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Final Project Report

Moving Santam Insurance Towards Industry 4.0 Through Dynamic Simulation Resource Scheduling

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Executive Summary

A report concluding the final phase of a project aiming to move Santam insurance toward industry 4.0 through dynamic resource scheduling.

Research was conducted in areas involving data and sensitity analysis, robust simulation scheduling as well as the preferred modeling platform- Simio® Simulation.

A large section of this project is contributed by a thorough data analysis which facilitated the use of various industrial engineering techniques in the processing a large raw data set, prioritising resources, defining relationships, identifying trends and associations, plotting distributions and coding the automation of repetitive calculations.

The input, processing and output logic segments behind the base simulation model is further explained and represented on the Simio® interface found in the appendices. Throughput and turnaround time were the metrics used in the successful validation of the simulation model.

The proposed "Equal-Mix" solution suggests a two-stage scheduling that is performed aimed at firstly minimising the variations in volume and thereafter maintaining the balance by allocating the same claim type proportions to handlers as that which is received that day.

An additional "Min-Claim" scenario is run as an alternative to the initial solution, in which the scheduler simply allocates the claim the the handler with the least claims. This was deemed worthwhile as an alternative that does not require extensive knowledge and infrastructure.

Both scenarios resulted in an increased throughput of internal claims, potentially elimination the need for costly external assessor but at the trade of an increased turnaround time. A more balanced system was achieved.

A change management program is suggested to supplement the implementation of the solution and a workshop covering simulation and an improved data gathering policy is also advised.

The final recommendation would be to continue exploring the use of simulation as a decision making tool throughout the workplace and invest in the training and infrastructure which will advance the company into areas that will be crucial to their long term success.

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1 Background

1.1 Company background: Santam Insurance

Founded in 1918, Santam Insurance has grown to be one of the leading short term insurance providers in South Africa. Offering a comprehensive range of short term insurance products and services, Santam consists of five business units and currently has a market share of 22 percent (Insurance.co.za - South African Insurance Quotes,2018) and thus strive to stay up to date and relevant with the latest technological advances.

1.2 Industry 4.0 and the Service Sector

As a result of continuous technological developments, a new trend of digital applications in industries has come to rise. Industry 4.0 is based on six design principles that focus on the automation of processes and data exchange. Concepts such as decentralized decision making, vitalization and real time big data processing (Underwood, 2018) have become a game changer for service industries in particular. The short term insurance industry has been one of the slower industries to step towards integrating trending technologies into the workplace, but have recently started advancing towards the potential benefits that could come from making use of even a few of the concepts.Through automating processes within the system the company can significantly improve customer service and assist in differentiating them from their competitors in the ever evolving environment that they form part of.(Accenture.com, 2018)

1.3 Simulation Scheduling in Industry 4.0

In an Industry 4.0 application volumes of data are collected from a process on a continual basis, which requires that the scheduling system have the ability to receive, process and re-optimise given the real time data and produce a fast, detailed and accurate schedule best suited for that current situation. By building a scheduling simulation model the logic can accurately depict the behaviour of the real system by the flow of jobs/material through the system in a time-ordered sequence (Zaayman and Innamorato, 2018).

This solution could then be directly applied back into the workplace with minimum reaction time.This is particularly important in highly stochastic scenarios and if implemented correctly can show to be more beneficial that a deterministic constraint-based approach to scheduling (LLC, 2018). A simulation model also provides an animated representation of the actual system from which the execution of system behaviour can be observed over a time period. This is an aspect which is advantageous not only in validation and verification of the system, but also in convincing stakeholders of the validity of the schedule.

2 Problem Overview

Santam insurance receives thousands of claims that have to be processed every day. These claims follow the basic outline of the system shown in Figure 1. The process starts with the client sending in a claim form for the damage or loss of an item that has been insured. The claim form is validated to ensure that all the necessary information in available and that the claim falls within the coverage of the policy. Once this is confirmed then the claim is registered on the company's mainframe system.

Claims get routed to departments based on the area of insurance (Motor, business,Non-Motor claims etc.), where the claims are received by various "Claim Service Consultant" (CSC) agents. These desktop agents look at the claim and decide whether there is merit to send out an assessor to evaluate or if they can process and finalise the claim themselves. This would occur in instances involving low value claims such as cellphones, camera and laptop thefts.

The assessors go out to various locations to evaluate the damages and negotiate the value of the repair or replacement. This process can vary greatly in time depending on the category of the claim that is being assessed. Once the assessment is done, the claim is finalised by the CSC agent and the claim exits the departments system.

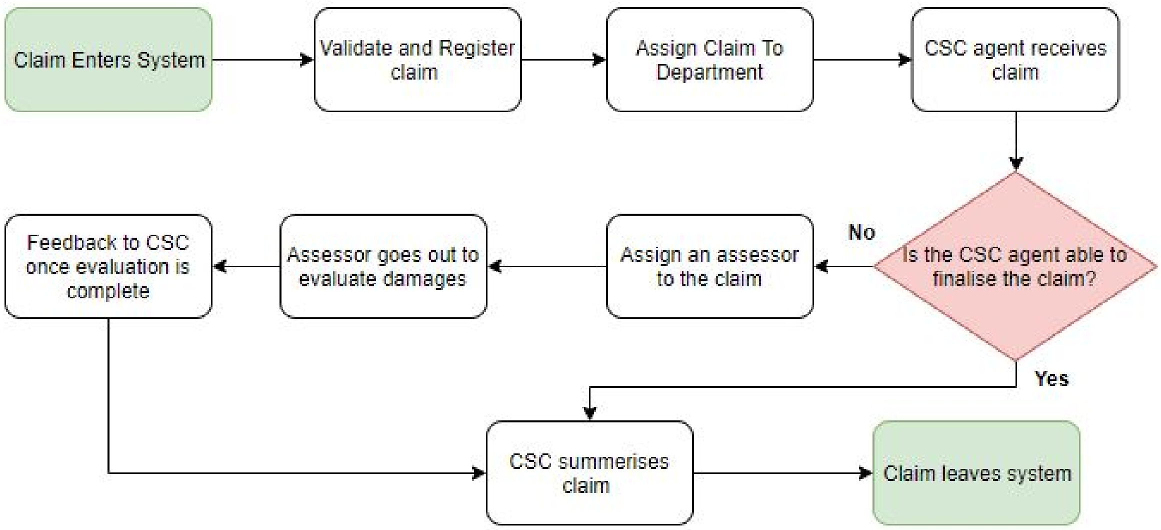


Figure 1: The claim process flow within the non-motor department.

Although it is currently possible to process the majority of their claims digitally, the allocation of claims to agents is still to a large extent a manual procedure. The work assignments are performed three times a day by the agent team leader who distributes the workload evenly among the team members.

The company's current policy is to manage the input queue to the depart in such a way that it remains empty, but no increase in throughput occurred as hoped, but instead a workload balance problem has since developed.

3 Problem Statement

Santam's non-motor claims department is currently experiencing a work balance problem and excessive strain in seasons of catastrophe where a surplus of claims enter the system. An opportunity of improvement has arisen to better manage resources and workforce utilization through the implementation of an alternate scheduling system while making use of technological relevant techniques.

4 Project Aim

As part of an initiative to apply Industry 4.0 principles to the company's processes it has been proposed that through scheduling simulations, it is possible to design a solution that will provide technical assistance, further automate the claims work flow and decentralize the decisions made by humans in the process. This will increase the claim process service level and improve the load balancing within the workplace.

By considering factors such as the current claims in process, the time each category spends in the system, the skills of assessors, and the capacities of the resources in the system a simulation scheduling model could be used to make dynamic decisions.

5 Project Scope

The insurance industry is a risky business and involves many stochastic factors that need to be taken into account when scheduling and thus using a simulation scheduling approach would be most suited for the scope of the project. The model can be built in a modular way which will provide for future expansions into other areas within the department that requires intelligent scheduling.

The focus of the project will be on the non-motor claims department for the handling branch situated in Auckland Park, Johannesburg. Although the non-motor claims department consists of direct, intermediate, geyser, building, general and external claim branches, the scope of the simulation has been further defined to include only the service branches 455, 301 and 705. This is due to the fact that the direct and intermediate branches are merging to form a new branch, and the external claim branch does not make use of the scheduling procedure. The claim types as defined by the Pareto Analysis in Section 7 below will be modelled.

The scheduling focus will be placed on the section of the process where the service centre receives the claim from the call centre and the allocated to a claim handler, which is further explained in Section 7 below.

Catastrophes are considered to be of a value greater than R1 000 000 or more than 300 claims belonging to a single event. Catastrophes will not be included in the scope of this project. Claims which required additional assessors together with the allocated claim handler will also not be included as this does not account for the majority of the scenarios faced when handling claims.

6 Literature Review

Research was conducted on key areas in both the development of the solution and as well as the relevance of the suggested approaches in trying to meet objectives and address the need that is aiming to be met. Important factors such as schedule properties are elaborated on to set the mark for a good schedule; analysis techniques and approaches as well as the platform for the simulation is researched in depth to provide appropriate knowledge for future decision making and implementation of the suggested solution.

6.1 Pareto Analysis

A challenged faced by many managers is the multitude of questions that need to be answered in the workplace, and knowing where to start is often a daunting experience. For this reason the Pareto analysis is one of the most commonly used tools for separating a limited number of input factors as having the greatest impact on an outcome or overall goal, being either desirable or undesirable (Momoh, 2018).

Commonly know as the 80/20 rule, the principle is based on the idea that 80% of a projects benefit can be achieved by doing 20% for the work. Conversely, 80% for a situations problems can be traced to 20% of the causes (EduPristine, 2018).

Two main benefits of using the Pareto principle have been highlighted. Firstly, measures of the resulting quality of a business's process is categorised and stratified which allows leaders to identify classes or types of problems and secondly, the results of the Pareto analysis are displayed graphically in a Pareto diagram for that the significant few problems emerge from the general background (EduPristine, 2018).

6.2 Sensitivity Analysis

Sensitivity analysis is a technique used to determine how the values of independent variables will impact dependent variables within a given a set of assumptions (EduPristine, 2018). Based on the principle of changing the model and observing the behaviour, it analyses how sensitive the output is by changing the value of a single input.

Commonly used methods of sensitivity analysis include modelling and simulation as well as scenario (What-If) management tools such as those provided in Microsoft Excel. Multiple replicated of the proposed model will result in a sensitivity index with which one can calculate the output difference when one parameter varies from minimum to maximum value (EduPristine, 2018).

Techniques of correlation, regression and subjective sensitivity analysis are all commonly used methods of analysing input parameters.

The main application of sensitivity analysis lies in the the usage of models by managers and decision makers as it helps decision analysts to understand the uncertainties, pros and cons with the limitations and scope of a decision model.

Most if not all decisions are made under uncertainty, and by testing for the expected, minimum and maximum values of the parameters the user understands the range in which the proposed solution can be implemented.

6.3 Robust Planning and Scheduling

The development of schedules that perform well in real-life scenarios is a challenge that most companies are still faced with today (Vieira et al., 2017). A plan consists of a sequence of activities which must be applied so that the system can transition from the initial state to the terminal (destination) state. There are typically resources required for the completion of these activities. The allocation of resources to activities in time is a challenge which is solved through scheduling. It is important to define a measure of robustness as a property of a schedule, in order to determine the degree at which the quality of the schedule is reduced during its execution (Jankovific, 2015).

A robust schedule is the one which minimizes costs or the impact of delays and disruptions when they occur (Chiraphadhanakul and Barnhart, 2011; Hadianti et al., 2013). To evaluate the robustness of a given schedule design, many executions of the schedule in stochastic conditions is required.This may be done by using a simulation model where the system is described based on many replications of the model as well as the probability of activity failure can then be determined. (Jankovific, 2015) then goes on to say that robustness of a schedule can be altered by changing factors such as the order of execution of activities, the time reserves of activities and the order of allocation of resources to activities.

6.4 Scheduling and Project Management

Projects are becoming increasingly larger and more complex and the need for greater control over potential losses and risks have risen. An article by (Chen et al., 2012) explores the way project management has evolved due to the need to control costs and schedule, which have led to the asking of questions concerning the probability of reaching project objectives, impacts of unforeseen conditions on schedule adjustments and how to distribute resources as near to optimally as possible. Another challenge faced by managers is the implementation of a change management approach to keep up in competitive business environments (Hlupic and Vreede, 2005). As it was shown in a study conducted in (Hammer and Champy, 1993), that nearly 50% of Business Process Re-engineering projects fail due to the inability to predict the risk that the change to the system will bring.

Simulation has shown great potential to aiding these project management challenges and (Chen et al., 2012) proposes the use of an Intelligent Scheduling System (ISS). By combining computer simulation and analytical techniques this approach can reap the benefits of both simulation and mathematical modelling. ISS integrates important system factors simultaneously during the simulation run which results in a near-optimum scheduling solution. This also aids in the risk analysis of project cost and duration.

The outputs that can be expected from a typical ISS model consist of resource distribution, production rates, project schedule and cost, utilisation rates and stochastic risk analysis, as well as what-if analysis of possible scenarios and subsequent scheduling adjustments based on unanticipated conditions.

6.5 Simio® Simulation Software

6.5.1 Overview

Simio® Simulation and Scheduling Software was developed by a highly experienced team working for the private company, Simio LLC, whom strive to deliver solutions for the design, emulation, and scheduling of complex systems (Simio, 2018).

The modelling framework used in Simio® is based on intelligent objects and supports both continuous and discrete systems. Large scale agent-based modelling applications include airports, manufacturing, supply chain, health care, business processes etc.

Simio® has taken a completely graphical approach to object building. This has largely eliminated the need to write programming code and has simplified the object building process. Simio® not only has application in system design but is also considered to have an ISS functionality in its risk based scheduling applications. This separates it greatly from its competitors and makes it ideal for increasingly digitalised working environments (Zaayman and Innamorato, 2018).

A sample of the Simio® interface and features can be found in Appendix D.

6.5.2 Risk based Planning and Scheduling

Risk-based Planning and Scheduling (RPS) is a patented approach which takes advantage of the built-in variation of a simulation model in order to assess the risk associated with a specific deterministic schedule. This approach is used to generate schedules that minimize risk and reduce cost whilst the Simio® model fully captures the detailed constraints and the variations of the system (Zaayman and Innamorato, 2018).

When the model generates a RPS schedule it firstly removes all variation and unplanned events from the system automatically, running the scenario in a purely deterministic mode (the ideal scenario). This first schedule is then compared to a second one generated in a replicated model wherein the variation is included. The program then performs a probabilistic analysis to estimate the underlying risks associated with the schedule. The risk measures outputted by RPS include the probability of meeting targets and the associated risk of the performance of the different tasks. RPS provides a realistic view of expected schedule performance and the information required to take early action in the operational plan to mitigate risks and reduce costs.

6.6 Resource Scheduling Methods

The importance of effectively managing personnel and equipment whilst still avoiding idle resources have been especially realised in companies that manage different projects at the same time.

The significance of the use for infinite and finite capacity scheduling is highlighted in (Prince, Joseph and Brako, 2017) as a factor to consider when developing a scheduling system. Finite capacity takes the existing resource load into account when scheduling orders and operations and then calculates the start and end dates. In doing this, the goal is to ensure a steady flow of work throughout the system. Infinite capacity scheduling tools consider the order due date first and then attempts to reconcile the result with the capacity available. Although a simpler approach, the real time restrictions on the system cannot be taken into account and this approach is better suited for systems with a minimal stochastic nature (Prince, Joseph and Brako, 2017). Scheduling often attempts to simultaneously attain contrasting objectives such as low inventories, high efficiency and good customer service. Both (Prince, Joseph and Brako, 2017) and (Ertogral and Bamuqabel, 2008) have thus set out to analyse ways in which resources can effectively be scheduled as to lead to organizational efficiency.

6.6.1 Technique review

Much research has been done in consideration of the challenges that workforce management pose. Analytic queuing models and simulation models have been developed for computing staffing levels able to guarantee the desired level of service (at a notable cost and level of expertise), while mathematical programming approaches have been used to develop optimal shift schedules able to cover such levels. Although a lower cost solution, the assumptions made in standard queuing models and integer programming algorithms separately often do not hold in practice. This has led to the natural progression into the integration of staffing and shift scheduling into suitable mathematical programming formulations.

Artificial intelligence techniques have been applied to scheduling problems in areas of industry that involve executions by intelligent agents, autonomous robots and unmanned vehicles (Vlahavas and Refanidis, 2018).Decision support systems with integrated artificial intelligence have been particularly beneficial to scheduling staff that are faced with systems that consist of a large number of human factors which cannot be quantified in software and therefore require the discretion of the person tasked with the rostering (Ernst et al., 2004).

Metaheuristics consist of hybrid heuristic algorithm methods that are suited to solve difficult and usually combination optimisation problems within a reasonable time (Ertogral and Bamuqabel, 2008). These methods tend to be robust, simple to implement and make it easy to deal with complex objectives due to the stochastic components in the algorithms. Metaheuristics tend to be suitable for global optimization and are often found in health and transport sector applications (Yang, 2018).

Constraint programming is an approach which makes use of a mathematical modelling language to encode and solve constrained optimization problems through systematic deductive reasoning (Kanet, Ahire and Gorman, 2004). This is achieved using a wide range of search strategies and is very flexible in terms of formulation power and solution approach. The flexibility is particularly useful when the the problem is highly constrained and when a feasible (not necessarily optimal) solution will suffice. This technique is rather inefficient in terms of optimisation on its own and although the area of hybrid techniques seem promising, more research is required to determine the best way to combine the flexibility of constraint logic programming with other optimisation techniques (Ernst et al., 2004).

6.6.2 Scheduling Procedure Framework

Staff scheduling and rostering methods in particular are addressed by the authors' review in (Ernst et al., 2004). They suggest a process composed of six main modules to consider when classifying a staff scheduling problem. Decomposing a problem into separate modules makes the schedule more traceable and generally agrees with the company's business practices. Furthermore, the requirements for the modules will depend on the application of the schedule. The process starts with demand modelling, in which the demand for staff is ascertained through the translation of the predicted pattern of events into the associated duty requirements. Staff demand can be based on task, shift or flexible demand. This project will deal with a flexible demand as found in typical call centre applications in which requests for service have random arrival rates and possibly random service times. The staffs leave days would then be considered and how they are to be spread between work days. Shift scheduling then takes place through the assigning of a number of candidates to particular shifts. Factors that should be taken into account include staff experience, service time per duty type and the timing of breaks within regulation and company requirement.

Work schedule of duties for each staff member over a designated planning horizon are then constructed. This module takes the company policy and the pattern of demand into account as to ensure a schedule that is feasible for the staff member while still meeting demand. It may also then be necessary to assign numerous tasks to a single shift which requires a certain staff skill set or level of seniority associated with a line of work. Finally, the staff members are assigned into individual lines of work, which is a module that often takes place during the construction of the work schedule.

6.7 Relevant Techniques

The fundamental techniques in relation to each other can be seen in Figure 3 below. It can be seen that simulation is the largest contributor and facilitates/encompasses three other techniques relevant to this project. Simulation will be performed on the platform provided by Simio simulation software which is discussed in Section 2 above.

Data analysis techniques such as trend analysis, chi squared goodness of fit tests, sensitivity analysis, generating relevant proportion and general data handling will be done using Microsoft Excel and RStudio software packages. This is a crucial technique which plays a role in the inputs needed for the simulation and existing schedules as well as the overall project management. The data was received in a very raw form and required much work to turn into valuable information that could be used. This was used by coding Microsoft Excel Visual Basic Macros, combining various formulas and pivot tables.

Data analysis will also take place in validating the base model of the simulation and further in conclusion of the project to assess the results and determine if any improvements have been made.

The data security had to be ensured through a law-related technique by the signing of a Non-Disclosure agreement and additional data encryption when the files were to be transferred. The scheduling and optimisation of the claim handling process will be done through simulation as a tool and decision support system which will be taken further into the implementation of the solution at a later stage.

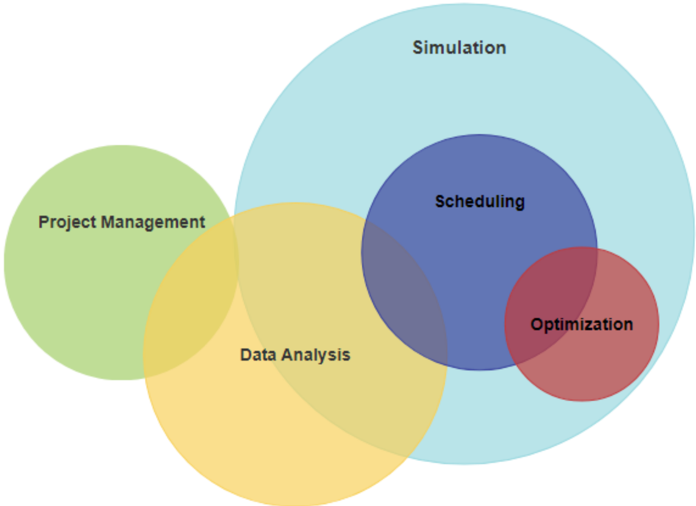


Figure 2: Industrial Engineering Techniques used in completion of this project.

Techniques acquired in information system design was utilised in the design of the relational data tables used in the model. Techniques include the use of entity relationship diagrams and BPMN charts used in mapping the flow of the process.

Project management skills are prevalent throughout the completion of the BPJ modules and include of the use of Gantt charts, budgets, relationship diagrams, skill matrices etc. Professional communications will form part of report writing and delivering presentations to both university staff and industry members. Conducting interviews with staff members and information sessions with industry partners also required this skill.

The motivation of the project can form part of productivity and industrial analysis when appropriate business trends were identified and applied to aid in the solving of this problem and the further benefit of the solution in staying relevant and competitive.

Much logical thinking and general engineering discretion was required in structuring the process that will be simulated and in deciding what factors to take into account and which to emit as to ensure a reasonable run time within an acceptable margin of accuracy.

7 Process

Santam currently manages its claim handling process on a system that assigns a status to the claim depending on where in the process it is. The main steps in the process is described in Figure 2 below.

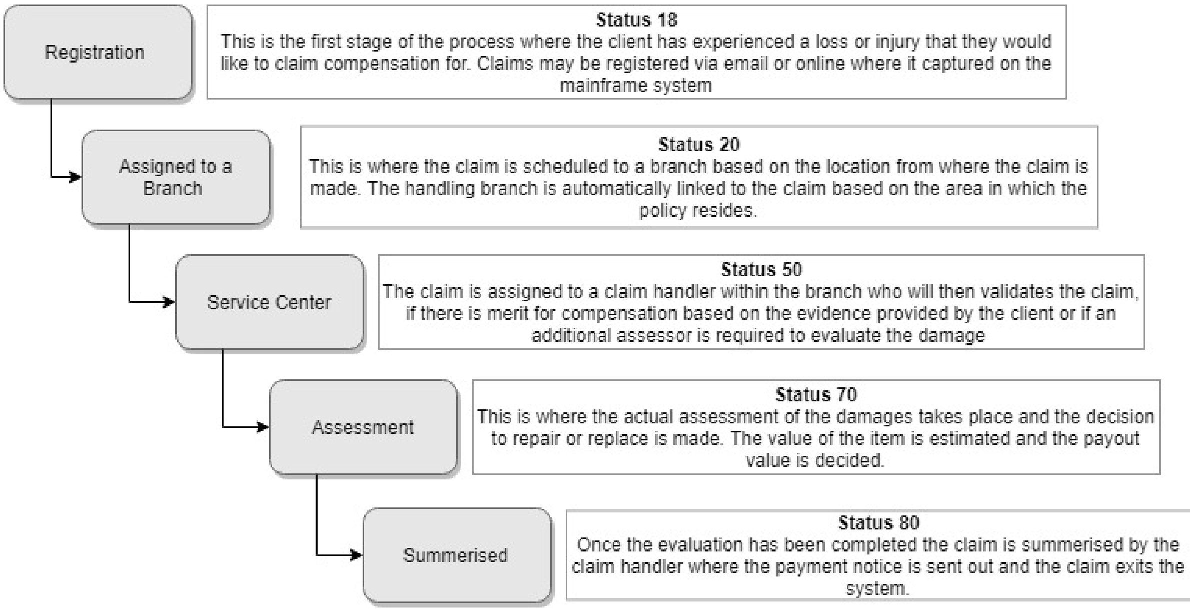


Figure 3: Waterfall diagram of the steps the claim follows through the system.

The focus of this project will be status 60 as this is where the manual scheduling takes place. The majority of the claims enter the system through a call centre (10% paper based claims are received via brokers), where an agent registers the claim and captures details such as policy numbers, date of incident, event description etc. and then directs the claim through to a service centre department that deals with the nature of the claim.

Once it is received by the service department the client is contacted and the claim is validated, this entails the quantification of the claim value and the merit for the claim. The claim can be re-segmented to another service department if it has not been correctly allocated or if there are items on a claim that require assistance from more than one departments, for example if a cars window was broken and the items inside the car were stolen, then the glass department and the general theft department is required.

The validated claims are then received by the scheduler from various service departments and manually allocates the queues to claim handlers once a day. The scheduler also performs a register of the claim handlers and notes how many claims have been untouched from the previous day, are currently outstanding for finalisation and how many are being carried over to the next day. In an interview conducted with one of the schedulers, Erasmus, (2018) it was made known that the claim allocation is based on their own discretion and simply tried to give every claim handler a ”good mix” of claim types. If an excess of claims are being carried over from the previous day, the scheduler is has the option to contract external assessors located throughout the country. The claim is then allocated to the claim handler who reviews the documentation and requirements of the claim. The claim is given a low priority when it is first received by the claim handler and gradually increases it priority the longer it is unattended to. Cash payments are made for replacement and reimbursement cases when the client has made use of their preferred service provider.

For scenarios that require repairment there might be a need for negotiation by the claim handler or an an assessor which then goes out to the location to determine if the claim amount is reasonable before any payment is made. The claim is then put on hold until the keep reason is satisfied and the claim can the proceed to be finalised. Keep reasons could include the waiting on documentation, assessor feedback, legal issues or the client being unavailable Each keep reason has a specified waiting period as specified by company policy before the claim is withdrawn, in which case the client is notified and the claim must the be reopened and place in status 50 again to be rescheduled.

Working hours are on week days from 8:00 to 16:30, however claim handlers in status 70 can choose to work over time and on weekends to clear up their queues and call centre agents are also available on weekend for claim registration but schedulers in status 60 are not active on weekends.

8 Data Analysis

8.1 Assumptions and Notes

A data set containing 23 weeks worth of data was made available for processing. This was the highest level of mainframe data that included data from all the service branches, processing scenarios, type and handlers available to the department. Naturally assumptions and substantial processing was required in order to get the data relevant to the scope of this project.

- The data set contains minimal/no effects of seasonality and trend which could be observed within the 23 week time frame.
- The claim handlers ID's that have a record of 115 claims allocated to them within the time frame are considered to have part time handler duties, form part of another Santam department or are subject to data integrity consequences (not logging into the system, working on another ID etc.) and will not be regarded in the simulation model.
- In order for the turnaround time to be calculated within working hours the assumption is made that claims started overtime on the day will be counted at 8:00 the next day, and claims finished overtime will be counted at 16:30 the same day.
- Claims started over a weekend will be counted on the Monday and claims finished on the weekend will be counted on the Friday. These assumptions only hold in the calculated on the turnaround time, the arrivals of the claims are modelled as they are.
- Claims directly allocated to handlers do not effect the scheduling improvements which are being aimed to be made, they act as a constant added to the system which will mot be affected by the scheduling and will not be modelled in order to simplify the model.

All claims have been discussed and approved by industry members.

It is important to note that all the data sets displayed within this report have been altered with constant value in order to maintain the confidentiality of the client but still to display the trend/effect of the situation being addressed.

8.2 Data tables

Similar to the data tables used in Microsoft Access databases, Simio Simulation makes use of relational tables to relate and connect data tables which are then referenced by objects and processes in the model. The tables used in this project will be used to store properties associated with claim handlers, claim types and registered claims. Routing logic is also defined for claims going through re-segmentation, reopening or normal straight through assessment.

The relationships between the property data tables are represented in the entity relationship diagram below, created using Lucidchart: Online Diagram Software. Due to confidentiality restrictions the actual data tables will not be shown.

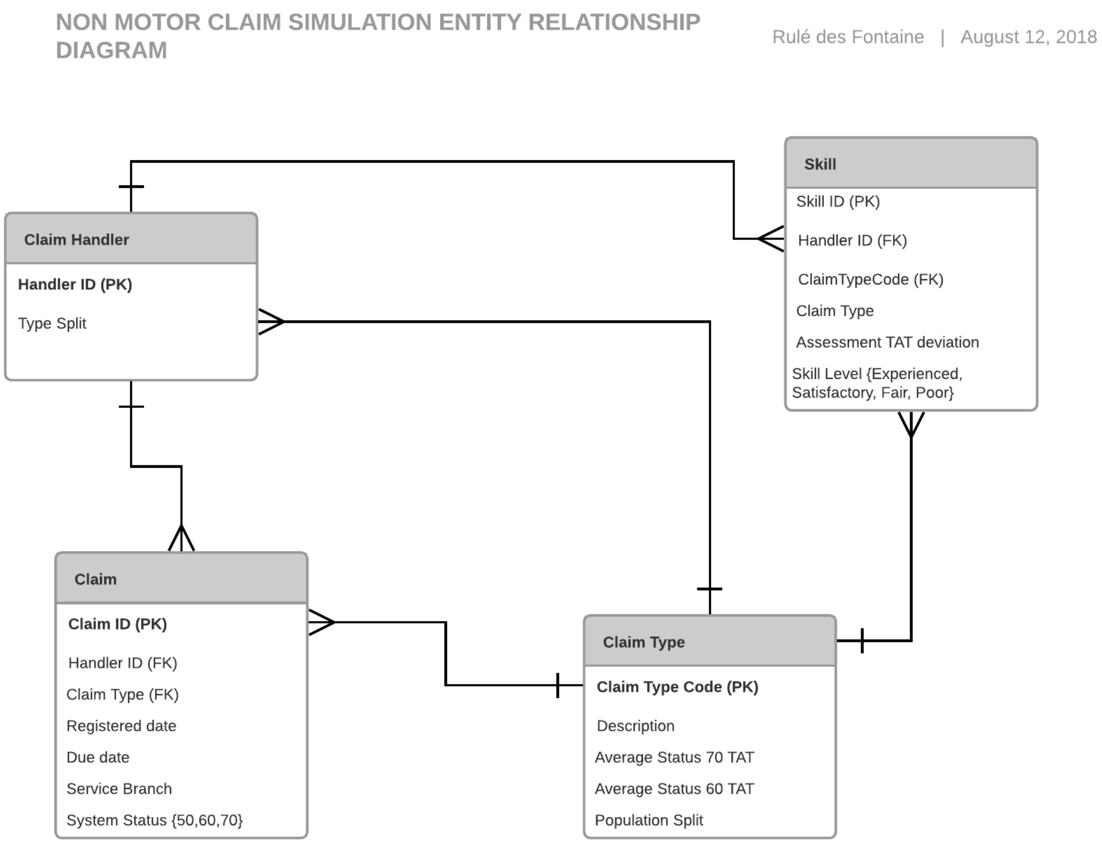


Figure 4: Entity relationship diagram for the relational tables used in the simulation model

An hourly arrival rate table was created to drive the creation of claim entities. It was noted that the arrivals of claims for different days of the week were substantial (Figure 5) and it was thus decided to further segment the arrivals to unique days. The model will therefore loop through a seven day hourly arrival until the simulation end date/time is reached. A segment of the arrival table can be found in Appendix E: Simio Simulation model.

A sharp dip in claim arrivals can be seen at 13:00 when lunch is taken and the most arrivals occurring in the morning between 8:00 and 9:00. As expected a much lower count is seen over the weekend followed by a higher count on a Monday.

8.3 Pareto Analysis

A claim may belong to one or more of 39 type categories depending on the nature of the incident. It was therefore decided to perform a Pareto analysis in order to identify the significant few claim types to be included in the model as to adequately simplify

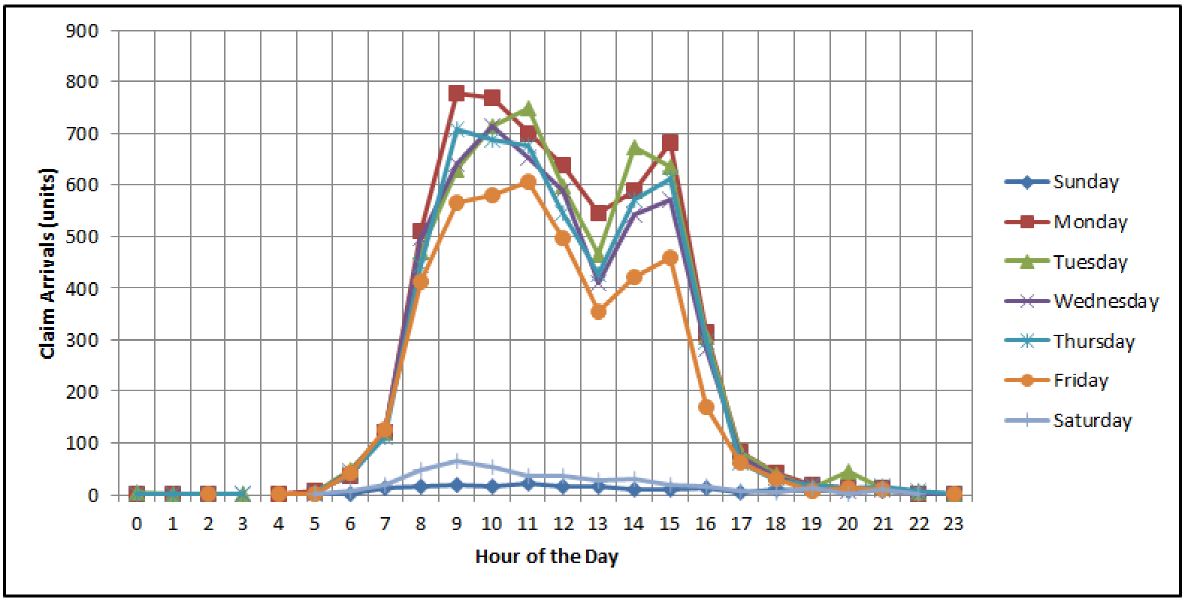


Figure 5: Hourly Arrival Rates per Day of the week

the model and decrease the run time (Processing time) by reducing the number of objects modelled in the simulation. The results of the analysis can be seen in Figure 6 below.

It can be seen that 82.32% of the total registered claims within this scope is accounted for by 4 type categories. However, upon consulting with industry managements it was agreed to include the following two categories in the model as they also contribute a similar significant amount to the total. The model will therefore include claims belonging to types geyser, special peril, lightning, accidental loss, power surges and theft without force.

8.4 Distributions and Trends

The problem being addressed by this project can be seen in the distribution of claim types throughout the workforce, the number of claims allocated, the time in system of the claims and the total claim throughput of the system. The figures that follow contain the current distributions of these metrics and the desired outcome achieved through the implementation of an improved scheduling.

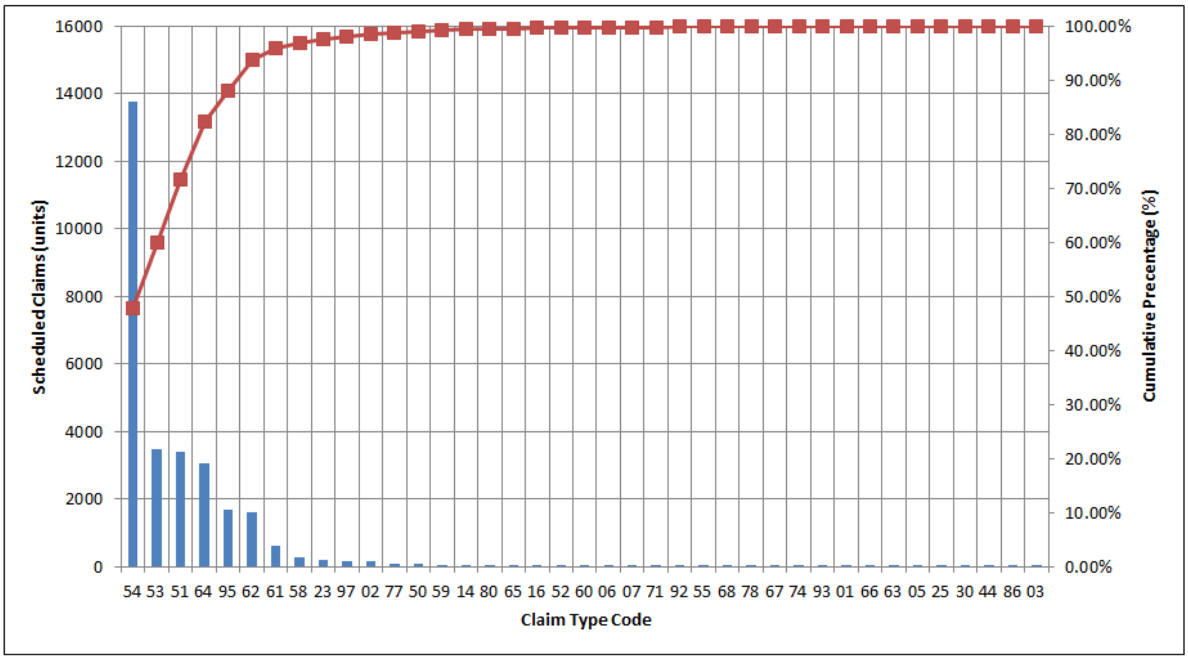
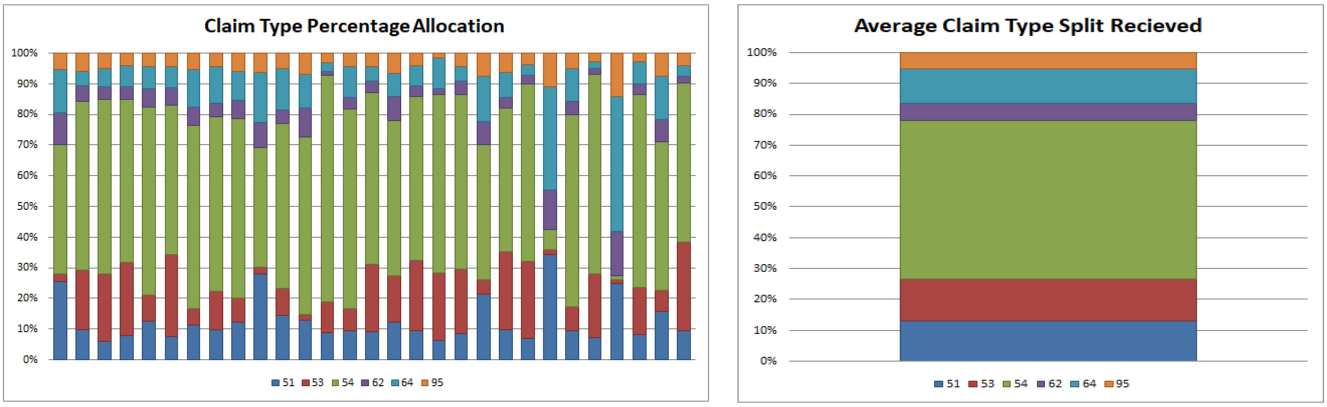


Figure 6: Pareto analysis result graph

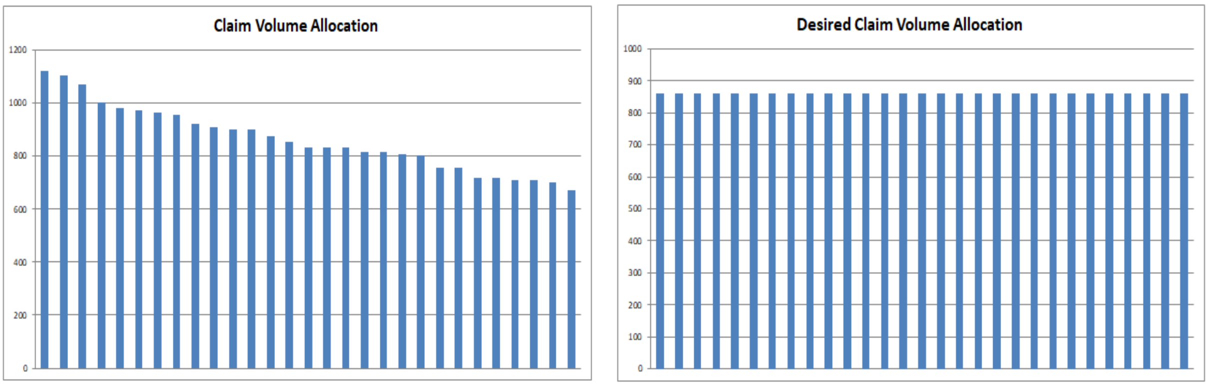


(a) (b)

Figure 7: A set of two subfigures: (a) Current claim type distribution as a percentage of total claims received; (b) Desired claim type distribution as a percentage of total claims received, for each claim handler

It can be seen that there is quite an uneven distribution of claim types among handlers, especially for claim type code 53 and 62. The company would like to achieve a more balanced distribution which will additionally aid in the movement to multi-skill the handlers in the assessment of various claim types. The desired balance was derived from the claim split received which, if carried over into the split allocated to handlers will result in the overall system balanced in the same proportions. This split however should only be allocated once the multi-skill program has reached maturity as the current experience among the handlers are rather wide when dealing with the different types of claims.

Considering volume distribution, it is clear that some handlers have been allocated much more claims than others. The consequence was noted in practise with a large work in progress counts and unrest among employees claiming that some handlers work harder than others.



(a) (b)

Figure 8: A set of two subfigures: (a) Current spread of claim volume among handlers for a 23 week period; and (b) Desired ideal spread of claim volumes for a 23 week period

It is important to note that the desired spread is only feasible if the split describe above is also implemented. Different types of claims require different processing times which will once again imbalance the number of claims summerised per handler.

8.5 Turnaround time

The turnaround time within each status was calculated from the date and time created/finalised, which is logged whenever a claim moves from one status to another. The time stamps were firstly converted into seconds past midnight, which was then adjusted to account for time stamps occurring outside working hours (8:00-16:30) as to find the time spent within the available processing time. The dates were converted to days of the week and adjusted for the overtime occurring over a weekend, which is also not considered working hours as per company policy.

The actual calculations were done using a coded Microsoft Excel Visual Basic Macro, this was the most efficient methode considering the repetitive nature of the calculation on a large volume of rows. The macro can be found in Appendix B: Data Analysis. This was then segmented into claim types and analysed in RStudio (Figure 9)

The turnaround time represents the time spent in a status, this however is not a good representation of the actual contact time a handler spent on the claim as this includes the time waiting for documents, responses and other such activities; in which case the handler would have moved onto a new claim in the meantime. This processing time was determined through the performance of time studies, in which the average contact time was found. It was then decided to used a triangular distribution to account for the less likely by still present minimum and maximum processing times of 5 and 75 minutes respectively. Confidentiality adjusted samples of the time studies can be found in Appendix D: Time Study.

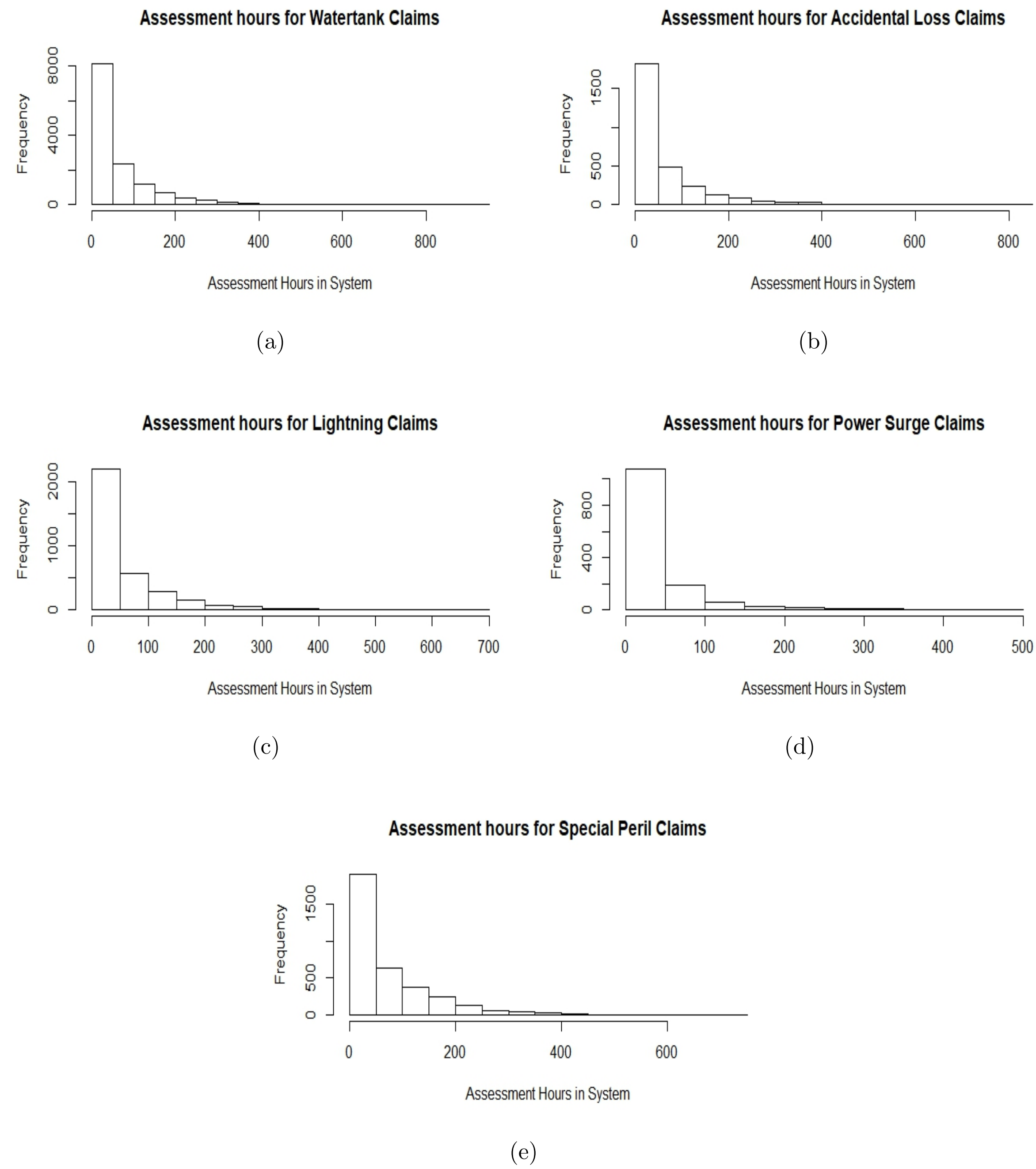


Figure 9: A set of five subfigures: (a) Distribution of the Assessment hours for Watertank claims; (b) Distribution of the Assessment hours for Accidental loss claims; (c) Distribution of the Assessment hours for Lightning claims; (d) Distribution of the Assessment hours for Power Surge claims; and, (e) Distribution of the Assessment hours for Special Peril claims.

All status 70 assessment times follow an exponential distribution and the results of the chi-squared goodness of fit test can be found in Appendix B: Data Analysis.

9 Solution

9.1 Base Model

The base model was built on the Simio simulation platform, basing its processes logic defined in the flowchart found in Figure 10 below. This was transferred onto the the model interface where logic was built in forms of processes, functions and object selection (Appendix E: Simio Simulation Model).

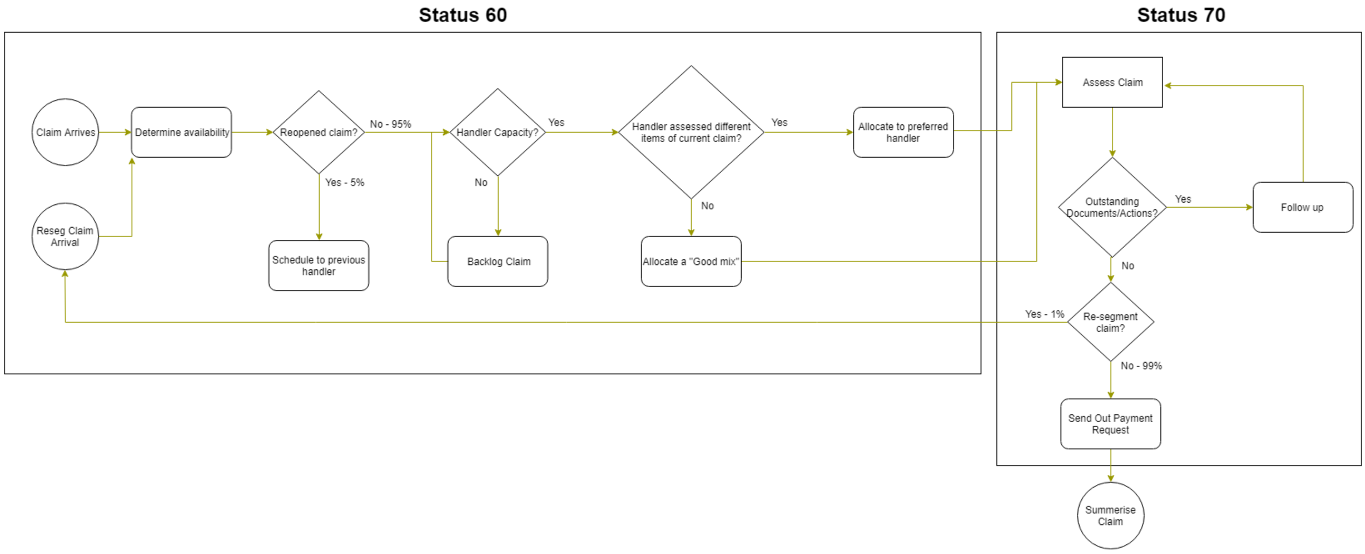


Figure 10: Base case simulation logic

9.1.1 Source

Status 60 is initialised by the arrival of a validated claim from a service branch, this will act as the source in the model which is driven by the rate table(Appendix E: Simio Simulation model). The source will be active 24 hours a day, 7 days a week as this is when status 50 is active. The model makes use of a single entity representing the claim which can take on one of six symbols, depending on the type of claim it represents. This is done by initialising a process on the OnCreate event of the source which allocates the symbols according to the claim type proportions derived from the data.

9.1.2 Reopened and Re-segmented claims

The scheduling of the claims start by performing a register of sorts which determines the available handlers as well as the handlers who plan on going on leave - they will not be available to receive new claims as they are allocated 3 days prior to empty their claim queue. The availability of the handler is modelled within the server object which has made provision for occurrences such as breakdowns, failures and leave. The operating times of the handlers was achieved by linking the server to a work schedule

- an system function of Simio in which the working hours of the business are specified and the processing of the server is suspended outside of this time frame.

The claim is then checked whether is has been reopened. Reopened claims are scheduled the claim handler who was responsible for it when it was summerised or closed. This will be achieved by a string variable that is updated with the handler ID once it enter a server to be scheduled; and a boolean variable that is set true after assessment based on the proportion of claims that have been reopened in the past. If the boolean variable is set true, the preferred handler will be set to the last handler ID updated in the string variable.

Similarly, the re-segmented claims are routed back to scheduling after assessment based on a proportion found in the data set provided. The routing logic is for these two cases are achieved by adding the proportions to the Weighted Selection property of the paths, which will route the entity accordingly.

9.1.3 "Good mix" Logic

The approach that was taken in this part of the logic was to try and capture the behaviour of the scheduler as accurately as possible to manipulate the input data described above based on the decisions the handler makes to produce the results found in the historical data. That way validation will take place with the proportions found in the data and not drive the processing logic with the outputs that are being worked towards. This approach will also highlight the areas of the scheduler logic that need attention and is the best way to represent reality.

Since the logic is heavily based on the number of claims and acknowledgement of the claim type (not necessarily the impact of the type), each server will be assigned count variables for each type of claim in its buffer and the total number of claims it has assessed within the week. These values are stored in a data table for their respective claim handlers.

A process is triggered which firstly checks whether the claim is re-segmented/reopened, and schedules them to the preferred handler. The logic considers the claims waiting in the schedulers input buffer and assigned a predetermined batch size ranging from 1 (for handlers with high counts) to 10 (for handlers with low counts). A claim is then randomly assigned to a handler until its batch size has been reached. Once assigned to a handler, the claim count increases, the priority is set to low and increased the longer it remains unattended to and the system time created is assigned to the Created property of the claim entity.

The remaining high priority claims are scheduled to external handlers if the capacity of the system is exceeded. Values in data tables are located and updated using search and assign function blocks and the destination node of the entity is set with the SetNode function block once the claim has been assigned to the handler and exits status 60.

9.1.4 Handler Processing

All the processing steps performed in status 70 take place within the claim handler server. The contact processing time is modelled with a triangular distribution and the entity remains in the handlers output buffer for the remaining turnaround time modelled by the exponential distributions found in Section 9 above. Counters and variables are updated before the reroute transfer node (reopen/re-segment decision is made) is reached once it exits the server output buffer.

The claim then enters the sink which represents the start of status 80 where the claim is finalised and summerised.

9.1.5 Tallies

Tallies form a crucial role in the accumulation of results throughout the run of the simulation. These are points in the simulation that are used to note elements such as duration and counts of entities that will provide useful information to the user.

9.1.6 External handlers

Management currently allows a percentage of the total claims received to be scheduled to external handlers on a daily basis, regardless of the policy to schedule 9 claims per available handler. This has shown to be very costly and the result of adhering to the 9 claim policy on the number of external handlers required is explored in the experiments.

10 Suggested Solution

10.1 Balanced Proportion Allocations

The conceptual design suggested in the preliminary report of this project will be extended to include the idea of a balanced claim distribution in both type and volume. This was done to address the scenario that might arise when employees start intentionally working slower to avoid additional claims being assigned to them if only handlers who have empty queues are allocated claims while the others appear to be fully utilised when the productivity of the system decreases with lower output realisations.

The scheduling will consider not just the volume of claims received in a day but also the claim type split and thereafter aim to allocate the claims in the same proportion. The counters allocated to respective handlers will be used to keep track of how many claims of the particular type have been allocated and finalised. If an imbalance occurs then the scheduler should calculate the proportion of the current claims type in its available buffer, trigger a process that searches an object list for the claim to the handler that has the lowest number of that claim type within their system and allocate the claim to the respective claim handler.

The processes, node lists and states used to model this scheduling logic can be found in Appendix E.

10.2 Minimum Claim Allocations

The scheduling logic to allocate the next claim to the handler with the least number of claims in their individual systems - regardless of the claim type, was considered a worthwhile experiment due to its simplicity and potential to improve the current "good mix" logic. This is also a solution that could be implemented without the need for additional software infrastructure in the work place and extensive simulation knowledge by the user.

This logic was modelled using the routing logic already embedded in the transfer node "Outbound Link Rule", as seen in Figure 11. The selection expression searches for associated servers, evaluates their current load and returns the input node to the server that will minimize that expression. The claim is then sent off and leaves status 60.

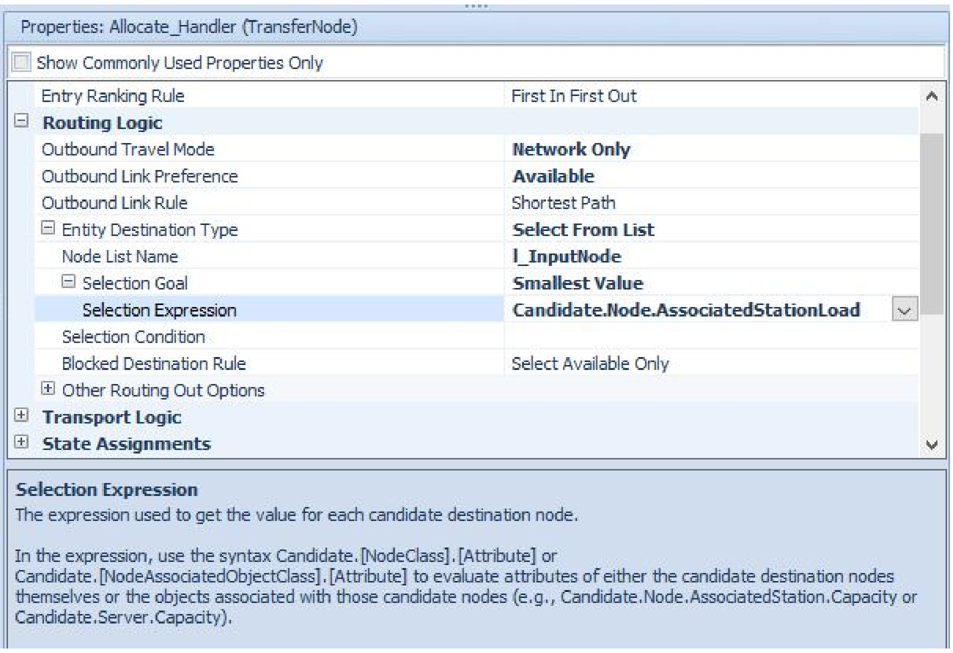


Figure 11: Node Properties forming the foundation of this simulation logic

Both approaches will allocate to the external handlers based on the internal systems planned capacity of 9 daily allocations per handler and the remaining claims in the schedulers buffer is then allocated to the external handlers. The two logic alternatives have been modelled as experiments alongside the validated base case.

11 Validation

11.1 Metrics

Due to the actual contact time per handler not being recorded in practice, the validation metric has been changed from handler utilisation to the average time in system and claim throughput. The motivation is be that through achieving a more balanced system through an improved scheduling system the the time in process and work in process will decrease allowing for an increased throughput. These are the same outputs that were aimed at being measured with utilisation as the model metric.

The turnaround time distributions per claim type as determined from the given data set can be seen in Section 8 above. The weekly average claim throughput found in Table 1 below will also form part of the validation process

Table 1: Validation Metrics

	Accident	**Lightning**	**Power**	**Special Peril**	**Theft**	**Geyser**	**Avg.**
Turnaround time (hours)	61.71	57.83	39.60	77.64	72.56	64.46	62.30
Throughput (week)	123	146	60	151	62	576	187

The metrics were obtained by the model tokens triggering a write out process to an Excel .CSV file which was further manipulated once all 30 experiment runs were completed. These write outs were cross referenced by the values found in the Simio generated results pivot table (Appendix E).

Files containing properties belonging to the scheduler server, the claim model entity and claim handler servers were generated to record the validation metrics for both the base model and the suggested solutions. The results of the base case simulation in relation to the actual results are shown in Table 2 and Table 3 below.

Table 2: Average time in system (hours) for the base case simulation runs.

	Claim Type						
Run no.	**Accident**	**Lightning**	**Power**	**SpecialPeril**	**Theft**	**Geyser**	**Total**
1	62	58	51	77	73	65	64
2	58	54	45	75	68	59	60
3	56	52	39	70	62	57	56
4	64	56	46	77	70	63	63
5	72	67	58	86	80	72	73
6	68	66	56	85	78	70	71
7	63	58	52	79	73	64	65
8	62	60	49	79	74	63	65
9	52	49	39	65	63	52	53
10	53	49	40	64	63	54	54
11	65	60	51	84	78	67	68
12	65	61	52	79	76	66	67
13	62	58	47	78	70	62	63
14	63	61	48	80	74	66	65
15	66	61	55	82	76	68	68
16	57	55	41	73	64	59	58
17	66	60	54	79	75	67	67
18	58	53	43	72	65	59	58
19	59	55	47	75	72	61	62
20	66	59	52	78	75	66	66
21	57	54	47	73	68	60	60
22	68	62	55	82	79	69	69
23	59	57	44	75	67	61	61
24	63	58	53	78	75	63	65
25	61	58	50	78	71	65	64
26	69	64	55	82	77	70	69
27	57	53	41	69	67	57	57
28	67	63	55	83	73	66	68
29	60	58	48	77	74	63	63
30	69	64	55	82	77	70	69
Average	62	58	49	77	72	63	**64**
Actual	62	58	40	78	73	64	**62**
%Diff	-1%	-1%	-24%	1%	1%	2%	-2%

Table 3: Claim counts entering and leaving the system (throughput) for the base case simulation runs.

Run no	**Claims Entered (Status 60)**	**Claims Finalised (Status 70)**
1	27122	26808
2	27111	26796
3	26634	26192
4	26920	26449
5	26643	26226
6	27064	26580
7	27033	26626
8	27005	26698
9	26841	26522
10	27036	26619
11	26711	26201
12	26986	26524
13	27109	26770
14	26718	26280
15	27126	26780
16	27005	26659
17	26912	26554
18	27124	26825
19	26838	26485
20	27147	26762
21	26836	26405
22	26803	26471
23	26626	26082
24	27119	26749
25	27123	26765
26	26863	26502
27	26912	26473
28	27042	26584
29	26844	26431
30	26626	26082
Average	26929	26530
Actual	26959	25876
%Diff	0.110%	-2.53%

The outcomes for the base mode are within a 5% deviation of the original data and therefore adequately satisfy the confidence interval. The model can therefore be used as a base for the suggested solutions.

11.2 Volume stress test

Before using the model in practice, it is company policy for the model to undergo a volume stress test. This is a form of sensitivity analysis in which the arrival rates will be doubled and the behaviour of the model is observed. This verifies whether the model will operate within an acceptable certainty should there be a period of increased claim arrivals (fire and holiday seasons etc.) or if a catastrophe takes place.

Simio simulation has a built in sensitivity analysis function which is set up during the design phase of the experiment. Independent variable are defined, number of replications are specified and the responses are tabulated in the results sheet. An example of this can be seen in Appendix E: Simio Simulation Model.

Independent variables of this simulation include :

- Reopen proportion
- Re-segment proportion
- Arrival rate adjustment factor (stress test)
- Claim Splits

The volume stress test will be done by managers who have access to the historical catastrophe data that this scope does not include.

12 Results

Each suggested solution has been modeled as an experiment of which thirty replications were run fora period of 23 weeks(1 January - 10 June). The full table of results for both scenarios can be found in Appendix F and the averaged metrics are summarised below.

12.0.1 Time in System

It can be seen that all suggested scenarios have a turnaround time that is longer than the scheduling logic. This is as a result of the increased throughput contributed by the decision to allocate the policy amount of claims to the internal system as opposed to the external handlers.

Table 4: Summary of the turnaround time results.

Scenario	Accident	Lightning	Power	SpecialPeril	Theft	Geyser	Avg
Equal Mix	73.31	69.87	59.97	88.52	83.54	74.48	74.95
Min Claims	74.11	69.69	60.00	88.50	83.82	74.95	75.18
Base	62.25	58.13	49.02	77.19	71.91	63.44	63.66
Actual	61.71	57.83	39.60	77.64	72.56	64.46	62.30

The Equal Mix experiment has a lower average turnaround time. This however is only marginally with respect to the Min Claims experiment which seems to portray a more irregular behaviour from the Figure 12 below.

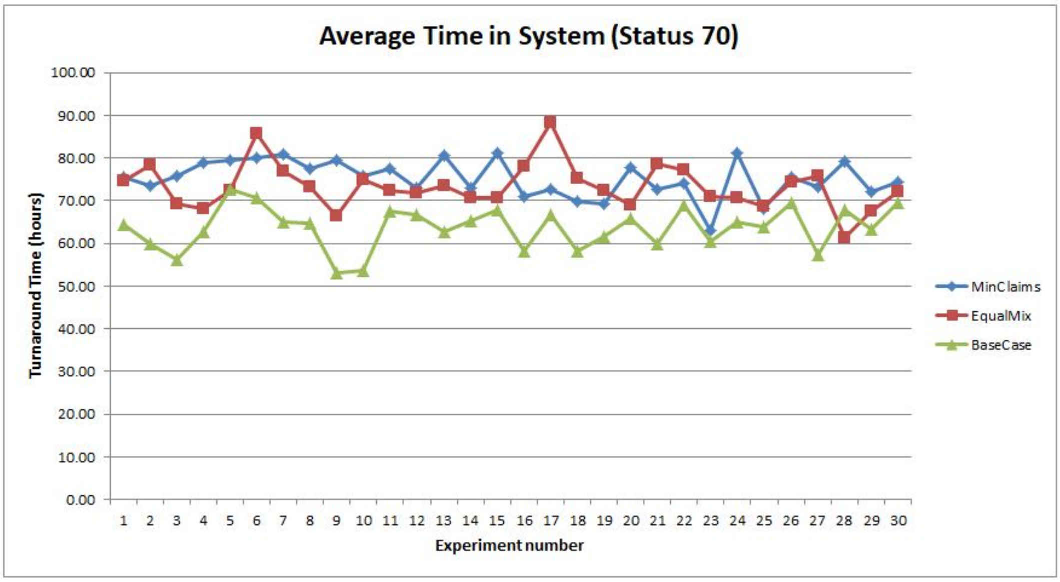


Figure 12: Average time a claim spent in status 70 for each scenario

Furthermore, the suggested solutions should not be judged on the turnaround time alone but rather in combination with throughput results before making a final decision.

12.0.2 Throughput

There is a massive increase in throughput when the experiments are run. As previously mentioned, this is contributed by the external routing policy. The experiments show that the company can greatly decrease or completely eliminate the need for external assessors. A trade off however needs to be made on the finances saved by using the internal capacity in the relation to the impact of the increased turnaround time on the companies customer service policy.

Table 5: Summary of the claim throughput results.

	Created	**Finalised**	**Resegmented**	**External**
Equal Mix	26964	26486	277	13
Min Claims	26907	26390	282	0
Base	26929	25530	274	1633
Actual	26959	25876	311	1618

The Equal Mix experiment showed the highest return on throughput and a very occasional use of external handlers, the alternate method completely eliminates the need but provides a lower throughput of finalised claims.

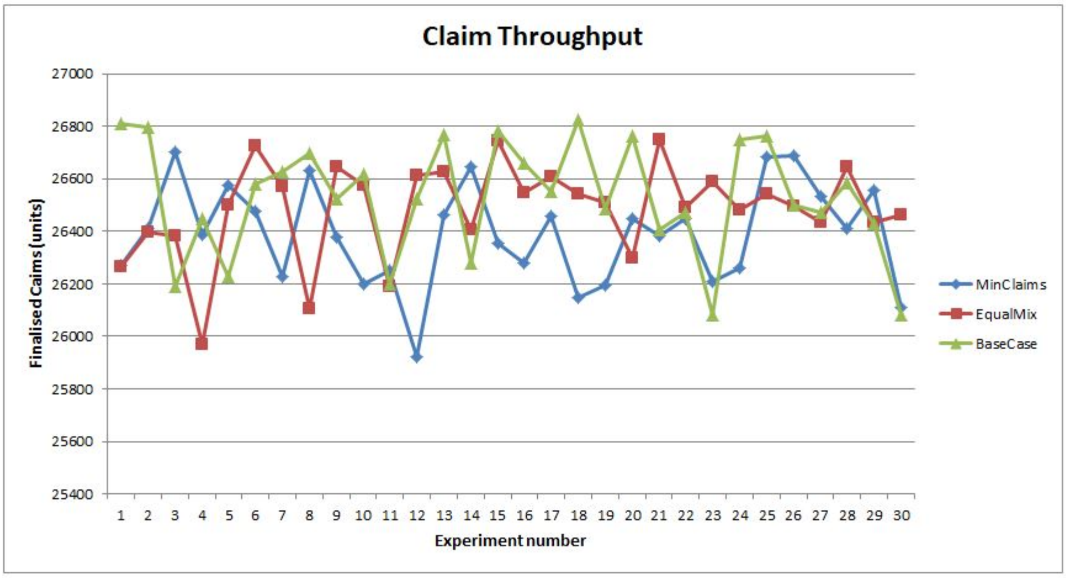
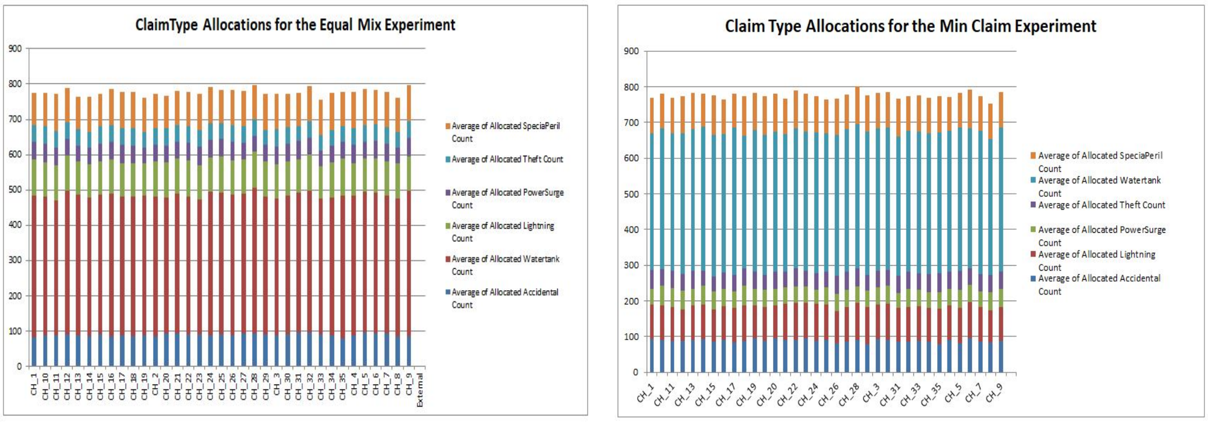


Figure 13: Number of finalised claims at the end of the 23 week period for each scenario

12.0.3 System Balance

By adjusting the scheduling logic a large improvement in system balance could be achieved. Figure 14 shows the distribution of claim types to the internal handlers.



(a) (b)

Figure 14: A set of two subfigures: (a) Equal Mix experiment claim type allocations and (b) Min Claim experiment claim type allocations

A more balanced system will improve the perception of favour within the work force and optimise the use of the available claim handling capacity.

13 Recommendations

It is highly recommended that if the company chooses to implement the suggested solution of this project, it is it done together with a change management program and a workshop for all levels of employees on simulation and how it is used to impact the working environment. This is to ensure that the handlers at the other end of the model and specifically the scheduler is aware of the changes taking place and how to effectively utilise the proposed methods of scheduling.

Manager should also be aware of the handlers motivation and monitor their behaviour towards the new scheduling procedure in order to take action against cheating behaviour and an intentional decreased working pace.

It would also be suggested that the department improves their data collection policy and run the model with data of a higher integrity so that the scope could be increased to include all the claim handlers.

The aim and core competencies if the business should be revisited before making a final decision on the outcomes of this project. Trade-offs in customer service, cost efficiency, system capacity and risk tolerances need to be evaluated again. The companies commitment to training and development also plays a large role, as additional training and knowledge is required if improvements are to be seen. Although the suggested solutions did not result in major improvements, exploring the use of simulation is still encouraged as it is a powerful decision making tool and the base case model could still be used for risk management throughout the workplace.

14 Conclusion

Santam would like to move towards an Industry 4.0 based platform - this is a change that will require time. This report and solution should be used to start conversations, change thinking and introduce new technologies into the company by showing the benefits that could be achieved. The Equal Mix suggested logic could provide a short term improvement as it does not require complex calculations to allocate the handler until such time that training and software are made available; and the continuation of steps being made to explore concepts and implementations of Industry 4.0 which will be crucial in the long term survival of the company.

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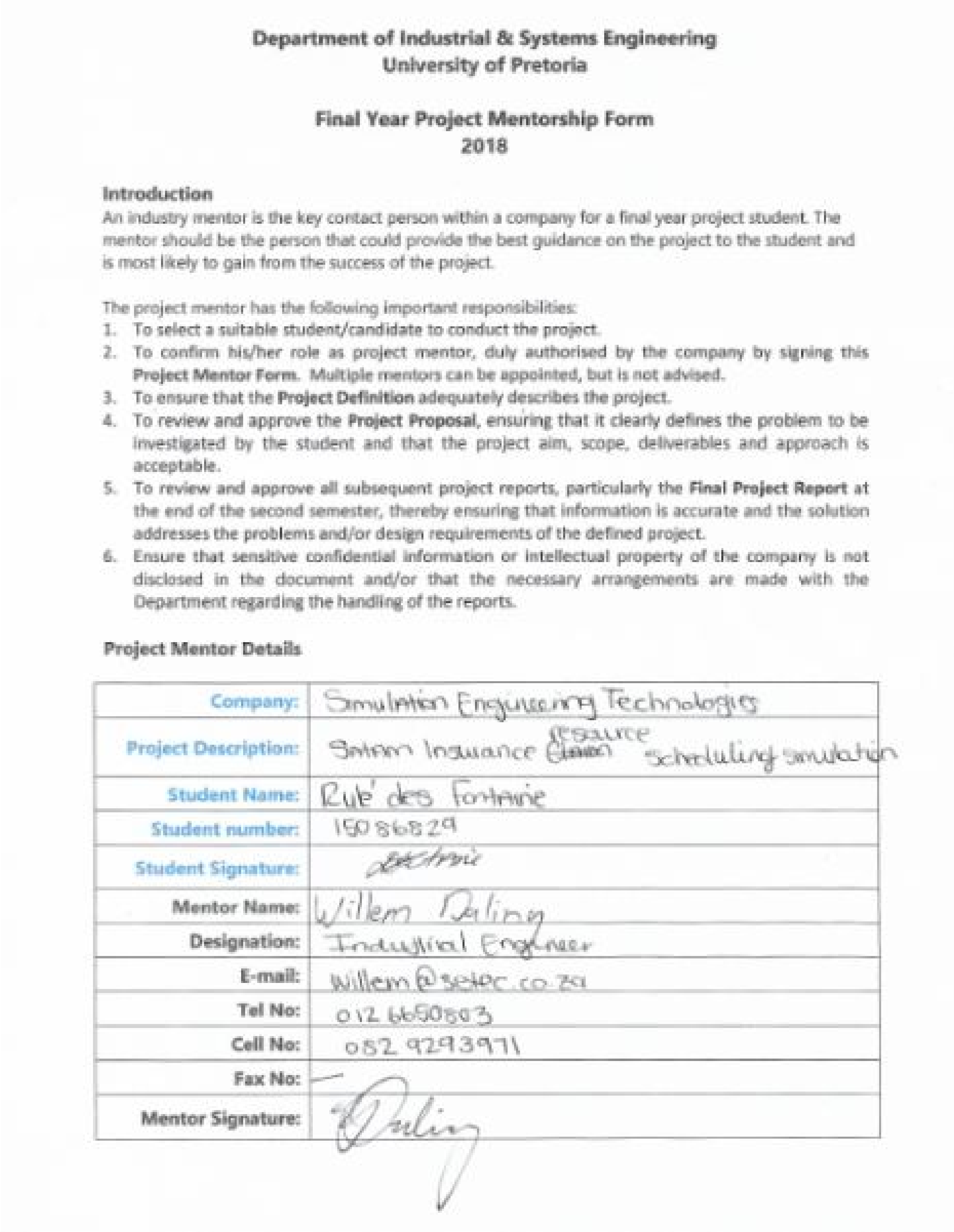
16 Appendices

16.1 Appendix A: Industry Sponsorship Form

form.JPG form.JPG



Department of Industrial & Systems Engineering
University of Pretoria

Final Year Project Mentorship Form
2018

Introduction

An industry mentor is the key contact person within a company for a final year project student. The mentor should be the person that could provide the best guidance on the project to the student and is most likely to gain from the success of the project.

The project mentor has the following important responsibilities:

1. To select a suitable student/candidate to conduct the project.
2. To confirm his/her role as project mentor, duly authorised by the company by signing this **Project Mentor Form.** Multiple mentors can be appointed, but is not advised.
3. To ensure that the **Project Definition** adequately describes the project.
4. To review and approve the **Project Proposal**, ensuring that it clearly defines the problem to be investigated by the student and that the project aim, scope, deliverables and approach is acceptable.
5. To review and approve all subsequent project reports, particularly the **Final Project Report** at the end of the second semester, thereby ensuring that information is accurate and the solution addresses the problems and/or design requirements of the defined project.
6. Ensure that sensitive confidential information or intellectual property of the company is not disclosed in the document and/or that the necessary arrangements are made with the Department regarding the handling of the reports.

Project Mentor Details

Company:	Simulation Engineering Technologies
Project Description:	Sanlam Insurance resource Scheduling simulation
Student Name:	Rulé des Fontaine
Student number:	15086829
Student Signature:	[signature]
Mentor Name:	Willem Daling
Designation:	Industrial Engineer
E-mail:	willem@setec.co.za
Tel No:	012 6650803
Cell No:	082 9293971
Fax No:	—
Mentor Signature:	[signature]

Figure 15: Industry Project Sponsorship form

16.2 Appendix B: Data Analysis

```r
##Watertanks -54
TypeTAT54 <- subset(Status70$TAT.hours., Status70$Type.Code == "54")

h3<- hist(TypeTAT54, breaks = 15, xlab = "Assessment Hours in System", main = "Assessment hours for Watertank Claims")

m54 <- mean(TypeTAT54)
n54 <- length(TypeTAT54)

#chi squared test
x <- subset(Status70, Status70$Type.Code == "54")
arrive <- diff(x$TAT.hours.)
arriveClean <- (subset(arrive, arrive >= 0))

arriveRate <- 1/mean(arriveClean)

arriveRate

null.probs <- diff(pexp(h3$breaks,arriveRate))
chisq.test(h3$counts, null.probs, rescale.p = TRUE, simulate.p.value = TRUE)

###########################
```

Figure 16: Chi-squared test for exponential distribution for Watertank claims

```r
mydata<- read.csv("Final.csv", header = T)

Status70 <- subset(mydata,mydata$Diary.Entry.Status.Code..DE. == "70" )

#####Lightning######

TypeTAT51 <- subset(Status70$TAT.hours., Status70$Type.Code == "51")

h1 <- hist(TypeTAT51, breaks = 15, xlab = "Assessment Hours in System", main = "Assessment hours for Lightning Claims")

m51 <- mean(TypeTAT51)
n51 <- length(TypeTAT51)

  #chi squared test
x <- subset(Status70, Status70$Type.Code == "51")
arrive <- diff(x$TAT.hours.)
arriveClean <- (subset(arrive, arrive >= 0))

arriveRate <- 1/mean(arriveClean)

arriveRate

null.probs <- diff(pexp(h1$breaks,arriveRate))
chisq.test(h1$counts, null.probs, rescale.p = TRUE, simulate.p.value = TRUE)
```

Figure 17: Chi-squared test for exponential distribution for Lightning claims

```r
##Power Surge - 95
TypeTAT95 <- subset(Status70$TAT.hours., Status70$Type.Code == "95")

h5<- hist(TypeTAT95, breaks = 15, xlab = "Assessment Hours in System", main = "Assessment hours for Power Surge Claims")

m95 <- mean(TypeTAT95)
n95 <- length(TypeTAT95)

#chi squared test
x <- subset(Status70, Status70$Type.Code == "95")
arrive <- diff(x$TAT.hours.)
arriveClean <- (subset(arrive, arrive >= 0))

arriveRate <- 1/mean(arriveClean)

arriveRate

null.probs <- diff(pexp(h5$breaks,arriveRate))
chisq.test(h5$counts, null.probs, rescale.p = TRUE, simulate.p.value = TRUE)

###########################
```

Figure 18: Chi-squared test for exponential distribution for Power Surge claims

```r
##Special Perils -53
TypeTAT53 <- subset(Status70$TAT.hours., Status70$Type.Code == "53")

h2 <- hist(TypeTAT53, breaks = 15, xlab = "Assessment Hours in System", main = "Assessment hours for Special Peril Claim

m53 <- mean(TypeTAT53)
n53 <- length(TypeTAT53)

#chi squared test
x <- subset(Status70, Status70$Type.Code == "53")
arrive <- diff(x$TAT.hours.)
arriveClean <- (subset(arrive, arrive >= 0))

arriveRate <- 1/mean(arriveClean)

arriveRate

null.probs <- diff(pexp(h2$breaks,arriveRate))
chisq.test(h2$counts, null.probs, rescale.p = TRUE, simulate.p.value = TRUE)

############################
```

Figure 19: Chi-squared test for exponential distribution for Special Peril claims

```r
###Accidental Loss -64
TypeTAT64 <- subset(Status70$TAT.hours., Status70$Type.Code == "64")

h4<- hist(TypeTAT64, breaks = 15, xlab = "Assessment Hours in System", main = "Assessment hours for Accidental Loss Clai

m64 <- mean(TypeTAT64)
n64 <- length(TypeTAT64)

#chi squared test
x <- subset(Status70, Status70$Type.Code == "64")
arrive <- diff(x$TAT.hours.)
arriveClean <- (subset(arrive, arrive >= 0))

arriveRate <- 1/mean(arriveClean)

arriveRate

null.probs <- diff(pexp(h4$breaks,arriveRate))
chisq.test(h4$counts, null.probs, rescale.p = TRUE, simulate.p.value = TRUE)

############################
```

Figure 20: Chi-squared test for exponential distribution for Accidental Loss claims

Table 6: Chi-squared goodness of fit test results for exponential distribution

	Lambda	X^2	**P-value**
Watertank	0.0139	304	1
Lightning	0.0168	140	1
Accidental Loss	0.0148	187	1
Special Perils	0.0118	195	1
Power surge	0.0245	90	1
Theft with Force	0.0137	198	1

16.3 Appendix C: Pareto Analysis

Table 7: Pareto analysis applied to claims accounted for by claim type codes

Type Code	Count of Claim ID	Cumulative %
54	13758	47.82%
53	3460	59.85%
51	3397	71.66%
64	3072	82.34%
95	1671	88.15%
62	1614	93.76%
61	615	95.89%
58	257	96.79%
23	205	97.50%
97	169	98.09%
02	149	98.61%
77	74	98.86%
50	69	99.10%
59	47	99.27%
14	32	99.38%
80	23	99.46%
65	23	99.54%
16	22	99.61%
52	21	99.69%
60	11	99.73%
06	10	99.76%
07	10	99.79%
71	9	99.83%
92	9	99.86%
55	8	99.89%
68	6	99.91%
78	5	99.92%
67	4	99.94%
74	4	99.95%
93	3	99.96%
01	2	99.97%
66	2	99.98%
63	1	99.98%
05	1	99.98%
25	1	99.99%
30	1	99.99%
44	1	99.99%
86	1	100.00%
03	1	100.00%

16.4 Appendix D: Time Study

301			
TIME STUDY ANALYSIS			
Process Step	**Unit time (minutes)**	**% Occurrence**	**Total Time (minutes)**
Check the cover on the schedule (should be uploaded against claim)	7.5	100%	7.5
Completing the Merit & Quantum report	22.5	100%	22.5
Check the Estimate/Re-Estimate	0.75	100%	0.75
Advice Broker of Settlement (e-mail) & confirm the account details	0.75	80%	0.6
Load the payment on BPM/JDE & Keep the claim (Await RSS Approval)	3	100%	3
Finalise the claim on BPM	3	100%	3
Negotiate with Broker	10.5	15%	1.575
Appoint contractor for a quote and damage assessment (E-mail & note on BPM) (Waiting for Docs)	3	15%	0.45
If not Cash payment is not accepted, load order for Santam contractor & Keep the claim (Await RSS Approval)	4.5	15%	0.675
If detail received, keep the claims for 2 days after the repair date ("Awaiting FRC") - not all assrs do this onwards	3	15%	0.45
Phone client to confirm that repairs are done	7.5	100%	7.5
			48

Figure 21: Adjusted time study result for the Geyser service branch

455			
TIME STUDY ANALYSIS			
Process Step	**Unit time (minutes)**	**% Occurrence**	**Total Time (minutes)**
Check the cover on the schedule (should be uploaded against claim)	7.5	100%	7.5
Completing the Merit & Quantum report	22.5	100%	22.5
Check the Estimate/Re-Estimate	0.75	100%	0.75
Advice Broker of Settlement (e-mail) & confirm the account details	0.75	85%	0.6375
Load the payment on BPM/JDE & Keep the claim (Await RSS Approval)	3	100%	3
Finalise the claim on BPM	3	100%	3
Negotiate with Broker	7.5	15%	1.125
Appoint contractor for a quote and damage assessment (E-mail & note on BPM) (Waiting for Docs)	3	15%	0.45
If not Cash payment is not accepted, load order for Santam contractor & Keep the claim (Await RSS Approval)	4.5	15%	0.675
If detail received, keep the claims for 2 days after the repair date ("Awaiting FRC") - not all assrs do this onwards	3	15%	0.45
Phone client to confirm that repairs are done	0	100%	0
			40.0875

Figure 22: Adjusted time study result for the General service branch

705			
TIME STUDY ANALYSIS			
Process Step	**Unit time (minutes)**	**% Occurrence**	**Total Time (minutes)**
Check the cover on the schedule (should be uploaded against claim)	7.5	100%	7.5
Completing the Merit & Quantum report	22.5	100%	22.5
Check the Estimate/Re-Estimate	0.75	100%	0.75
Advice Broker of Settlement (e-mail) & confirm the account details	0.75	70%	0.525
Load the payment on BPM/JDE & Keep the claim (Await RSS Approval)	3	100%	3
Finalise the claim on BPM	3	100%	3
Negotiate with Broker	15	15%	2.25
Appoint contractor for a quote and damage assessment (E-mail & note on BPM) (Waiting for Docs)	3	15%	0.45
If not Cash payment is not accepted, load order for Santam contractor & Keep the claim (Await RSS Approval)	4.5	15%	0.675
If detail received, keep the claims for 2 days after the repair date ("Awaiting FRC") - not all assrs do this onwards	3	15%	0.45
Phone client to confirm that repairs are done	15	100%	15
			56.1

Figure 23: Adjusted time study result for the Building service branch

16.5 Appendix E : Simio Simulation Model

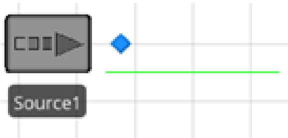
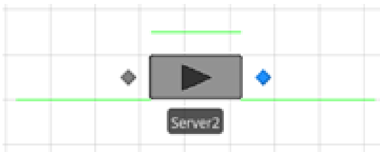
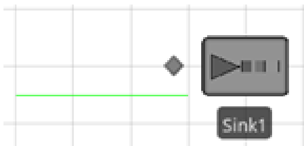
Simio Object name	Object Symbol	Description
Source		Creates entities that arrive in the system.
Server		Models a multi-channel service process
Path		A pathway between two Nodes where entities are based on speed.
Basic Node		A simple intersection of Links.
Transfer Node		An intersection where entities set destination and wait on Transporters.
Sink		Destroys entities and record statistics.

Figure 24: Objects used in the Simulation model

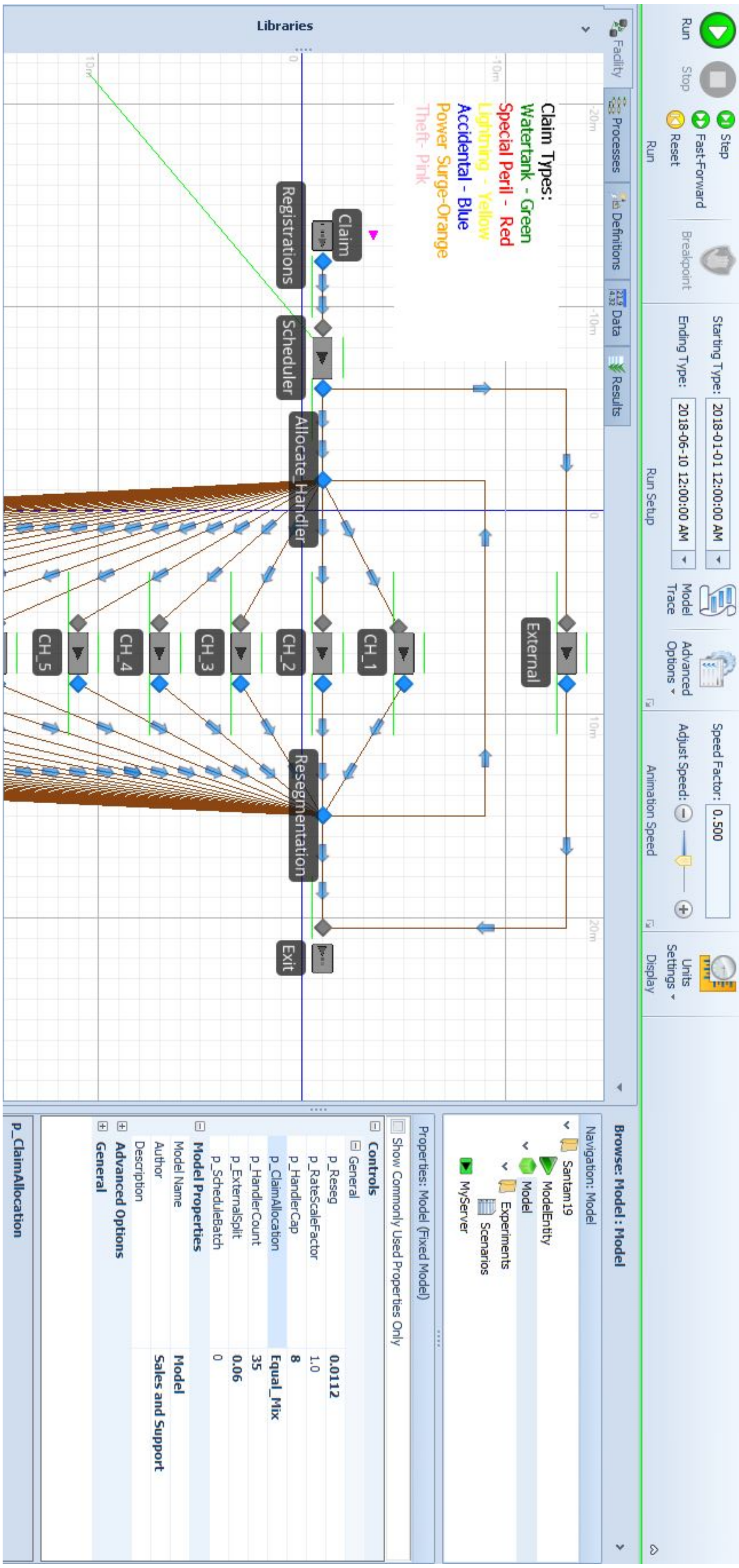
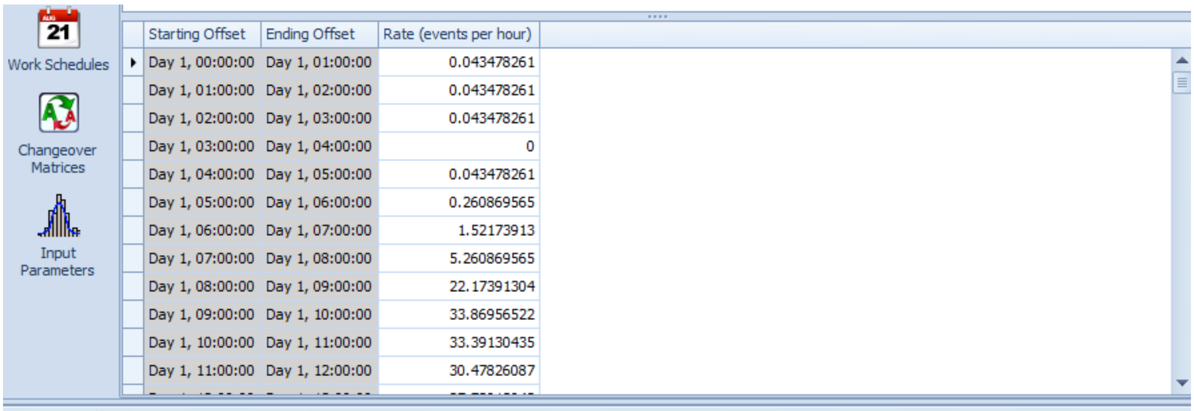


Figure 25: Model Interface



Starting Offset	Ending Offset	Rate (events per hour)
Day 1, 00:00:00	Day 1, 01:00:00	0.043478261
Day 1, 01:00:00	Day 1, 02:00:00	0.043478261
Day 1, 02:00:00	Day 1, 03:00:00	0.043478261
Day 1, 03:00:00	Day 1, 04:00:00	0
Day 1, 04:00:00	Day 1, 05:00:00	0.043478261
Day 1, 05:00:00	Day 1, 06:00:00	0.260869565
Day 1, 06:00:00	Day 1, 07:00:00	1.52173913
Day 1, 07:00:00	Day 1, 08:00:00	5.260869565
Day 1, 08:00:00	Day 1, 09:00:00	22.17391304
Day 1, 09:00:00	Day 1, 10:00:00	33.86956522
Day 1, 10:00:00	Day 1, 11:00:00	33.39130435
Day 1, 11:00:00	Day 1, 12:00:00	30.47826087

Figure 26: Hourly Arrival Rate Table

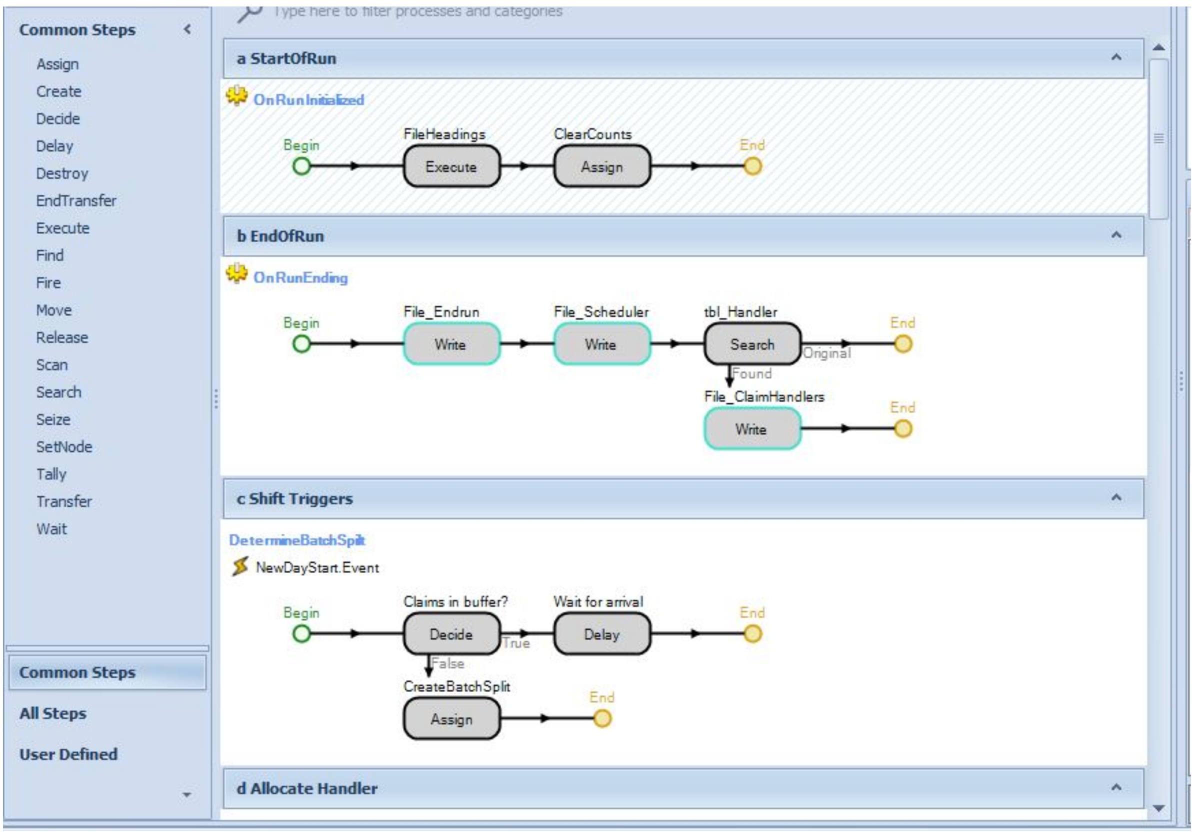


Figure 27: Processes used to write out statistic and check internal capacity

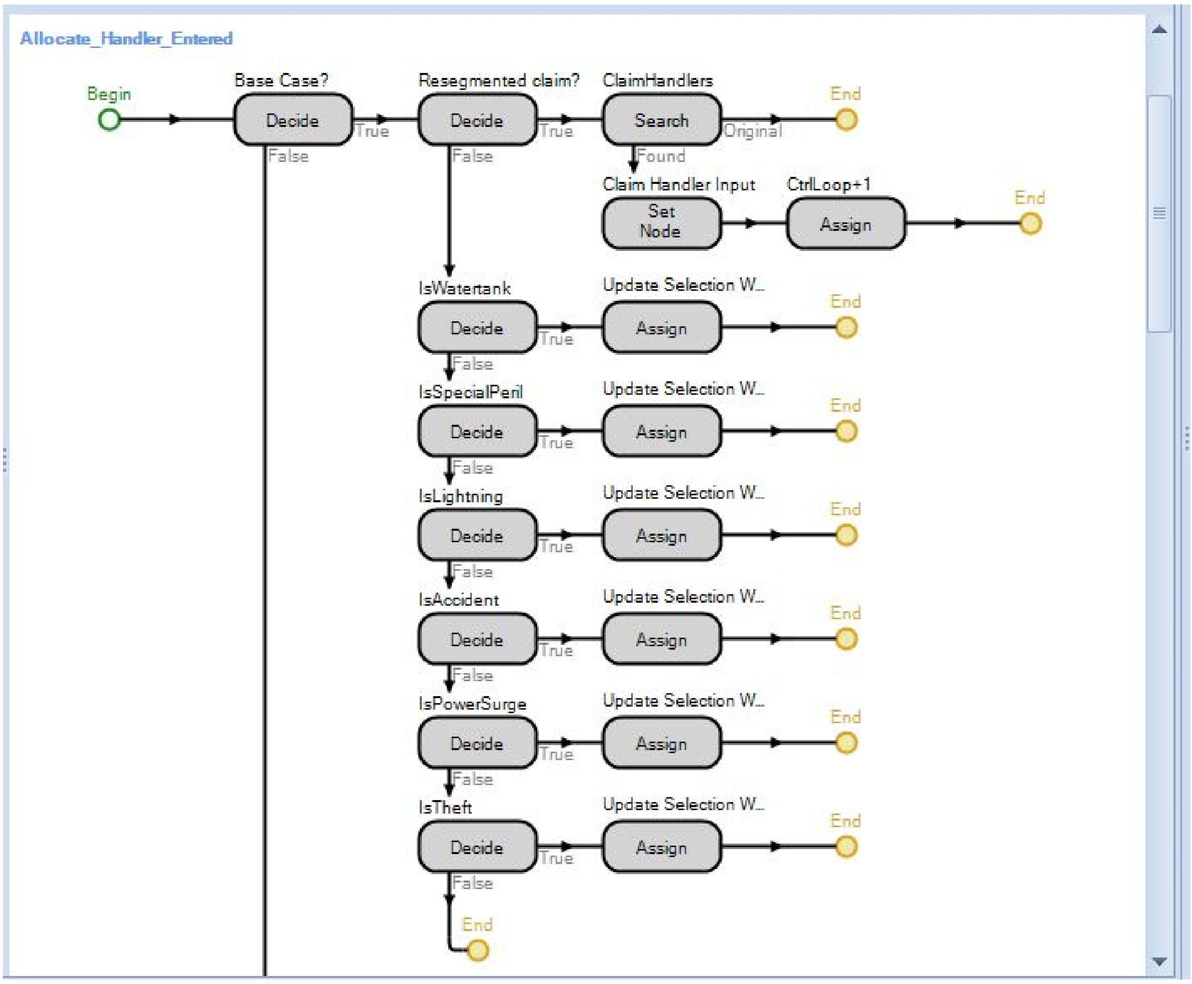


Figure 28: Main base case allocation process.

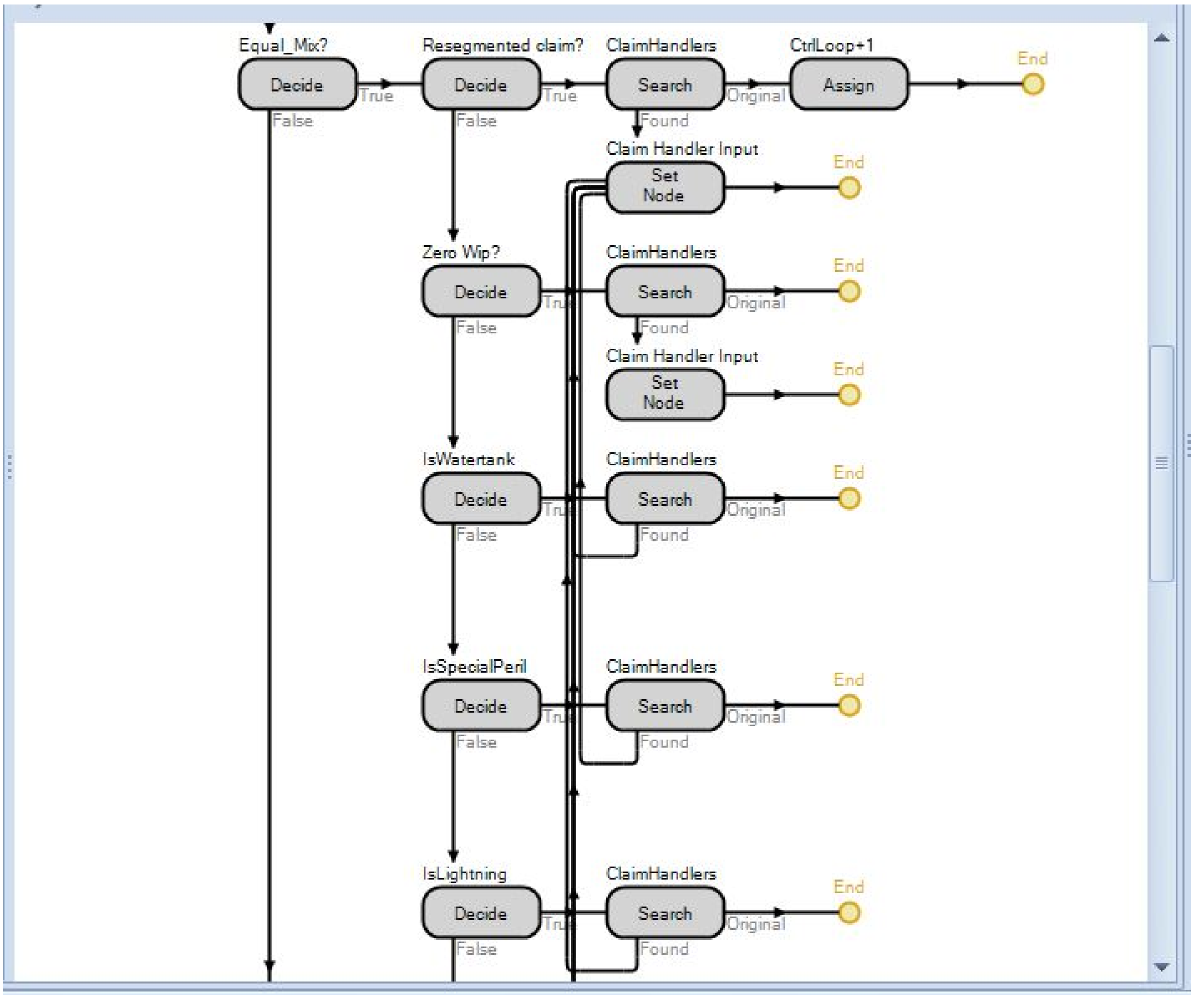


Figure 29: Main equal mix allocation process

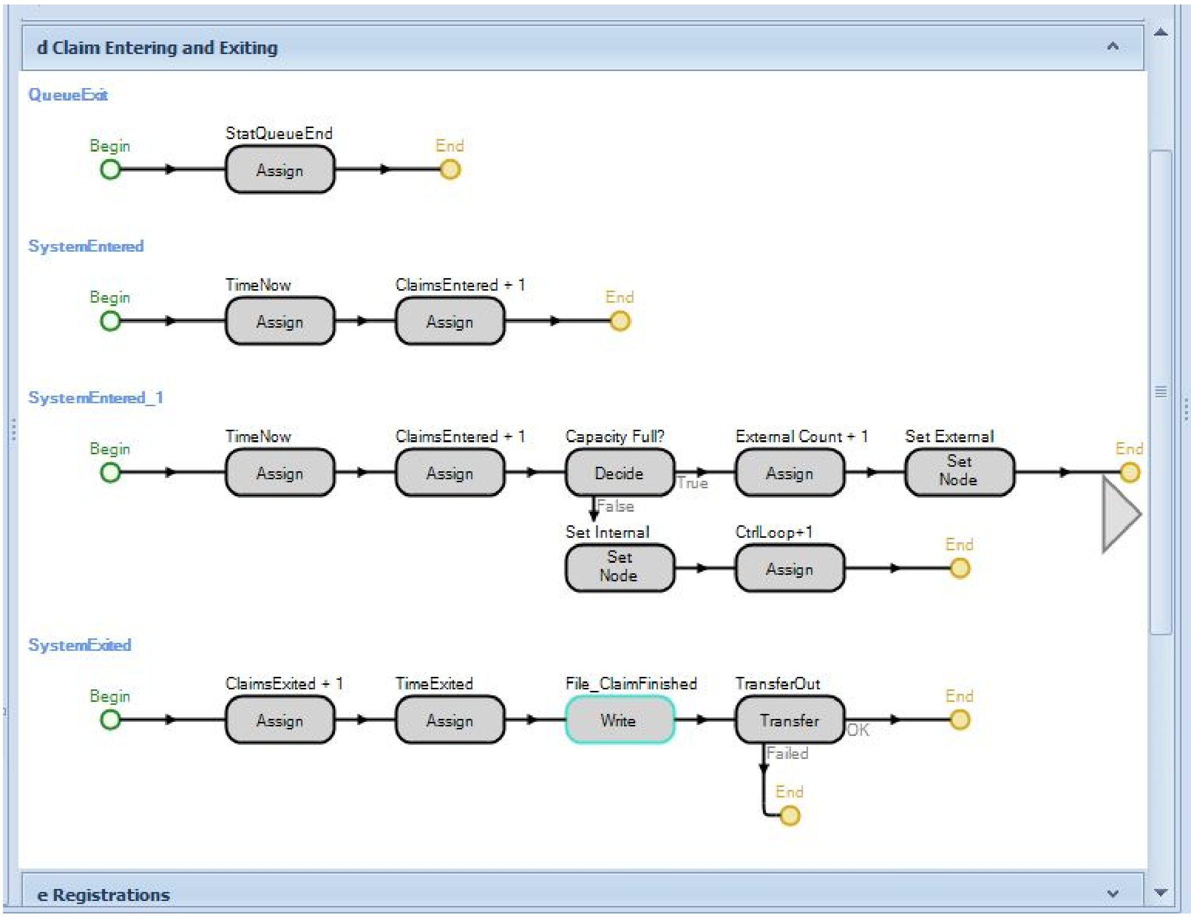


Figure 30: Processes used to assign counts, times and check system capacity.

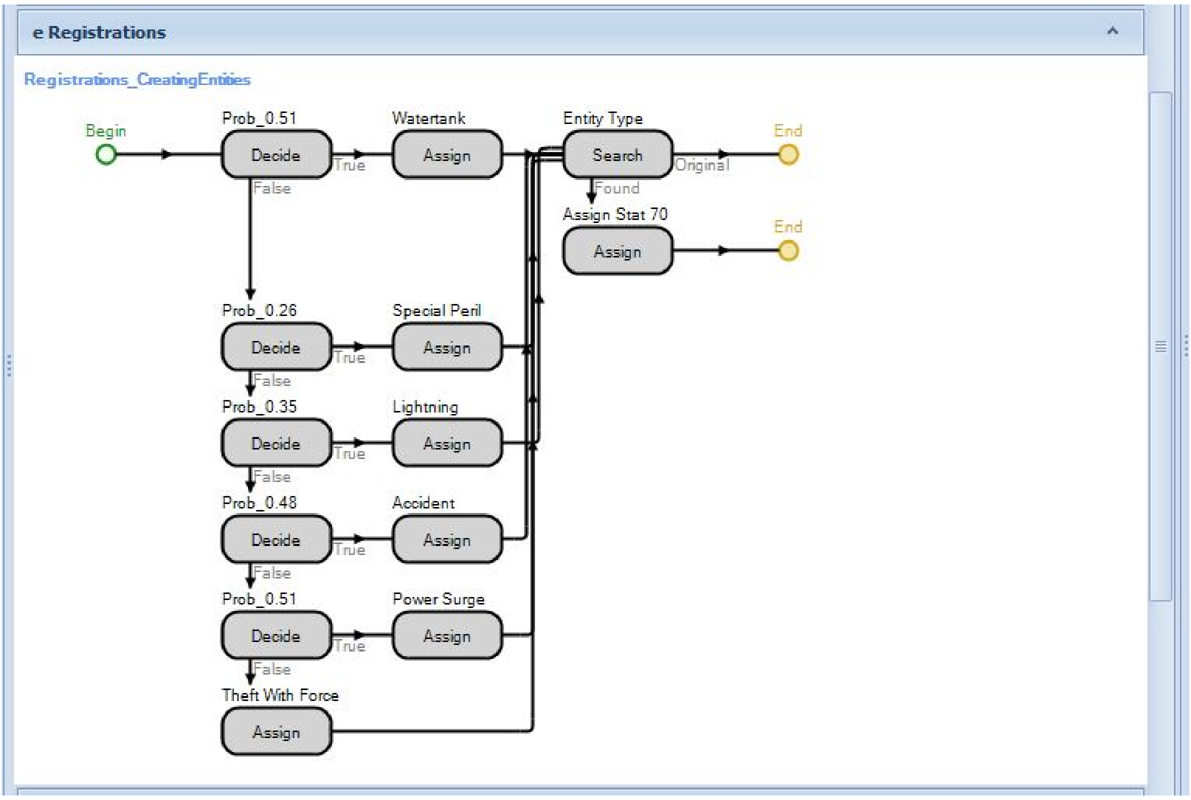


Figure 31: Process used to create entities with different symbols

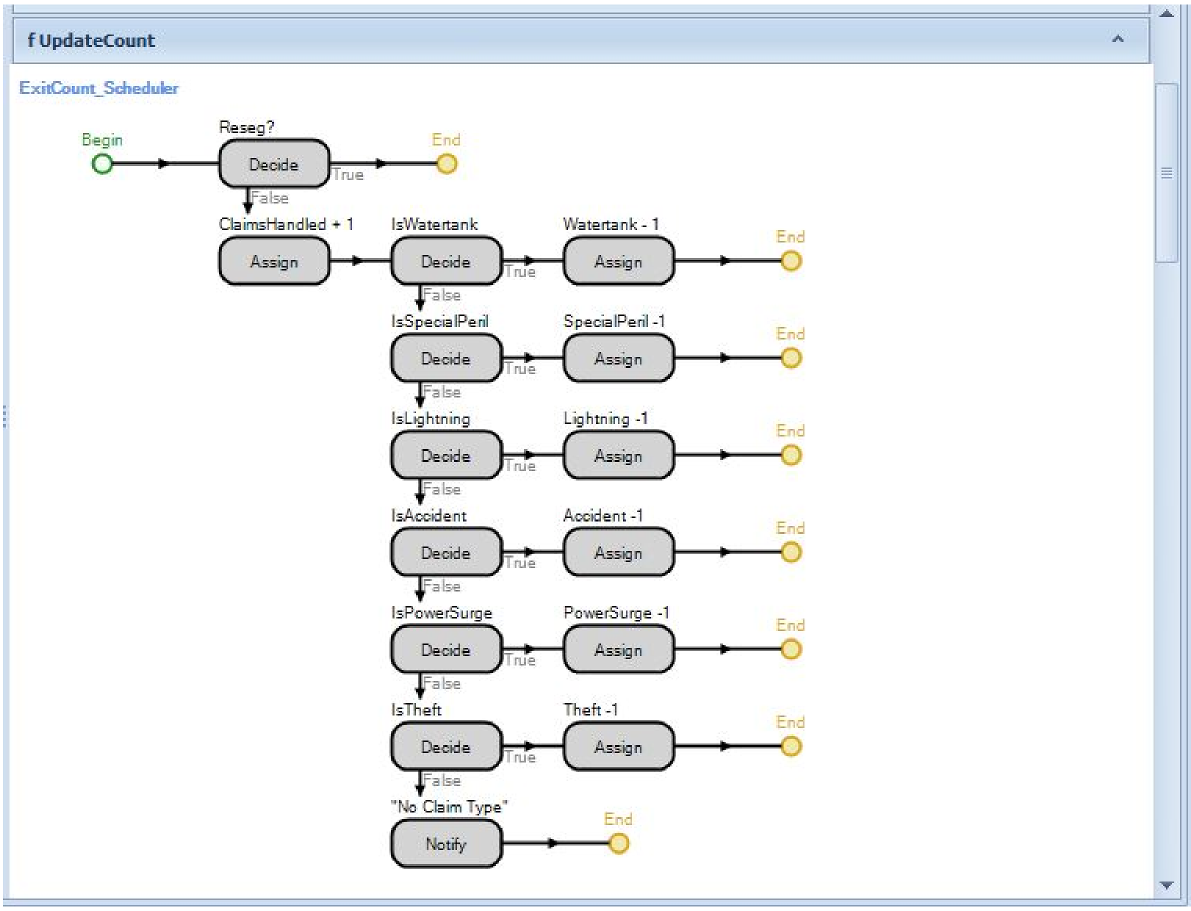


Figure 32: Process used to track claim types within status 60.

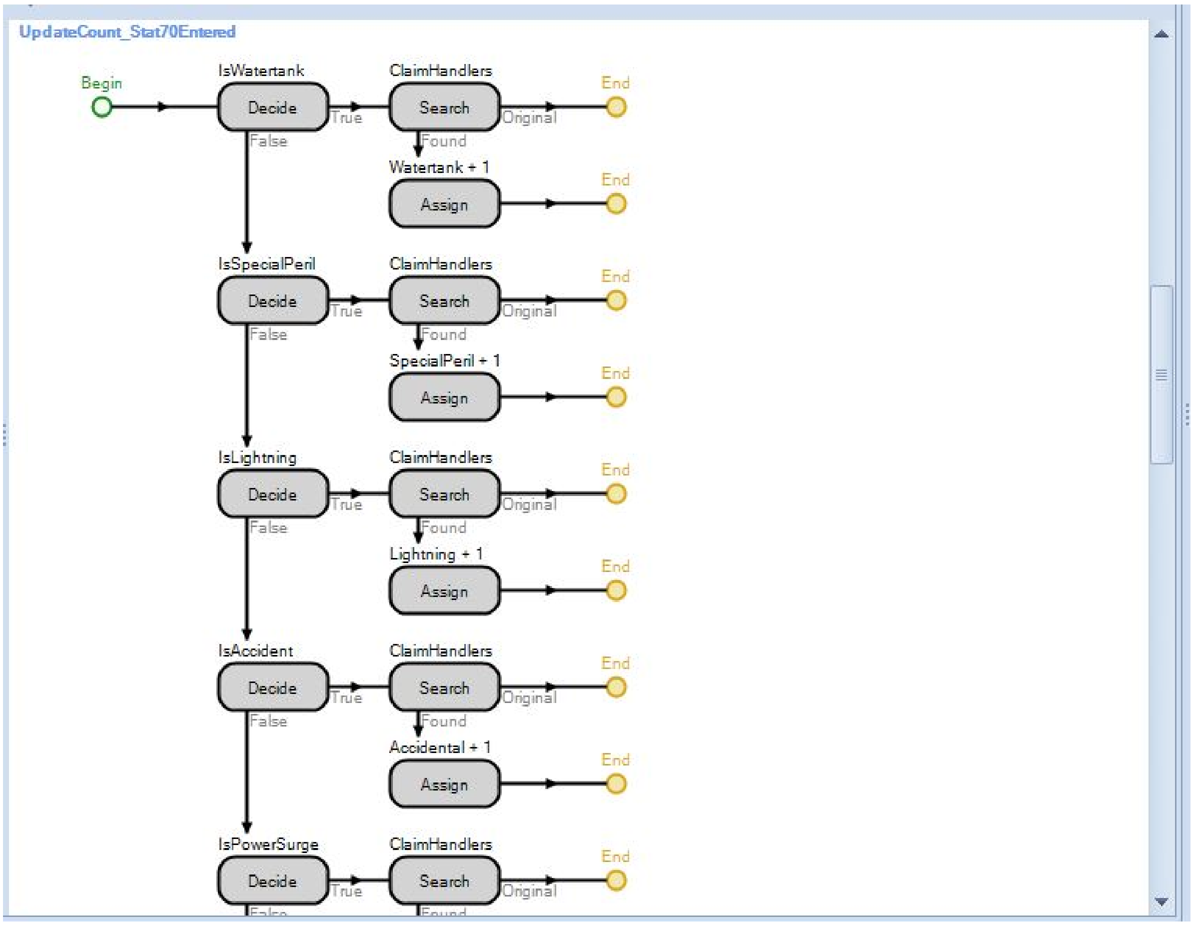


Figure 33: Process used to update claim counts for handlers entering status 70.

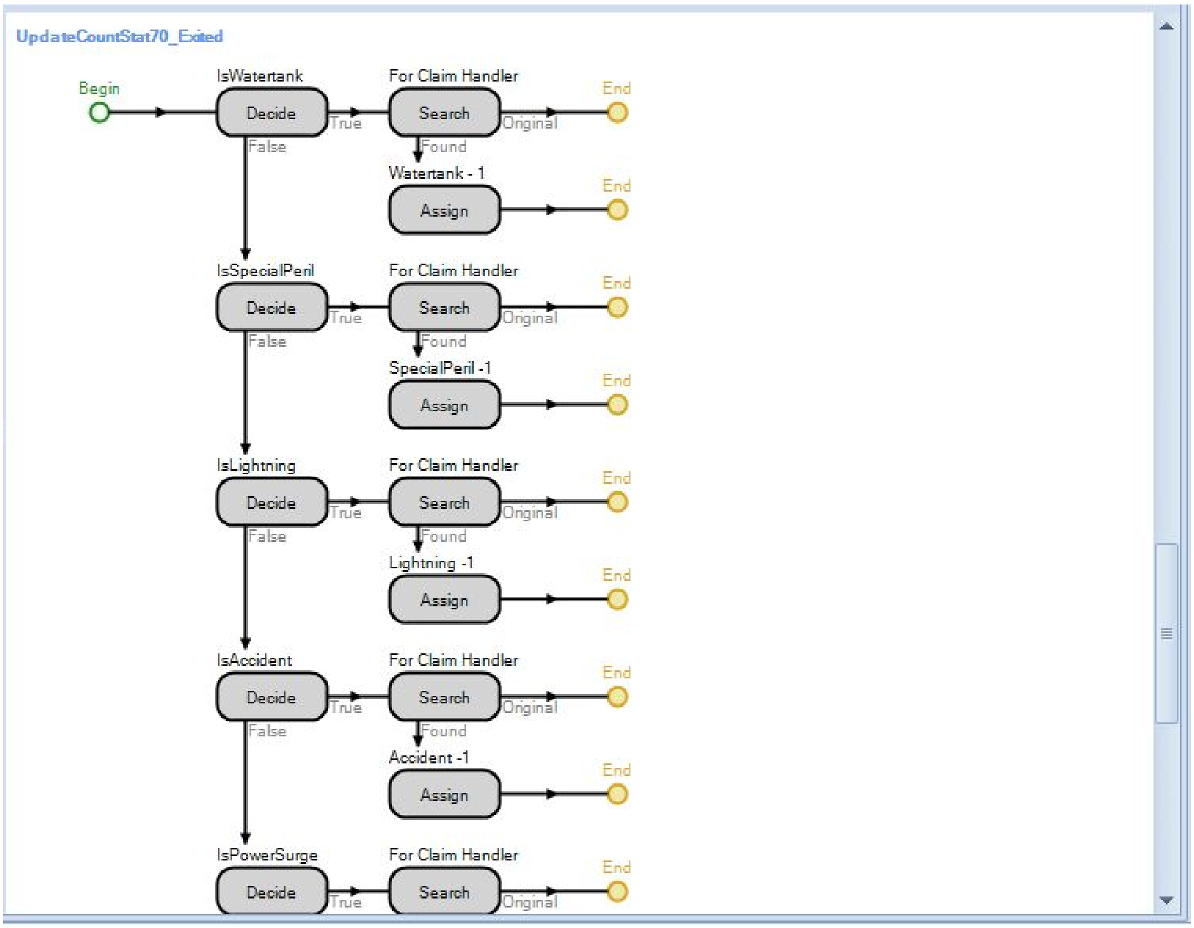


Figure 34: Process used to update claim counts for handlers exiting status 70.

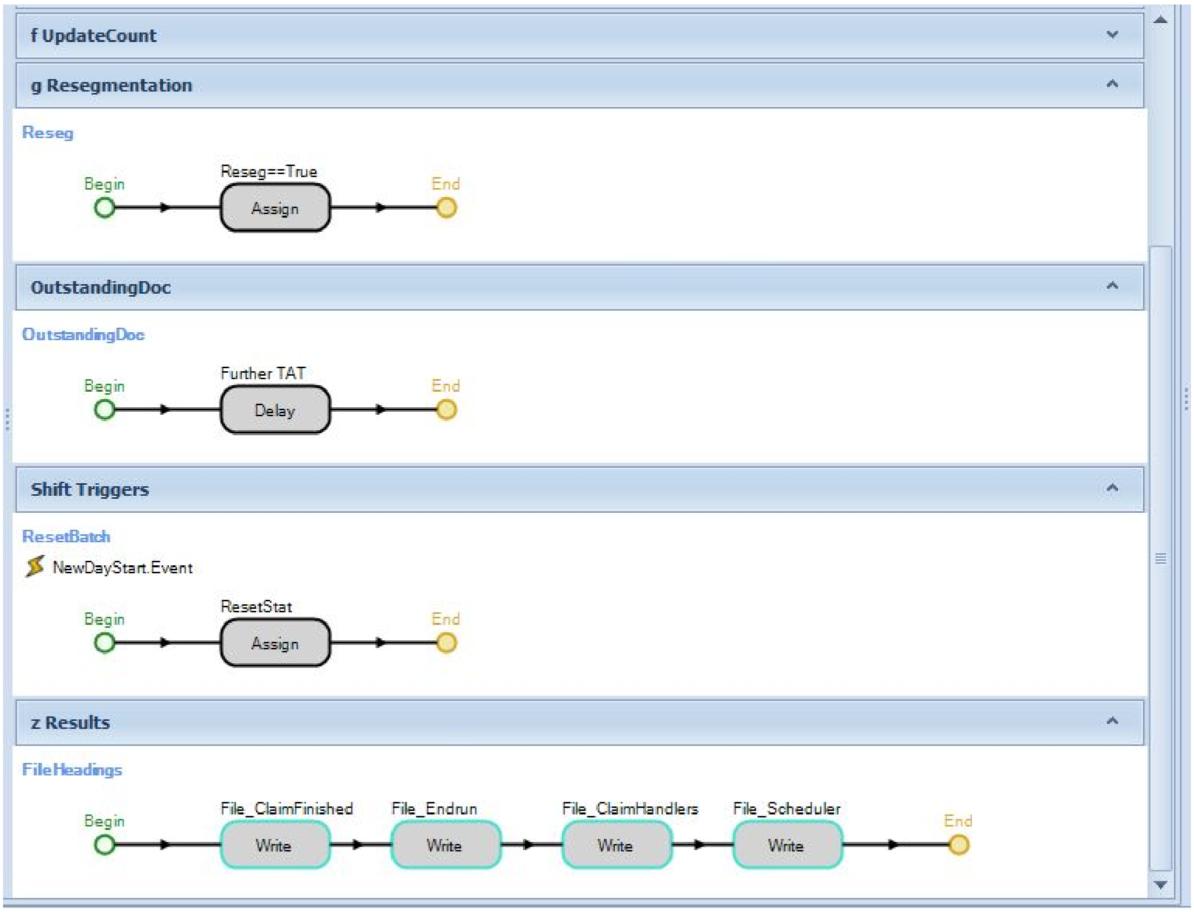
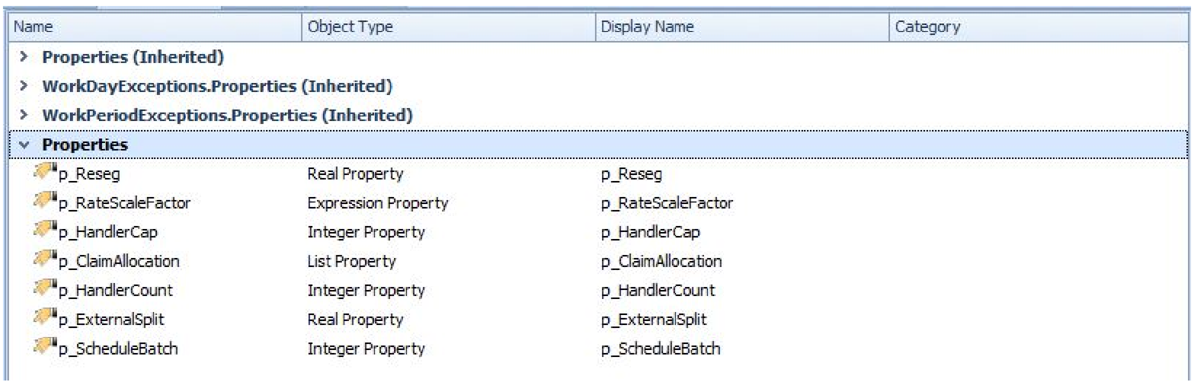


Figure 35: Processes used to create file headings, processing times and batch proportions.



Name	Object Type	Display Name	Category
Properties (Inherited)			
WorkDayExceptions.Properties (Inherited)			
WorkPeriodExceptions.Properties (Inherited)			
Properties			
p_Reseg	Real Property	p_Reseg	
p_RateScaleFactor	Expression Property	p_RateScaleFactor	
p_HandlerCap	Integer Property	p_HandlerCap	
p_ClaimAllocation	List Property	p_ClaimAllocation	
p_HandlerCount	Integer Property	p_HandlerCount	
p_ExternalSplit	Real Property	p_ExternalSplit	
p_ScheduleBatch	Integer Property	p_ScheduleBatch	

Figure 36: Model Properties

Name	Object Type	Display Name
> State Variables (Inherited)		
⌄ State Variables		
RefRow	Integer State Variable	RefRow
ClaimsEntered	Integer State Variable	ClaimsEntered
ClaimsExited	Integer State Variable	ClaimsExited
ExternalCount	Integer State Variable	ExternalCount
CtrlLoop	Integer State Variable	CtrlLoop
InternalCount	Integer State Variable	InternalCount
ZeroWip	Boolean State Variable	ZeroWip
WIPcount	Real State Variable	WIPcount
BatchWatertank	Real State Variable	BatchWatertank
BatchSpecialPeril	Real State Variable	BatchSpecialPeril
BatchLightning	Real State Variable	BatchLightning
BatchTheft	Real State Variable	BatchTheft
BatchPowerSurge	Real State Variable	BatchPowerSurge
BatchAccident	Real State Variable	BatchAccident
Status70Count	Integer State Variable	Status70Count
ExternalSplit	Real State Variable	ExternalSplit
SelectionWeight	Real State Variable	SelectionWeight

Figure 37: Model States

Name	Object Type	Display Name
⌄ Nodes		
l_InputNode	Nodes	l_InputNode
⌄ Objects		
l_ClaimHandlers	Objects	l_ClaimHandlers
⌄ Strings		
l_ClaimAllocation	Strings	l_ClaimAllocation
l_ClaimType	Strings	l_ClaimType

Node
Input@CH_1
Input@CH_2
Input@CH_3
Input@CH_4
Input@CH_5
Input@CH_6
Input@CH_7
Input@CH_8
Input@CH_9
Input@CH_10
Input@CH_11
Input@CH_12
Input@CH_13
Input@CH_14
Input@CH_15
Input@CH_16

Figure 38: Model Lists

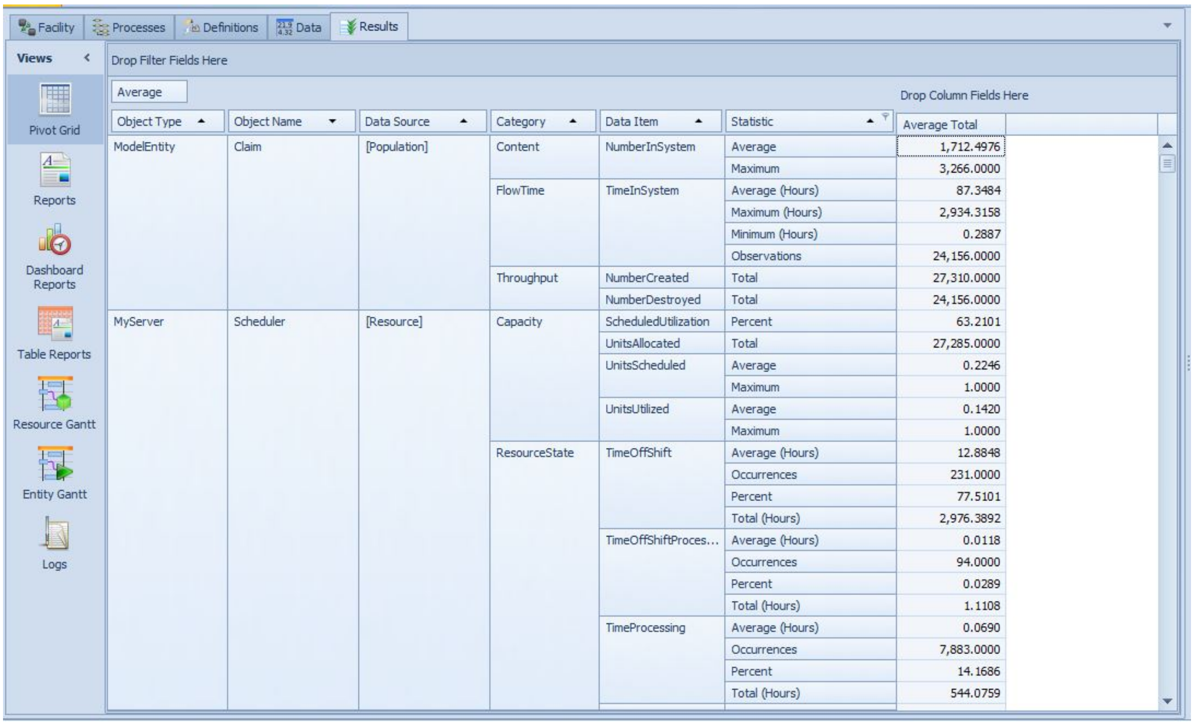


Figure 39: Model Result View

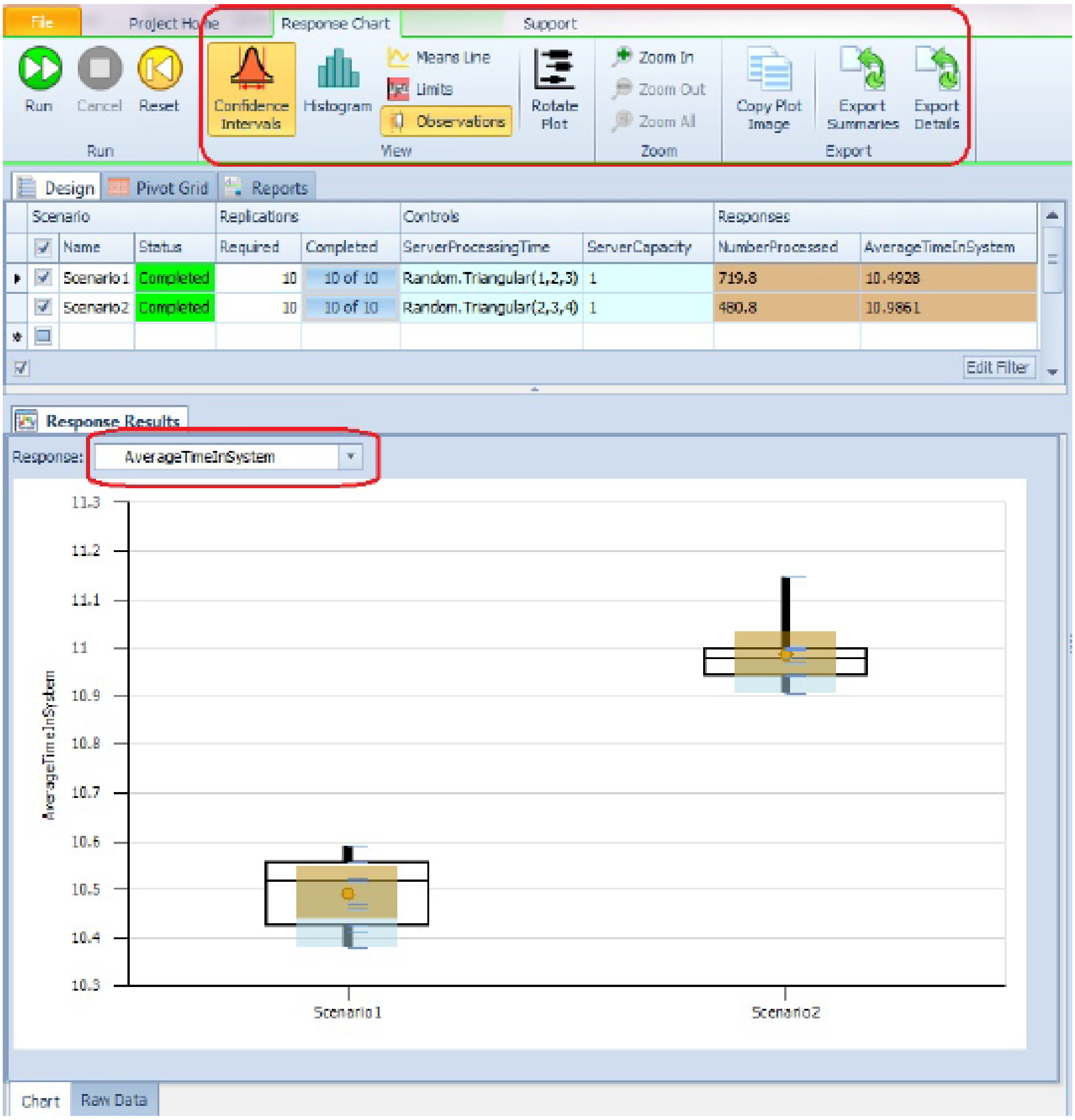


Figure 40: An example of the result sheet after an experiment run

16.6 Appendix F: Results

16.6.1 Equal Mix Experiment

Table 8: Time in system(hours) results for the Equal Mix experiment

Run No.	**Accident**	**Lightning**	**Power**	**SpecialPeril**	**Theft**	**Geyser**	**Avg TAT**
1	74.64	71.02	60.75	89.48	84.21	75.06	74.64
2	78.38	73.09	62.38	91.74	87.90	78.19	78.38
3	69.22	64.18	52.63	83.74	80.05	69.54	69.22
4	68.04	65.29	52.90	82.47	73.33	67.88	68.04
5	72.24	74.27	59.58	90.74	83.35	73.61	72.24
6	85.81	79.87	66.64	95.92	93.97	84.66	85.81
7	76.85	72.83	67.03	93.75	86.95	78.72	76.85
8	73.33	71.00	61.45	89.06	83.04	73.44	73.33
9	66.51	63.28	55.69	81.00	77.94	67.58	66.51
10	75.06	69.30	61.63	89.94	85.72	74.20	75.06
11	72.31	69.18	57.89	86.13	82.92	74.54	72.31
12	71.87	68.42	56.23	83.01	81.36	72.98	71.87
13	73.62	72.01	60.16	89.69	84.22	75.55	73.62
14	70.73	66.16	58.50	84.02	79.91	69.86	70.73
15	70.67	63.25	56.23	85.00	80.19	70.25	70.67
16	78.01	75.05	60.73	97.30	87.32	81.04	78.01
17	88.13	87.02	79.37	106.84	101.96	93.55	88.13
18	75.17	71.66	65.92	90.28	89.31	76.65	75.17
19	72.36	71.39	58.82	87.72	83.59	74.57	72.36
20	69.03	65.00	55.22	86.51	80.10	72.42	69.03
21	78.65	75.77	69.16	91.68	90.56	80.72	78.65
22	77.23	74.13	63.66	90.35	87.76	77.30	77.23
23	70.88	66.93	60.18	86.63	78.69	70.78	70.88
24	70.79	69.50	59.43	88.29	83.39	74.99	70.79
25	68.62	63.05	51.80	78.99	75.65	66.49	68.62
26	74.33	71.95	61.76	90.45	82.62	76.26	74.33
27	75.69	72.84	61.20	92.54	83.31	76.71	75.69
28	61.43	57.73	48.97	77.63	74.55	64.80	61.43
29	67.49	64.78	55.89	86.20	79.39	69.36	67.49
30	72.17	66.06	57.35	88.43	83.03	72.63	72.17
Average	73.31	69.87	59.97	88.52	83.54	74.48	73.31
Actual	61.71	57.83	39.60	77.64	72.56	64.46	62.30
%Diff	16%	17%	34%	12%	13%	13%	15%

Table 9: Throughput(units) results for the Equal Mix experiment

Run No.	**Entered**	**Exit**
1	26820	26263
2	26940	26398
3	26841	26383
4	26550	25971
5	27058	26500
6	27078	26728
7	27077	26569
8	26626	26107
9	27125	26644
10	27180	26577
11	26832	26190
12	27067	26614
13	26960	26628
14	26861	26407
15	27152	26745
16	27074	26547
17	26973	26607
18	27001	26543
19	26925	26509
20	26898	26296
21	27218	26751
22	26891	26492
23	26869	26590
24	26880	26483
25	27016	26543
26	26943	26497
27	26888	26436
28	27046	26645
29	26973	26434
30	27146	26461
Average	26964	26485
Actual	26959	25876
Diff	0.02%	2.30%

16.6.2 Min Claims Experiment

Table 10: Time in system(hours) results for the Min Claim experiment

Run no.	**Accident**	**Lightning**	**Power**	**Special Peril**	**Theft**	**Geyser**	**Avg TAT**
1	73.94	71.37	61.67	87.24	82.91	75.05	75.36
2	73.19	67.07	58.38	86.87	82.09	72.93	73.42
3	73.99	69.77	58.88	88.34	87.21	75.83	75.67
4	78.82	74.29	62.79	90.34	89.26	77.81	78.89
5	78.37	74.28	62.24	94.08	88.35	78.84	79.36
6	79.20	74.20	63.98	91.82	91.78	79.77	80.13
7	78.02	75.87	67.70	95.23	89.16	79.59	80.93
8	73.98	72.95	60.77	92.24	86.92	78.85	77.62
9	77.36	73.33	64.45	94.24	88.35	79.86	79.60
10	74.39	70.68	60.65	87.17	85.50	76.39	75.79
11	77.48	72.48	62.54	92.04	81.90	77.61	77.34
12	72.46	66.66	58.06	85.29	82.10	73.50	73.01
13	78.29	73.32	69.75	95.39	88.75	78.48	80.66
14	72.81	67.51	59.43	86.04	79.41	72.91	73.02
15	81.82	76.31	63.05	97.78	85.98	81.74	81.11
16	70.96	65.27	55.50	84.53	79.55	69.91	70.96
17	71.32	66.12	59.81	85.10	80.13	73.41	72.65
18	67.55	64.41	52.95	83.10	80.80	69.29	69.68
19	68.61	60.91	55.43	81.87	80.97	68.32	69.35
20	77.47	72.13	60.91	92.95	85.11	78.01	77.76
21	70.58	69.00	57.96	84.28	79.37	74.00	72.53
22	73.74	67.05	60.88	85.90	83.36	73.05	74.00
23	61.45	57.89	44.76	77.15	71.67	64.69	62.93
24	81.51	74.75	65.30	93.40	91.40	80.82	81.20
25	67.01	63.06	53.27	82.91	75.52	67.01	68.13
26	74.83	70.02	60.88	90.13	82.56	74.64	75.51
27	71.06	68.69	57.71	86.08	82.02	74.07	73.27
28	79.53	74.51	63.41	90.12	88.79	77.91	79.05
29	71.79	68.11	57.26	84.25	79.74	71.06	72.03
30	71.65	68.85	59.52	89.01	83.86	73.26	74.36
Average	74.11	69.69	60.00	88.50	83.82	74.95	75.18
Actual	61.71	57.83	39.60	77.64	72.56	64.46	62.30
%Diff	17%	17%	34%	12%	13%	14%	17%

Table 11: Throughput(units) results for the Min Claim experiment

Run No.	**Entered**	**Exited**
1	26938	26271
2	26936	26412
3	27039	26702
4	26862	26388
5	27041	26574
6	26961	26479
7	26791	26230
8	27073	26632
9	26854	26380
10	26872	26200
11	26848	26251
12	26503	25921
13	26957	26461
14	27150	26644
15	26925	26355
16	26824	26280
17	27024	26458
18	26678	26150
19	26689	26195
20	26972	26449
21	26957	26382
22	26946	26450
23	26674	26209
24	26970	26260
25	27011	26682
26	27164	26688
27	27181	26533
28	26811	26412
29	26918	26557
30	26650	26108
Average	26907	26390
Actual	26959	25876
%Diff	-0.2%	1.9%