KU LEUVEN

Faculty of Engineering Technology Campus Group T Leuven
Academic Year 2019 – 2020 Third Bachelor Phase
Course: Operations and Project Management

NAAM: Ciaran Van Hoeserlande & Sébastien van Baren

ASSIGNMENT 2: Jan's Car Wash

Note: All calculations for Part 2 and Part 3 are performed in an Excel file with filename 'digital attachment-EN_edited.xlsx', which can be found attached to this document. If you are interested in checking the validity of the calculations, we kindly request you take a look at the Excel file, as we wanted to focus on the discussion of the results instead of the calculations itself in this text.

Part 1: Analysis of the Current Process

In total we can distinguish seven different programs. Each program entails different steps, outlined below:

BASIC: Washing -> Drying -> After-drying

BASIC + INTERIOR: Washing -> Drying -> After-drying -> Cleaning Mats -> Cleaning Windows -> Cleaning Dashboard -> Vacuuming -> Interior Wax

PLUS: Washing -> Drying -> After-drying -> Rims -> Wax Exterior

PLUS + INTERIOR: Washing -> Drying -> After-drying -> Rims -> Wax Exterior -> Cleaning Mats -> Cleaning Windows -> Cleaning Dashboard -> Vacuuming -> Interior Wax

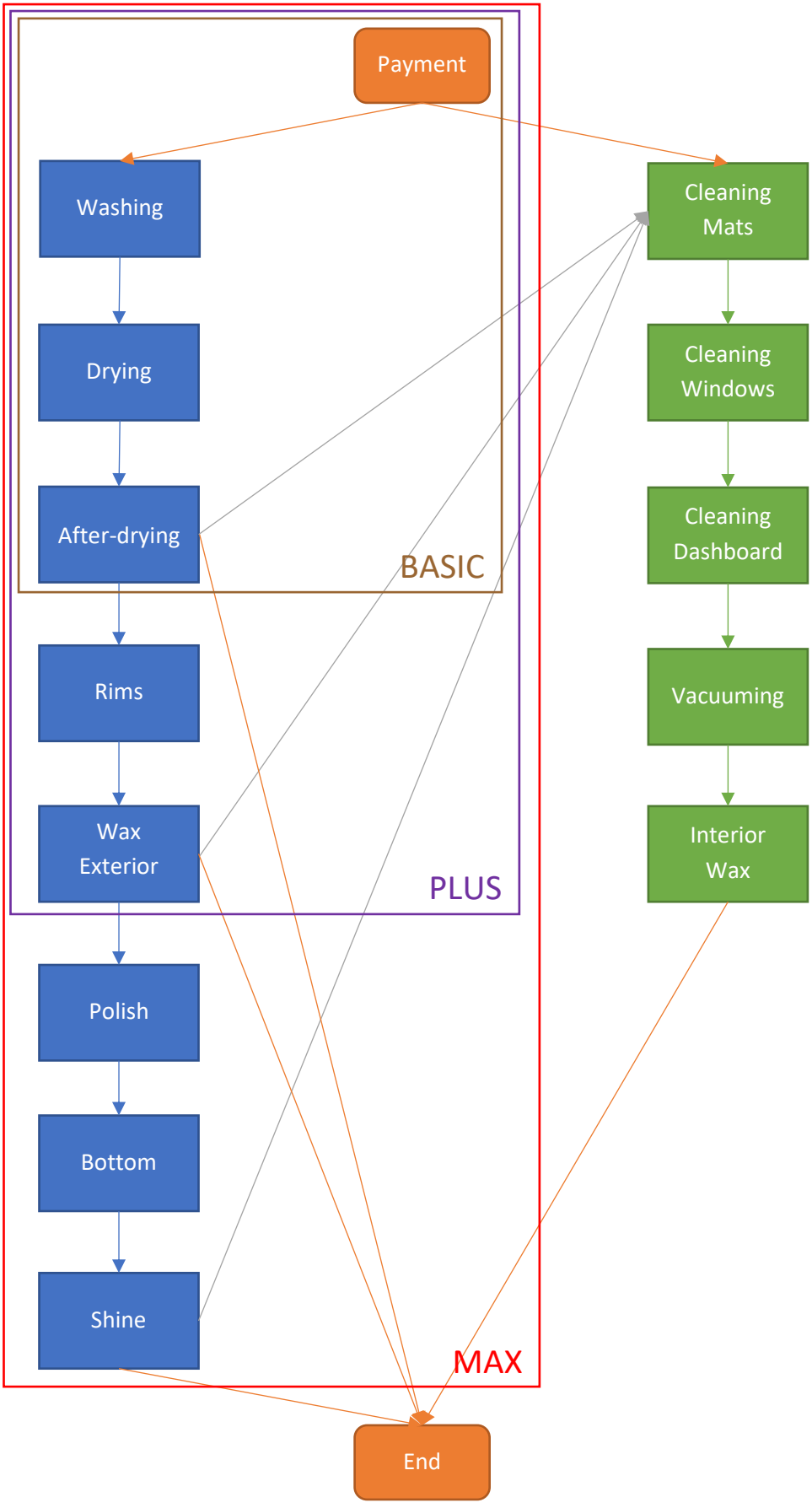
MAX: Washing -> Drying -> After-drying -> Rims -> Wax Exterior -> Polish -> Bottom -> Shine

MAX + INTERIOR: Washing -> Drying -> After-drying -> Rims -> Wax Exterior -> Polish -> Bottom -> Shine -> Cleaning Mats -> Cleaning Windows -> Cleaning Dashboard -> Vacuuming -> Interior Wax

INTERIOR ONLY: Cleaning Mats -> Cleaning Windows -> Cleaning Dashboard -> Vacuuming -> Interior Wax

When we assume that one employee works on one vehicle at a time, then the total capacity of the process is simply the number of employees present. In this scenario the total capacity is thus equal to 15.

When we put all of these programs together into a single flowchart, we obtain the following:



Part 2: Analysis Impact Self-Service Stations

To analyze the impact of self-service stations on the overall process, we must take into account the maximum average amount of time a step takes in the basic program. In other words, if a car is done being washed, but another car is still being dried, the first car will have to wait before it can move on to the next station. We decide to work with the average times of the 68 vehicles which follow the basic program. It is important to note, however, that two employees are working at the washing station. This means that the amount of time a car spends at that station will only be half because either two cars are being washed or two employees are washing one car. The average times at each step are given in the table below.

Program	**Average Time (min)**
Choose Program and Pay	2,71
Washing	5,08/2 = 2,56
Drying	1,91
After-drying	2,90

From the table we see that the maximum average time spent at one of the four stations is 2,90 minutes. Each step of the basic program will thus last 2,90 minutes because of the waiting times associated with the earlier completion of previous steps. The total average time a vehicle will spend when opting for the basic program is:

$$t_{tot} = \#_{steps} \cdot t_{step} = 4 \cdot 2{,}90\ min = 11{,}60\ min$$

Out of the 199 customers who visit Car Wash Inc., 68 choose the basic program. Of those 68 customers, Jan expects 10% would switch to using a wash box. The number of vehicles which will use the wash box is:

$$\#_{vehicles,washbox} = \%_{exp} \cdot \#_{vehicles,basic} = 0{,}10 \cdot 68 = 6{,}8$$

The total amount of time spent at the wash boxes would be:

$$t_{washbox,total} = \#_{vehicles,washbox} \cdot t_{tot} = 6{,}8 \cdot 11{,}60\ min = 78{,}88\ min$$

Since the car wash operates for about 11,5 hours a day, one single wash box would only be used for

$$\%_{usage} = \frac{78{,}88\ min}{690\ min} \times 100\% = 11{,}43\%$$

of the time. So, except if a much greater percentage of customers who choose the basic program switch to using wash boxes, it is not smart of Jan to invest in wash boxes, even if it means he could welcome more customers. The impact on the time in the original service can be determined through:

$$t_{won} = \#_{vehicles,washbox} \cdot t_{step} = 6{,}8 \cdot 2{,}90\ min = 19{,}72\ min$$

Knowing that the after-drying station operates for a maximum total amount of 435,33 minutes, the percentage in time saved by investing in a single wash box equals:

$$\%_{won} = \frac{19{,}72\ min}{453{,}33\ min} \times 100\% = 4{,}35\%$$

Part 3: Design

There are three major ways to improve the efficiency of the process. These three suggestions are based on the following assumptions:

- The aim is to fulfill the promise that a vehicle will be cleaned inside and outside within 45 minutes of arriving.
- The customers who chose not to clean the exterior of the vehicle will immediately be directed to the interior cleaning area.
- Customers who do wish to have their vehicle's exterior cleaned have to sit through the entire process, regardless of the program they have paid for. In such a way, a customer has to wait for the vehicle in front of him to finish with the next station before he can proceed.
- When multiple employees are working at a single station, the amount of time needed to perform the task at the station is linearly proportional to the number of workers. Thus, if it takes one employee five minutes to wash a single car, it takes two employees only half the amount of time to successfully finish the task. An exception to this assumption is the number of employees working at the register, the first station.
- Employees can be reassigned to stations. No new employees are hired, neither are any old ones fired.
- A machine completes a task in the same amount of time as a regular employee.

Taking the above assumptions into consideration, there are three solutions which require minimal economic investment and adjustment but improve the capacity of the process and shorten waiting times:

1. When we calculated the average waiting times in between the different stations, we noticed that the waiting times associated with choosing and paying for a program proves to be the largest bottleneck. The average waiting time before a customer can pick and pay for a program equals 28 minutes and 12 seconds. The total average waiting time per customer equals 38 minutes and 40 seconds, meaning the waiting time before being able to enter the car wash makes up for

$$\% = \frac{28{,}20\ min}{38{,}67\ min} \times 100\% = 72{,}94\%$$

of the total average waiting time per customer. One way to remediate this is by adding a second register at which customers can choose and pay for a program. As a result, there would be two registers that could each direct a customer to either the washing lane or the interior cleaning area. In order to make this work we are forced to reassign an employee from either the washing, polish/bottom/shine-dry, or vacuum station. After some calculations, we came to the conclusion that moving a worker from the polish/bottom/shine-dry station to a register had the greatest positive impact on average waiting times. As it turns out, implementing this solution cuts the average total waiting time down to 18 minutes and 1 second and the total time on average spent in the car wash down to 36 minutes and 33 seconds per customer. The average total waiting time thus amounts to a little less than half of the average time needed to go through the process. On top of that, making this adjustment to the process yields a decrease of 33,41% in time spent at the car wash and a decrease of 24,62% in the number of customers who have to spend more than 45 minutes in the car wash.

2. A second way in which the process can be optimized is through the use of multiple lanes. For example, sometimes the (n+1)th customer has to wait to receive interior cleaning as the nth customer is still getting its vehicle's rims cleaned, exterior waxed, and/or polished, bottom rinsed, and shine applied. This results in unnecessarily long waiting times. Adding a lane such that a customer who does not require a specific treatment can easily bypass the vehicle in front of him will greatly reduce waiting times. The optimal structure for this would follow the flow diagram in Part 1.
3. Lastly, certain stations can be fully automated. Employees can subsequently be reallocated to stations which prove to be a bottleneck. When choosing this solution, however, one has to take into account the additional costs of water and electricity use.

Even though the first solution proves to be the most effective one regarding its required economic investment, its implementation will not be sufficient to adhere to the promotion of cleaning every single car within 45 minutes. To be able to fully eliminate waiting times in the current process and fall below the 45-minute mark, Jan would have to introduce all three solutions. In that case he has to keep in mind that as he moves down the list of solutions, the mandatory economic investment increases proportionally.