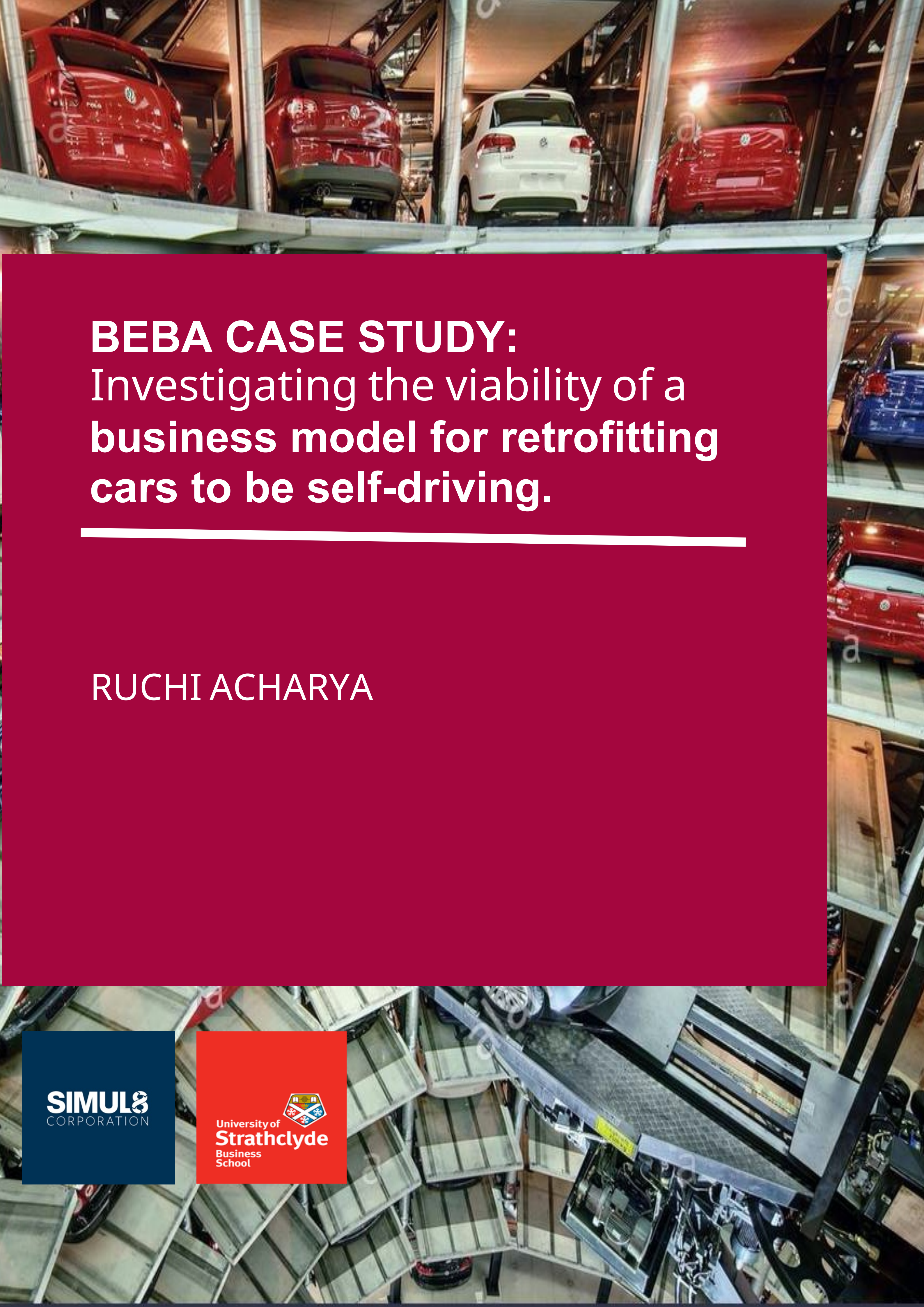

BEBA CASE STUDY:
Investigating the viability of a **business model for retrofitting cars to be self-driving.**

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1. EXECUTIVE SUMMARY

Innovation, stabilisation and continuous improvement have always been at the heart of the automotive industry. With upsurge in vehicle production, automotive vehicles program costs, suppliers and manufacturers highly rely on simulation software to support continuous improvement, maximize productivity, reduce costs and respond to changing customer demand.

Self-driving cars enhance productivity. The use of self-driving can, however, reduce road congestion and vehicle pollution. The development of this self-driving car can also help to promote the adoption of robotic consumer and industry applications as a core technology. The question now is it possible to convert current non-self-driving cars to become automated and if so is the cost less than purchasing a new self-driving car There is no better indicator on how companies will make that decision across many technological, business and societal questions than their using a business model and knowing its profit margin.

The main objective for our client was to investigate the feasibility of a business model for retrofitting cars to be self-driving. To assist the company's self-decision-making process it is crucial that profit returned within first 6 months should be greater than £1million. The sales strategy endorse that customers will be charges £3000 for cars retrofitted and returned in less than 100 working hours otherwise customers will be charges £1500.

In this report, we have used Simul8 software to design efficient automotive assembly process in an attempt to deliver retrofitting cars to be self-driving cars for the customers. In order to remit effective facility operational decisions, two simulation models Basic and Optimal Models have been generated for better understanding. This report conceptualizes the maximize throughput in the basic simulation model and discover several bottlenecks. To overcome the problem and to minimize the effects of downtime, an optimal model is used to plan, monitor and optimize operational factors. This further includes Activities assembly, staffing requirements and resource utilization. In the end a detailed conclusion has been provided from the outcome of the model.

2. CHALLENGES IDENTIFIED

Figure 1: Challenges identified for self-driving cars

2.1. Data Issues

Some of the consequences of using developing self-driving cars due to the advanced robotic technology system require a "closed" hardware/software ecosystem where companies share their data with third parties, and this could lead to the difficulties of legislation of the system because of the public concerns around safety and equity. There is another problem with data owner who is allowed to access data but in return it consumes a lot of data.

2.2. Cost and Affordability.

Car Companies that are keen on providing high-level services to its consumers and opting for best option to bring supply and demand at an affordable cost together as well have the most value to make a profit. So, they invest in research, marketing and continue to develop new innovation to be ahead of their competitors. Many aspects have to be taken into consideration:

- Before cars can be retrofit into self-driving cars they have to comply with regulations. These companies have a history of working with regulators or with automobile companies, they also work closely with the government to understand the car regulations and compliance to reduce car deaths, emissions and better transportation for everyone.
- This business model will help in decision making, and these decisions will have very important consequences for the future of car transportation.

2.3. Weather

The risk of Self-driving cars already has its own risk when exploring adverse weather conditions. The vehicle performance during snow and ice condition effect is not usually tested Self-driving cars should be programmed into driving algorithms. The weather might pose a big challenge to autonomous cars leaving poor visibility. Human road users knowing that automatic cars have no driver so there is no horn to alert road users. The solution to this problem is the use of LED signs mounted outside of the vehicle, which can help to announce status.

2.4.Regulation

In order for people to buy Automatic cars, the government must enact laws on the car manufacturer that the technology must be trusted as safe. The legal theorist requires Safety testing outside of the R&D environment in a statistically significant method. comprehensive feasibility and safety reports are required by the autonomous companies to produce by the ministry of transportation.

3. IMPROVEMENT PROPOSED

Figure 2: Model on Improving self-driving car experience

Self-driving software can't establish a lasting competitive advantage. Companies can develop more incentives and sufficient research to solve the problem. For example, General Motors which has spent over "581 million dollars to acquire Cruise Automation". There are also companies like European OEMs that are determined to solve the self-driving model equation process and the economic potential of the technology. The use of algorithms, simulation models, data collection and testing both using a hard will make the study more achievable.

3.1. Sensors

The use of sensor can help elevate some issues highlighted above like during bad weather conditions, cameras might seem to be cost-effective, but the range is limited, and visibility is reduced during bad weather. Sensor radar is a cheap and effective option and builds a high-resolution picture under any weather conditions.

3.2. Processing

Another improvement proposed is the use of processers in autonomous cars which can help use the data and integrate into a smart fusion system and turn it into actual driving. Some companies use simulations in order to determine the number of miles that the car can actually drive.

3.3. Pricing

Commercial cars can hardly become autonomous when the main components are not cost-effective because there is a high cost associated with sensors and possessor automobile car companies are trying to reduce the prices of sensors and processors so that the price of these autonomous cars can be reduced.

4. RESOURCE IMPLICATION EFFECT

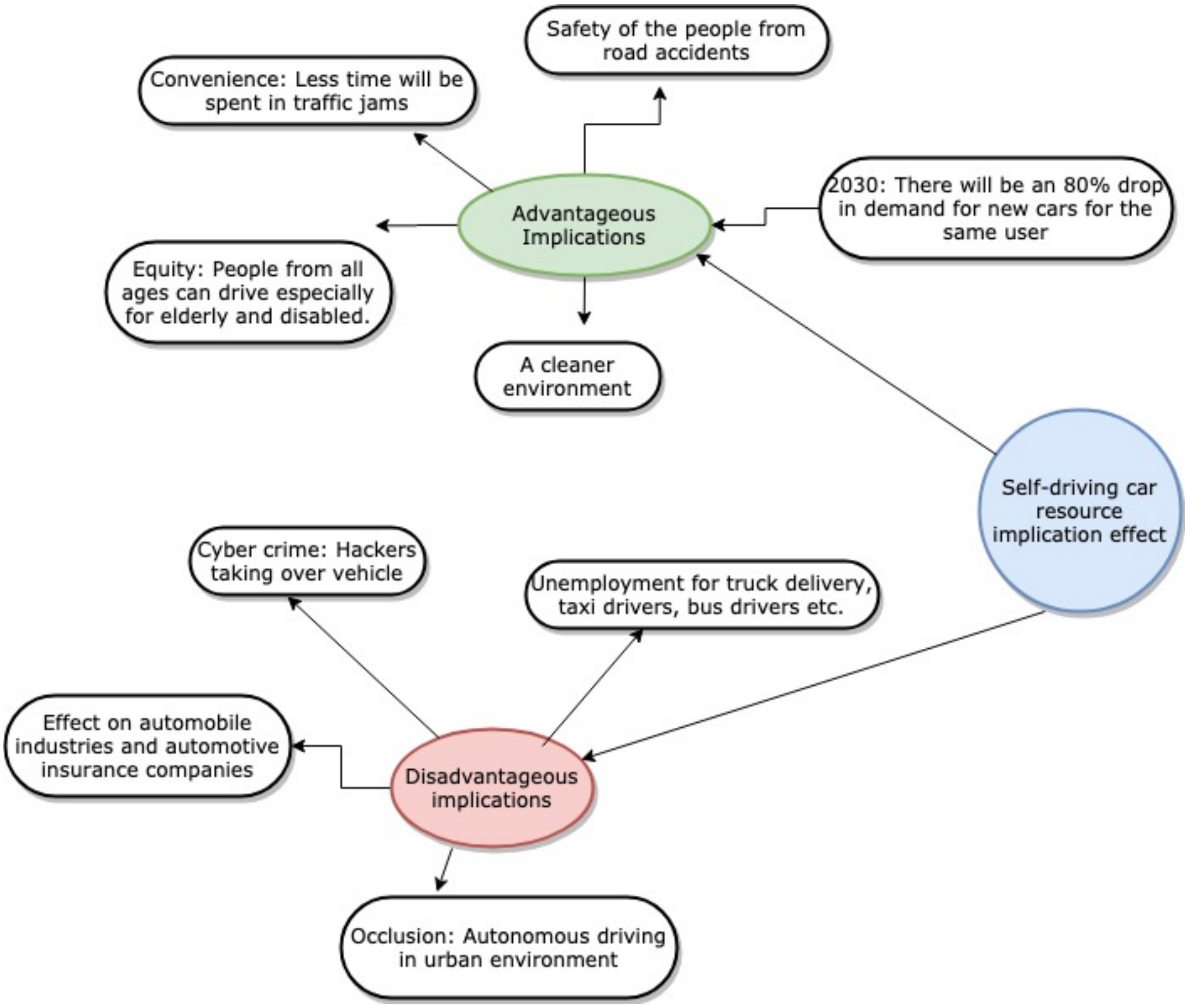


Figure 3: Self-driving car resource implication effect

4.1. Unemployment

According to the U.S. Bureau of Labour Statistics, 2012 "more than 1.7 million people were employed as tractor-trailer truck drivers". When cars, trucks, and buses become autonomous people their income from such channels would become jobless such as Taxi drivers, bus drivers and truck delivery driver which account to a large amount of the workforce. Other staffs that could be affected are supervisory staff, management and support staffs who work alongside with these drivers.

4.2. Hackers Taking Over Vehicles

Self-driven cars are usually controlled by computer hardware and software. A hacker could discover through security means ways to hack into the systems to take over a car grinding these robotic cars to a halt.

4.3. Effect on the Auto Industry and Auto insurance

Another consequence of autonomous cars is the fact that it could destroy the use of the automobile industry because people will prefer to call driverless cars from a shared fleet which would have an adverse effect on the economy. Insurance cost is usually priced depending on risks, such as an incident or accident. Autonomous cars can reduce it, as a result, the insurance cost could collapse as the risk which is associated with human driving is eliminated through technology.

5. BASE SIMULATION MODEL ANALYSIS

(Simulation software for automotive manufacturing from SIMUL8, 2020) With growing vehicle production program costs, manufacturers and suppliers rely on simulation software to support continuous improvement, maximize productivity, reduce costs and respond to changing customer demand. Simul8 is the best software tool to examine and optimize the operational factors as required in this project.

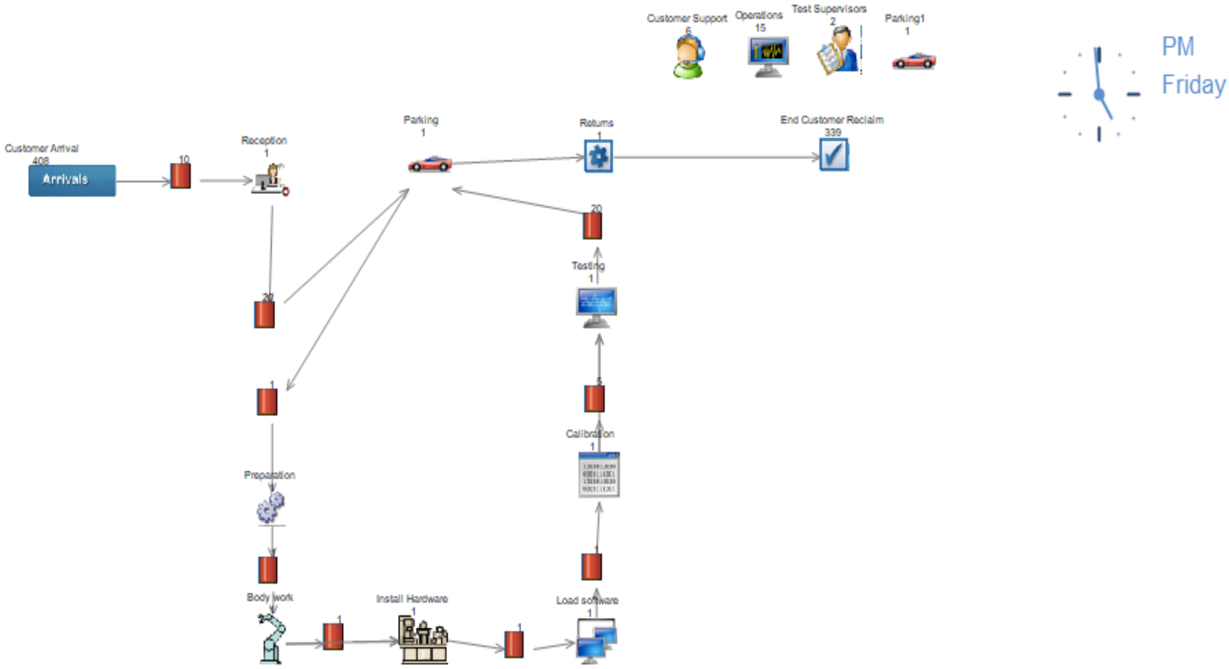


Figure 4. Processed data for currently proposed system-Base model (Source: Simul8)

The simulation building chart in the Figure 4. depicts the basic outline of the current retrofitting process plan that involves 10 Activities, 3 Resources, and numerous queues to attain the desired results. The operation is staffed with three major viable Resources: Customer Support, Operations, and Test Supervisors. An additional Car parking Resource has been added to ensure smooth functionality of the Parking process. After running the simulation in Simul8 we discovered that during the first 6 months of operation, the total expectancy of customer arrival is around 408 among which 339 customers could successfully reclaim their retrofitted cars.

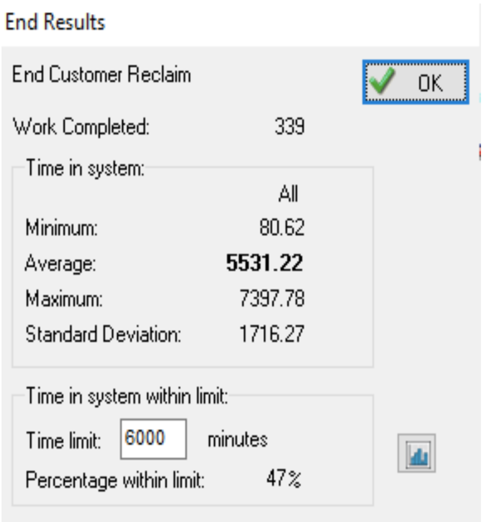
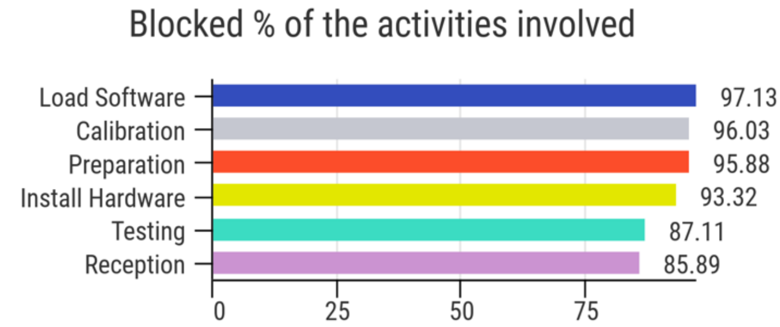
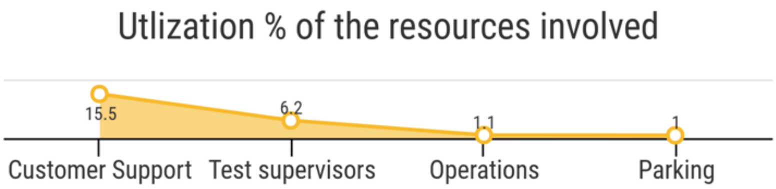


Figure 5: The result dialog box from the end customer claim for Base model

Data Analysis for the business model for retrofitting cars to be self-driving (Base Model)

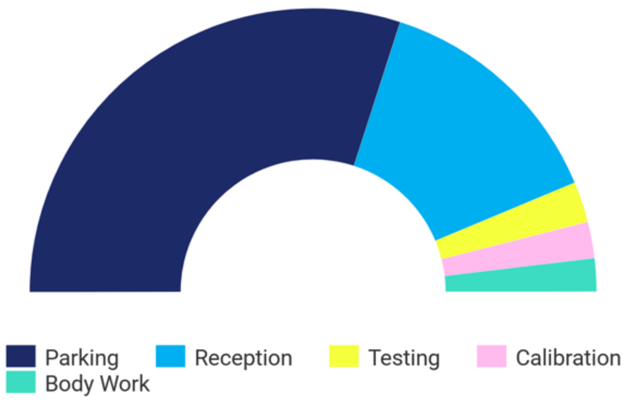




Utilization % and Blocked %

Observation 1: Based on the results obtained from the simulation, the blocked % is high in the Activities involved that further results in causing the smooth functioning of the Work items in the whole retrofitting process. Load Software and Calibration have the highest blocked % about 97.13 and 96.03. That further initiates that the objects it routes out don't have capacity to accept the completed work items.

Furthermore, among the resources highest utilization % is Customer Support about 15.5% followed by Test Supervisors by 6.2%, which is relatively low and need further upsurge.



Average Queuing time

Observation 2: Based on the analytical data obtained for the Queues using Simul8, we observed that there is highly time disproportion among the Activities involved. Parking is taking the maximum average queue timing for about 3169 minutes followed by Reception about 1452 minutes. Therefore, it is suggested in order to cut off the awaiting timing, additional queues are required among the activities Parking and Reception for better results.

Also, additional queues or increment in the queue capacity for Activities like Testing, Calibration, and Bodywork.

Cost (£)	Revenue(£)	Profit (£)	Avg. time (mins)
1081680	1017000	-64680	5531.22

Profit earned

Observation 3: Based on the income statement the total cost generated equals £ 1081680 and revenue equals 1017000. This further leads to a total negative profit of -£64680 for the time period of 5531.22 minutes. The negative profit strongly suggests opting for another optimal solution for the current process plan.

End customer reclaim: time

Observation 4: The above graph has been generated under the high analytical feature in Simul8. Here, we can observe the best average time for end customer end reclaim is 19 while the worst average time is 22. Therefore, based on the comparison a strategy plan can be laid down to target more customers by understanding and initializing the time-behavior.

5.1. OUTCOMES OF THE BASIC MODEL AND RECOMMENDATIONS

- Upon observation, we noticed that there is low utilization % for the existing Resources. Therefore, minimising the total number of Resources for the Activities is highly recommendable since it will cut-off the extra expenditure of the whole process, thereby increasing the profit and also increasing the utilization % of the Resources.

- The finance results includes an income statement that tell us about the cost, revenue and profit generated. We obtained a negative profit of -£64680. This further suggests that there is necessity to reduce the number of Resources and to endorse additional Activities. Since, the capital cost for the Activity like Installation of Hardware is £5000, so we accentuate it by installing 3 Hardware Activities in the optimal solution for the present model. Rest of the Activities has also been supplemented in the optimal solution to meet the profit margin as requested by the company.

- In order to satisfy the condition i.e, the charge amount is £3000 if car ready < 100 hours else £1500 for longer hours. This can be attained in simulation model through results in "End Customer Claim". The total percentage within limit (6000 mins) is 47%. Therefore, 53% will cost £1500 to the customers while 47% will cost £3000. Therefore, through optimal model in Figure 7, we were able to achieve Percentage within limit to be 100%.

- An additional Resource has been added for the Parking Activity to ease the process time and to run the process without any interruptions in the Parking process.

- In the beginning of the execution, there were numerous Activities that has been blocked that can be further monitored using High Analytical Panel in Simul 8. This means that Activity has completed processing the work item but the object it routes out to doesn't have any capacity to accept the completed work item. Therefore, fluctuations in the Resources has been taken place to avoid blocked% in the Activities and make it functioning for the client.

- An immense focus had been given to attain a balance between Activities and Resources, so that the model doesn't starve out of Resources as well as lead to over- exploitation of the existing Resources available.

6. OPTIMAL SOLUTION OF THE MODEL

Starting from the proposed model we have clearly noticed that the model was not generating positive profit. The model proposed was not providing a considerate revenue hence the costs presented were much higher than the incomes.

A possible optimal solution could be found by implementing in a more effective way the resources and by adding more stations in the production area. We have seen that in most of activities were blocked in the production area with very small utilisation percentages which means that the resources and the operational processes were not utilised efficiently to generate a positive profit.

Making a comparison between the model proposed and the optimal model presented below we could withdraw several key points:

- Lower operational costs by reducing the resources needed such as: Customer Support and Operations
- Making the production area and other testing area more efficient by adding more working stations like: Body Work, Install Hardware, Calibration and Testing.
- A reduction of waiting time for customers in reception area
- Testing area it was the most demanding area hence why we suggest an increase in test supervisors number for a better productivity.
- The workstations are more effectively utilised.

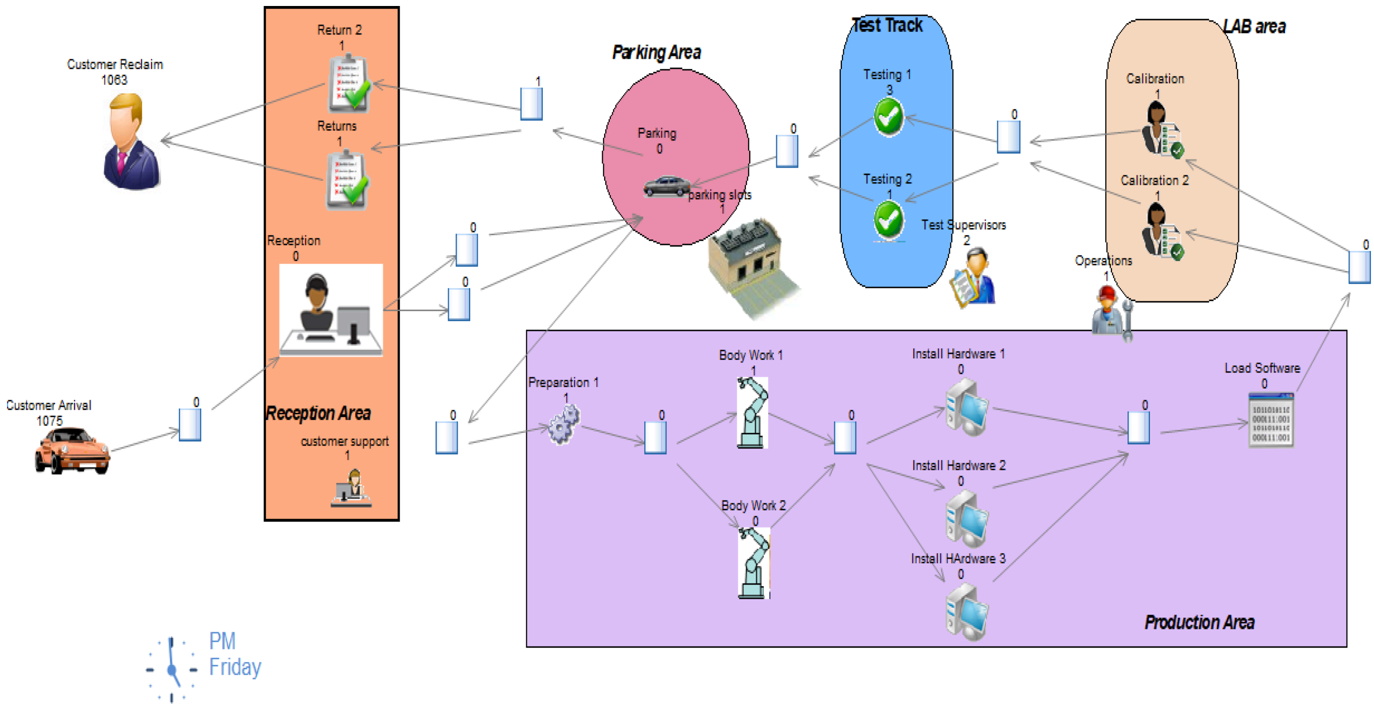


Figure 6: Optimal solution model (Source:Simul8)

The presented changes had resulted in a positive revenue and a reduction in operational costs presented in the graph below:

Costs	£ 1,506,436.00
Reception	£ 50,000.00
Parking	£ 100,000.00
Preparation 1	£ 19,290.00
Body Work 1	£ 76,400.00
Install Hardware 1	£ 79,100.00
Load Software	£ 1,000.00
Calibration	£ 48,200.00
Testing 1	£ 300,000.00
customer support	£ 72,000.00
Operations	£ 125,000.00
Test Supervisors	£ 132,000.00
Body Work 2	£ 76,400.00
Install Hardware 2	£ 78,500.00
Testing 2	£ 300,000.00
Install HArdware 3	£ 446.00
Calibration 2	£ 48,100.00
Revenue	£ 3,189,000.00
Profit	**£ 1,682,564.00**

Table 1: Income statement for Optimal solution model (Source: Simul8)

Company´s viability will be considered once the project ´s profit returned within 6 months from opening is more than £1 million. In our optimal model the project returned **£1,682,564.** The profit is over the target value and our revenue od 3,189,000 £ make the project profitable and viable. A total number of 1063 car were sold within the target of 100 hours (6000 minutes in the system) and the production had been done 100% under this limit.

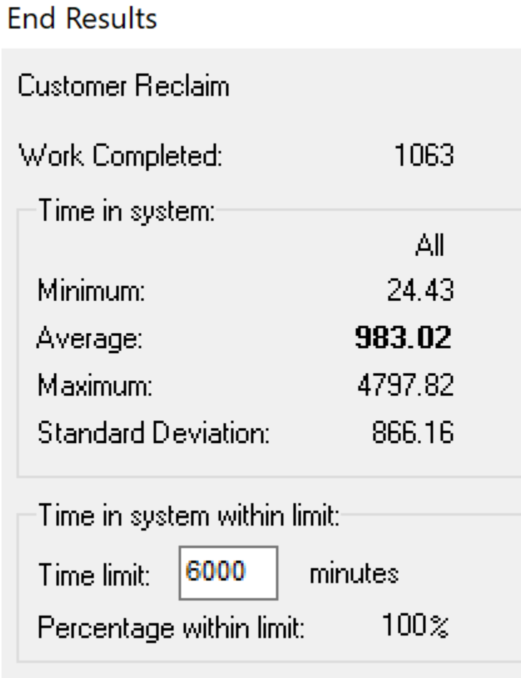
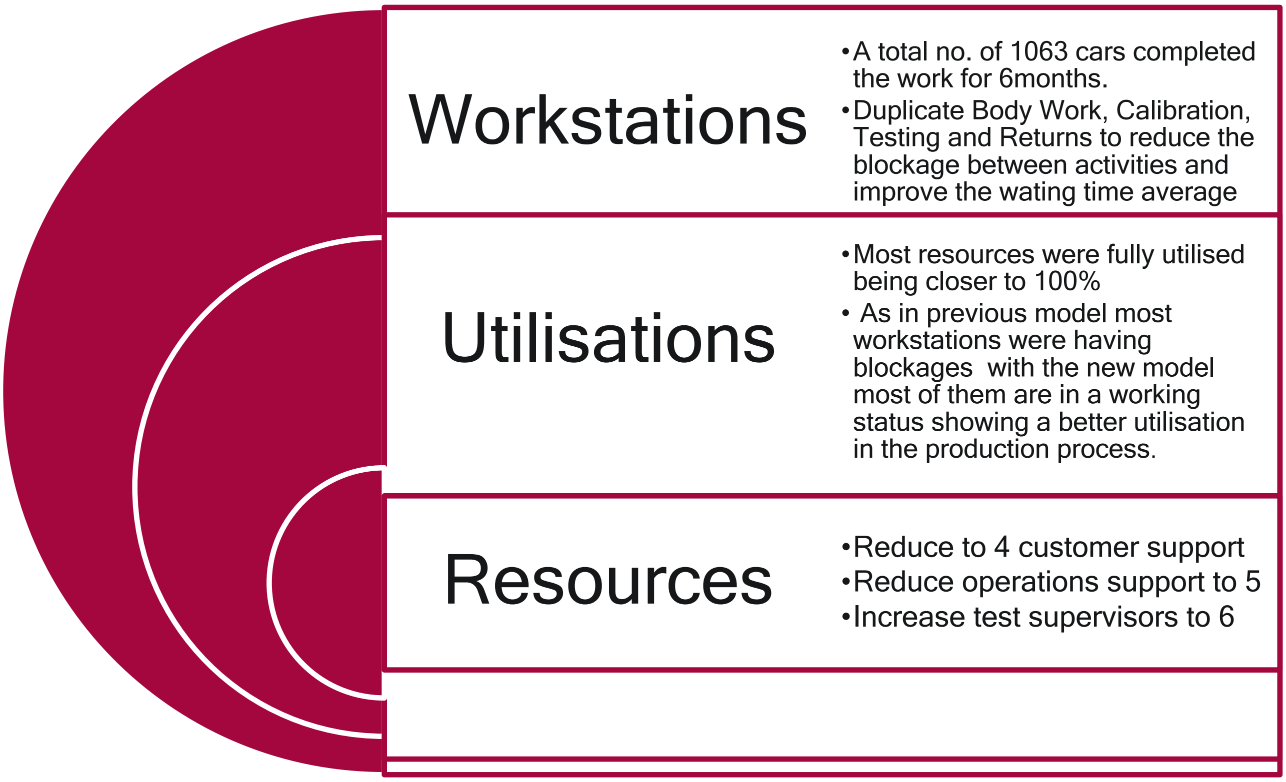
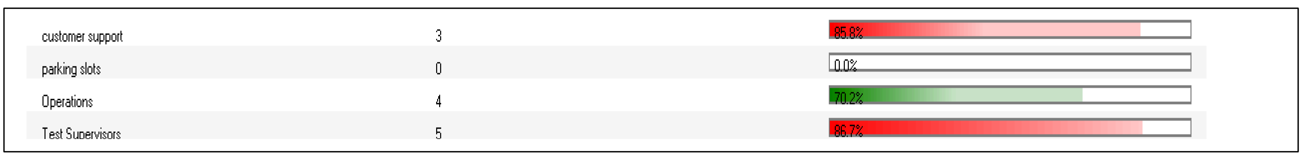


Figure 7: The result dialog box from the end customer claim for Optimal solution model



For a better understanding of our model we will provide a graphical explanation of our findings and outcomes:



customer support	3	85.8%
parking slots	0	0.0%
Operations	4	70.2%
Test Supervisors	5	86.7%

Table 2: Utilization % for the existing resources of Optimal solution model (Source: Simul8)

Name	Completed Jobs	Current State	Utilization %
Returns	737	Working	
Testing 1	460	Waiting	
Calibration	464	Working	
Load Software	928	Waiting	
Install Hardware 1	247	Waiting	
Body Work 1	464	Working	
Preparation 1	929	Working	

Table 3: Utilization % for the existing activities of Optimal solution model (Source: Simul8)

7. OVERVIEW OF THE MODEL

In an effort to move the company towards its goal, i.e., to reach £3 million sales profit within 6 months of operation there are some key factors that needs to be taken into consideration along with the company's present limitations in the process layout. (Tips for improving profits with lean manufacturing, 2020) The feasible steps involved to increase the profit: -

7.1. To identify the key operations or services where we can lower the price on the profitable products and thus automatically resulting in increase of the sales.

7.2. To increase the price on the least profitable items or to eradicate it from the whole process altogether.

7.3. To enlist the employees support in the streamline production and to cut the waste through lean manufacturing techniques. The company can also implement operational efficiency projects.

7.4.The company might consider to change the working time for employees and adapt to customers availability ,i.e opening the workshop on weekend time for customer better retention.

In order to meet identified market demands and potential, it is essential that feasibility and reliability of the operations remains complimentary with each other.

8. CONCLUSIONS

In our project analysis we just considering the financial and operational costs and calculate the revenue from its value, but we are not taking into consideration other possible factors such as:

- training of the employees that might be required in this project
- determine if technical resources meet capabilities and if the technical team is able to convert ideas into operating systems
- the environmental impact that the projects may have and its sustainability

The stage of the project planning and feasibility analysis is the one influencing the most in promoting a project, in which management department examine its feasibility through several methods and try many verifications beforehand. The most important factor in this stage is that project´s profitability part in which financial analysis is mainly determined.

The project feasibility examination is the complicated decision-making process where both the qualitative and quantitative factors are taken into consideration so that the model could be evaluated properly. This model provides a feasible solution to company´s requirements providing a profitable result above expectations.

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