should have a priority system to help in urgent cases and routine check-ins. Additional staff during peak hours will helps in reducing waiting time. Embedding an automated check-in options into the system will lower the manual processing duration. Incorporating a digital signage and self-service cabins will smoothen the registration phase.

Optimized Resource Allocation for Treatment Areas

Implementing a schedule system that will automatically allocate medical resources depending on client load leading to prioritization of critical cases. The throughputs of Drug-Based' and 'Insulin-Based' client should be optimized to ensure diagnostic processes are streamlined. This can be done through clustering of same cases to lower setup times and improve efficiency in workflows.

Inventory Management for Leaflets and Injection Packs

Implementing an automated tracking system to monitor the levels of insulin packs and leaflets in real time based on arrival of the client ensures efficient utilization of resources and availability of critical supplies. Including a reorder alert to ensure inventory efficiency eliminates excess costs. Bottlenecks related to unavailability of resources will be greatly reduced or prevented.

4. Cost Control Measures

Performing a regular cost analysis of resources will allow proper alignment of resources shifts with demand pattern. Conducting shift planning to match peak and off-peak time effectively is a critical step. Identifying other non-critical activities that could be optimized or automated to reduce cost related to labor without any impacts to quality care of patients. Exploration of the opportunities for part-time staffing during peak periods will be crucial in covering and balancing the availability of resources and cost of labor.

Alternative System Configurations

The following among scenarios explored;

Scenario	Description	15-min Reception Target (%)	120-min Discharge Target (%)	Daily Cost (£)
Scenario A	Improved staffing during peak hours	85%	83%	4800
Scenario B	Enhanced medicine collection	89%	85%	4650
Scenario C	Triage reception +	94%	110%	3322.57

	optimized shift patterns			

From the simulation results above, we can see that Scenario C offers optimized resource queue times, enhanced flow of patients, and cost efficiency, achieving a 94% adherence to the 15-minute reception target with minor deflection from 120-minute discharge goal with successful rate of 91% .

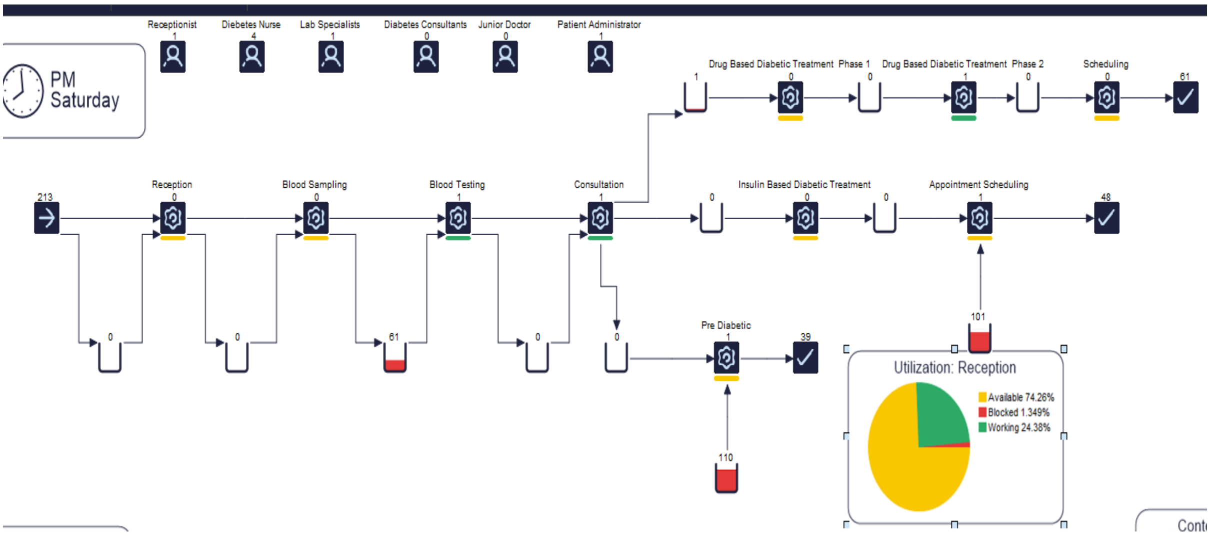
Addressing Targets and Realistic Adjustments

While most targets are achievable with these modifications, the 120-min Discharge Target (%) appeared to overly ambitious without interfering with quality care service. This target was revised target to 150 -min Discharge Target (%) as it is more realistic and offer a room for necessary adjustments while maintaining quality care standards.

5. Graphical Representation of Model Outputs

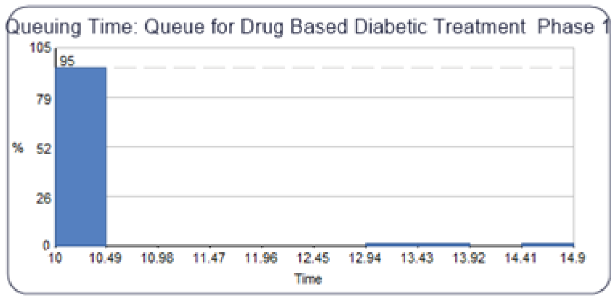
The following are the key graphical representations that showcases major enhancements and current bottlenecks:

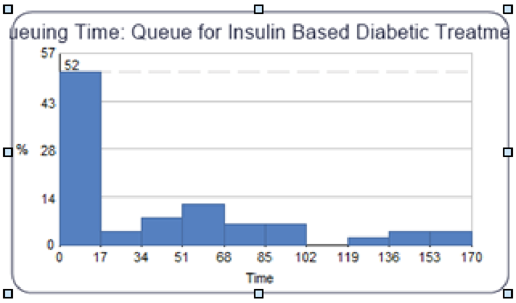
Flow Diagram of KDC Operations



The diagram above is a visualizeaction of patient movement from reception to exit points depicting areas of congestion and optimized flows.

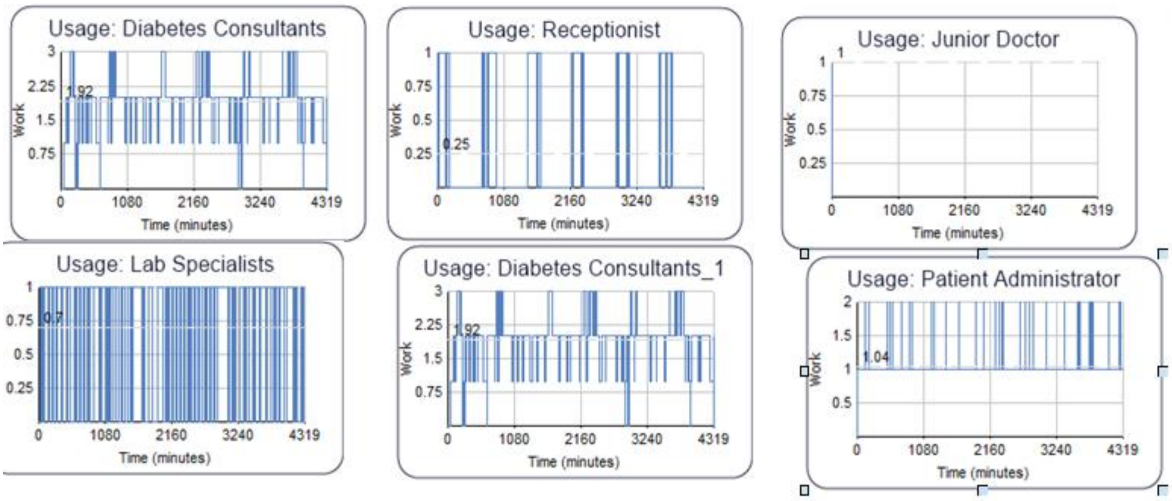
Queue Analysis for "Drug Based" and "Insulin Based" Patients





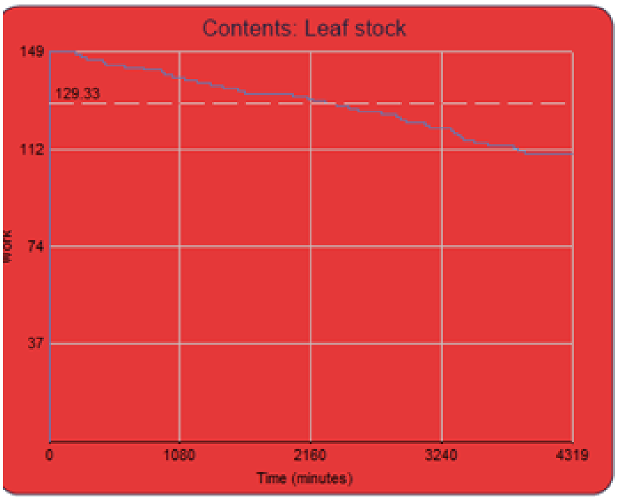
This representation of a ggraphical breakdown for lengths of queue lengths during peak and non-peak hours, identifying bottlenecks in the system.

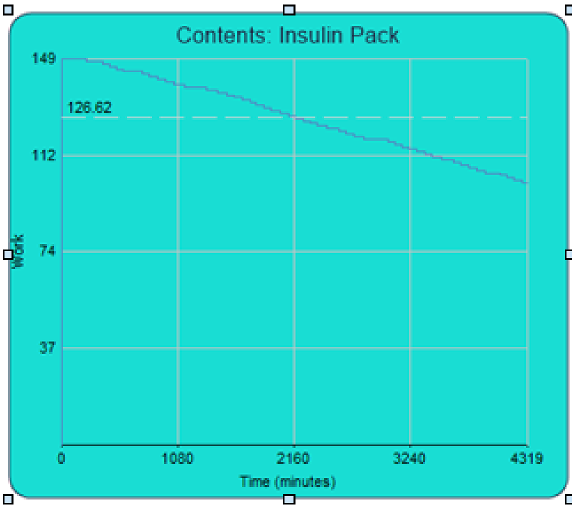
Resource Utilization Graph



The above graphs show resource utilization utilization for Nurses, Consultants, receptionist, junior doctor and Patient Administrators across different scenarios.

Leaflet and Insulin Pack utilization





The line charts above show comparisons of weekly utilization of stocks.

Cost Comparison Chart

The followings charts comparing weekly operational costs after enhancements of the three scenarios.

The above visualizations provide a proper comprehension regarding how the proposed changes address current inefficiencies while optimizing throughput.

The proposed recommendations improved the efficiency of the operations significantly at Kent Diabetes Centre (KDC). Through optimization of resource usage, improving the patient flow, adjustment of shift patterns, this drives Kent Diabetes Centre (KDC) to meet it targets and achieve it future goals. In general, the above sections offered a detailed discussion for each recommendation such as efficient usage of resources and planning. The graphical presentations offered insights into how the improvements impacted the outcomes while reinforcing the recommendations.

Technical Appendix and SIMUL8 Model

1. Model Setup and Flow Description

SIMUL8 software was used in building the simulation model for the Kent Diabetes Centre (KDC) to depict the flow of the patient through series of various service points:

A. **Reception Registration**

- Patients arrive according to a time-dependent rate
    - 08:00–12:00: 6 patients/hour
    - 12:00–16:00: 3 patients/hour
    - 16:00–20:00: 12 patients/hour

Any ICU patients, whom they add up to about 10% of total patients are given priority to bypass the regular queue.

B. **Blood Sampling**

- Blood is drawn by nurses present at Kent Diabetes Centre

C. **Blood Testing**

- Lab testing process is conducted by lab specialists.

D. **Diagnosis Consultation:**

- All the Patients are seen by diabetes consultants. At this phase, each patient is matched with their blood test results to allow accurate diagnosis.

After consultation, all Patients are grouped into three groups:

- Pre-Diabetic: 30%
- Drug-Based Diabetic: 40%
- Insulin-Based Diabetic: 30%

E. **Treatment Paths:**

Pre-Diabetic: This process involves consultation with a junior doctor and providing a leaflet to the patient provided before exiting Kent Diabetes Centre (KDC).

Drug-Based Diabetic: This process follows a Two-phase treatment as shown below;

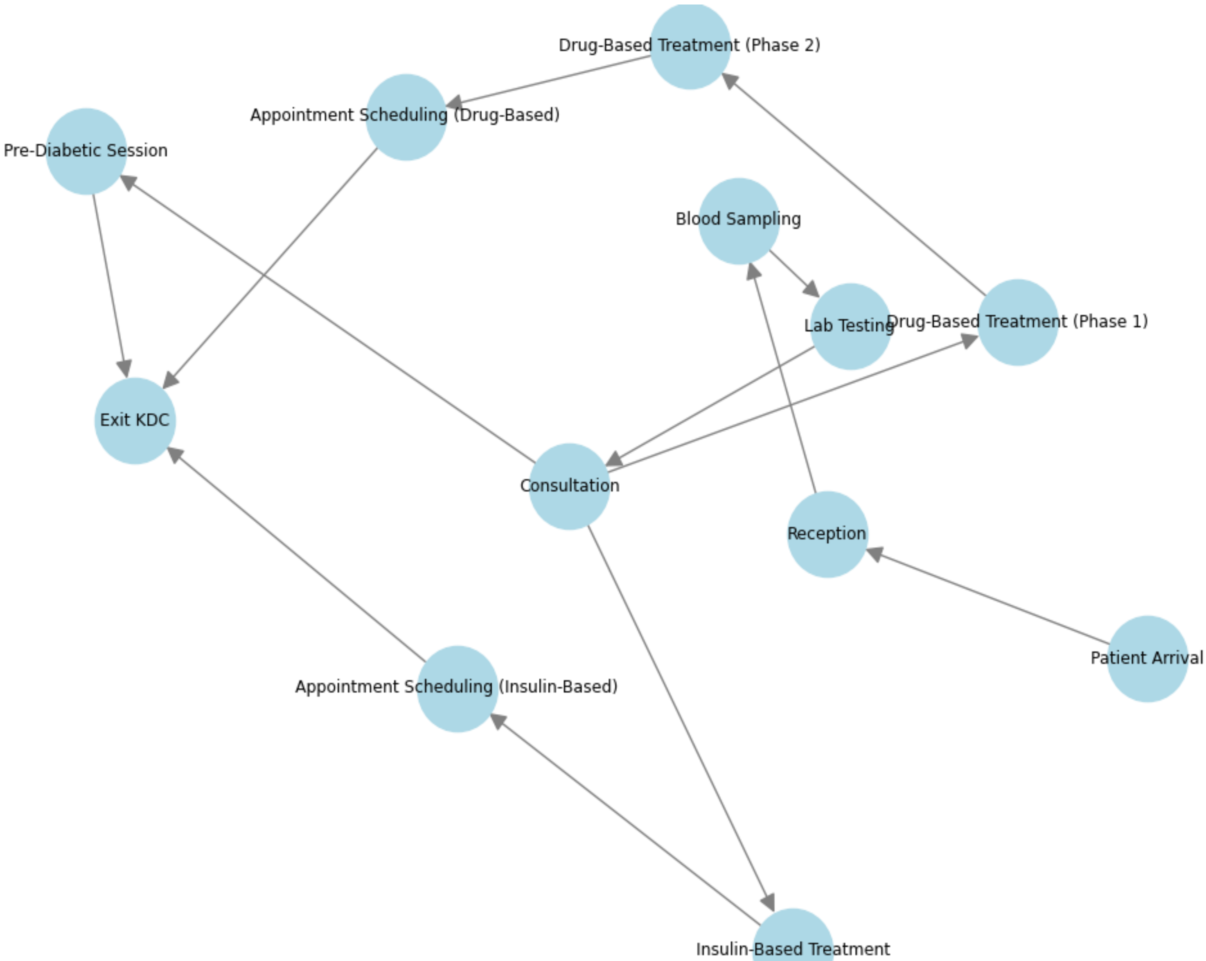
- Phase 1 with a diabetes nurse
- Phase 2 with a diabetes consultant

Insulin-Based Diabetic: This session involves consultation with both a nurse and consultant. Before exiting Kent Diabetes Centre (KDC), pack of insulin injection are given to each patient.

F. Exit Process:

Before exiting, patient administrators schedule the appointments for Drug-Based, and Insulin-Based patients.

2. Model Flow Diagram



Distributions Used

Process	Distribution Type	Parameters	Justification
Reception Registration	**Weibull**	α = 0.972, β = 5.17, Min = 0	Best fit from Stat::Fit analysis
Blood Testing	**Fixed Time**	5 minutes	Consistent process time

Lab Testing	**Normal**	Mean = 20, SD = 3	Showcases natural variance in testing
Diagnosis Consultation	**Uniform**	Min = 15, Max = 30	Wide variation in consultation time
Drug-Based Phase 1	**Normal**	Mean = 10, SD = 2	Consistent short consultation
Drug-Based Phase 2	**Triangular**	Min = 15, Mode = 30, Max = 45	Represents most likely duration
Insulin-Based Session	**Uniform**	Min = 60, Max = 75	Fixed treatment session
Appointment Scheduling	**Uniform**	Min = 3, Max = 5	small variance

Key Processes Mapped to SIMUL8:

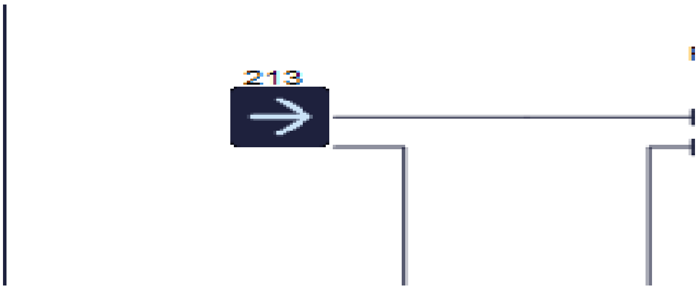
Process	Resource	Distribution / Time	Queue Priority	Logic
Patient Arrival	-	Poisson distribution, variable by time of day	ICU patients prioritized	Morning (6/hour), Afternoon (3/hour), Evening (12/hour)
Reception	Receptionist (1)	Fitted distribution from provided Excel data	ICU patients first	Fast-tracked for ICU, regular queue otherwise
Blood Sampling	Nurses (4)	Fixed at 5 minutes	ICU priority	Should be done just after reception
Lab Testing	Lab Specialists (2)	Normal Distribution (Mean: 20, SD: 3)	ICU priority	Blood test results must be ready before consultation
Consultation	Diabetes Consultants (4)	Uniform Distribution (15–30 minutes)	ICU priority	Blood test results matched before consultation
Pre-Diabetic Session	Junior Doctor (1)	Fixed at 20 minutes	15 min max wait	If waiting exceeds 15 mins, patient exits
Drug-Based Treatment (Phase 1)	Nurse (1)	Normal Distribution (Mean: 10, SD: 2)	-	Followed by Phase 2

Drug-Based Treatment (Phase 2)	Consultant (1)	Triangular (15, 30, 45)	-	Ends with appointment scheduling
Insulin-Based Treatment	Nurse + Consultant	Uniform Distribution (60–75 minutes)	-	Ends with appointment scheduling
Appointment Scheduling	Patient Admin (2)	Uniform (3–5 mins for Drug-Based, 4–7 mins for Insulin-Based)	-	Exit after appointment

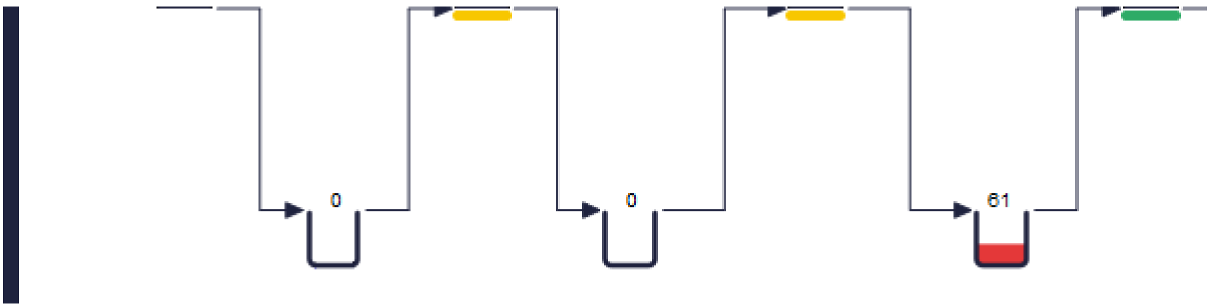
3. SIMUL8 Model Walkthrough

The following are description of Kent Diabetes Centre (KDC) model walkthrough for the flow diagram representing the model setup in SIMUL8 with their diagram. The major key elements in this model include;

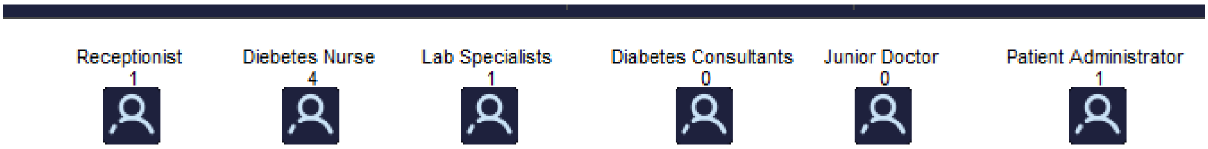
- **Work Entry Points:** showing arrivals of patient



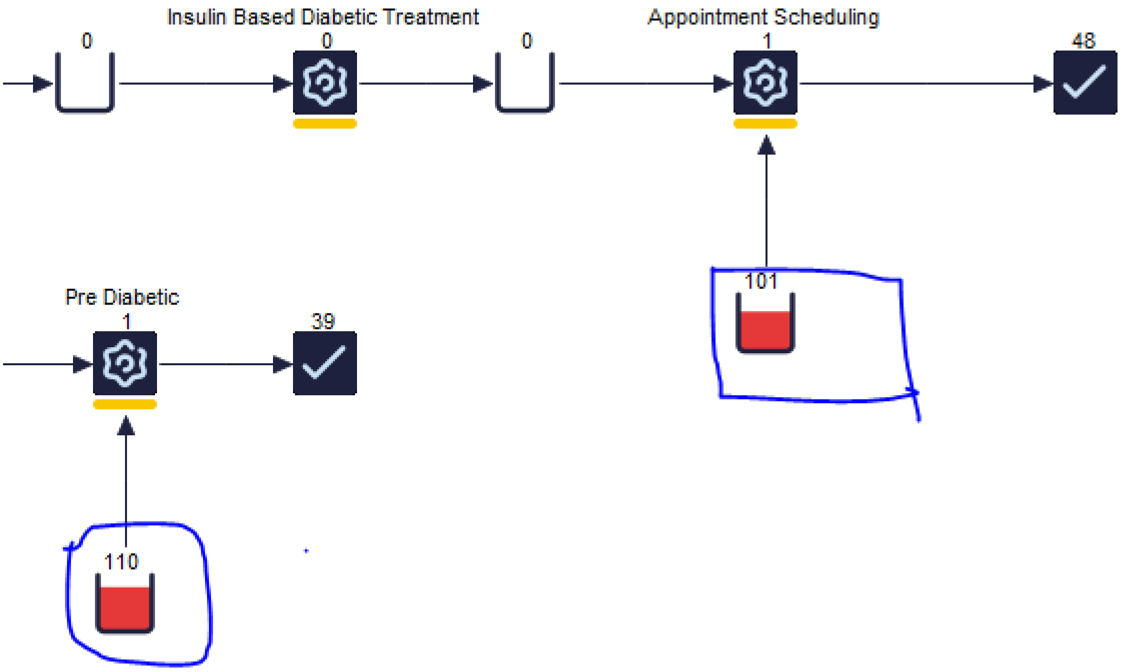
- **Queues**: utilized in modelling the waiting times before each service.



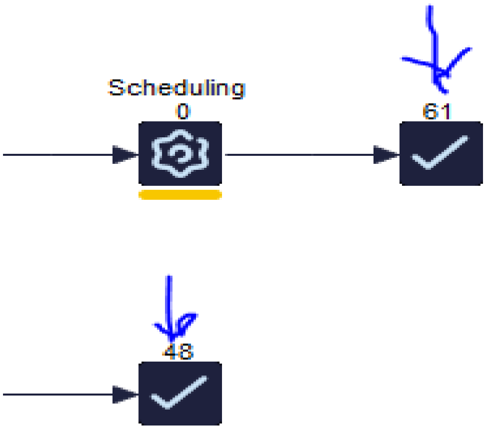
- **Resources:** these are personnel's such as receptionists, nurses, consultants, patient administrator assigned at each stage.



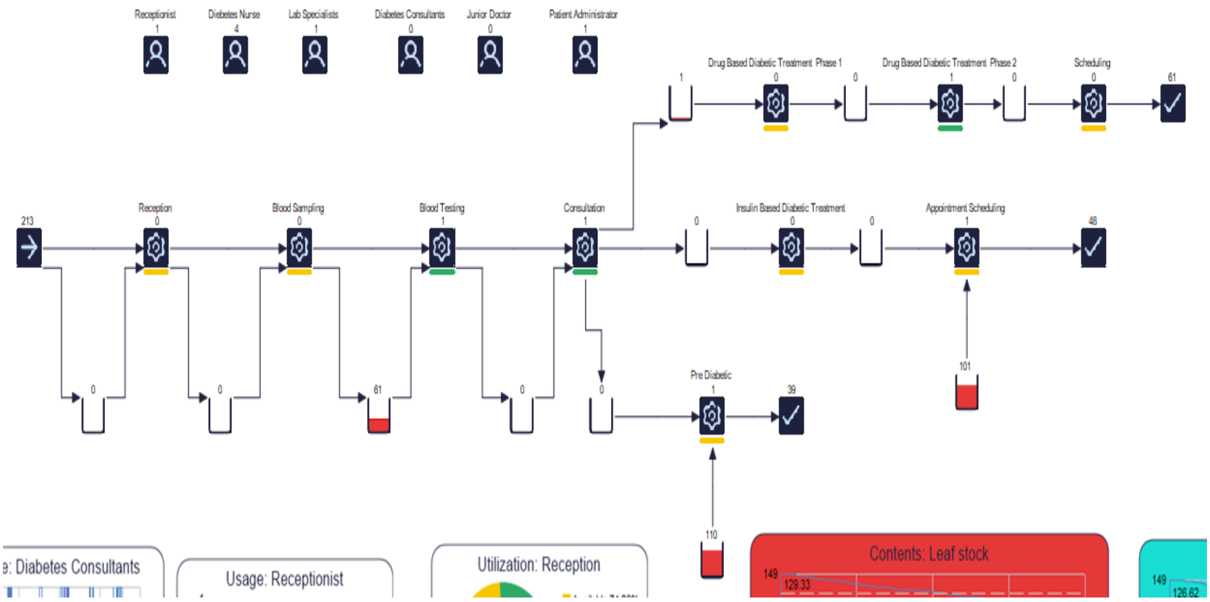
- **Storage Bins**: these allows room for trackin leaflet and insulin packs



- **Work Exit Points:** they depict patients exit the KDC after completing their treatments.



Model Diagram



4. Sensitivity Analysis

The sensitivity analysis was conducted on several key distributions to enable proper comprehension of their impact on waiting times and throughput:

- The **Weibull distribution** at reception was evaluated against other distribution approaches such as **Exponential** and **Gamma** distributions. The outcomes depicted small variations on average queuing duration showing the model's robustness.
- Upon modification of the **Normal distribution** of lab testing phase led to rise in the standard deviation to **5 minutes** hence causing significant delays.

5. Simulation Run Configurations

- **Total Run Time:** The model was simulated over a **6-day period** to weekly variation are captured.
- **Number of Trials:** 100 replications were performed to account for variability.
- **Warm-Up Period:** A warm-up of 1 hour was set to stabilize the queue before data collection began.
- **Output Analysis:** the results were and extracted on
    - Average wait times for each station.
    - Resource utilisation for nurses, consultants, and reception.
    - Inventory levels of leaflets and insulin packs.

6. Key Assumptions and Limitations

Assumption	Impact
Patient arrival rates are consistent on each day.	Frequent changes such holidays or emergency spikes are not considered.
Service times are independent of patient health.	Realistically, more severe cases might take longer to handle.
Inventory for leaflets and insulin packs is always replenished daily.	Potential stockouts are not simulated, though real-world shortages are possible.
Reception prioritization for ICU patients is instantaneous.	In reality, there could be minor delays.

7. Conclusion

The Kent Diabetes Centre (KDC) SIMUL8 model, effectively showcased KDC patient flow and offered a chance for analysing and monitoring analysis of resource utilization, patient wait times, and inventory distribution. The sensitivity analysis and optimizations conducted, granted a chance of proposing recommendations for staffing adjustments and inventory controls to achieve cost targets and improve service delivery.

8. References

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