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CAR WASH SIMULATION WRITE UP

The goal of the carwash simulation is to understand the principles of operations management and to learn decision making related to production process, capacity planning, inventory management and demand forecasting. All these decisions are interdependent and there are trade offs involved while playing the simulation. The goal of the simulation was to achieve highest level of customer satisfaction, while minimizing costs and maximizing profitability. In all the 5 rounds I played, the maximum profit I could make in 4 rounds was the same at $685 and in the last round I made around $670 (exhibit 1). In the first challenge that we played in class, there was no variability whereas when we moved to playing the round 2 – there was variable demand and variable performance at the service stations, but the objective remains to maximize the profits. In challenge 2, there is an option to increase capacity at any of the three processes, but a cost (investment in stations) is required to accomplish the desired outcome. The problem is somewhat complex because the stations are linked—the output of one station becomes the input of the next (i.e., cars must proceed from the vacuum station to machine wash and then to hand dry). Therefore, balance among stations and the need to invest in stations that become bottlenecks becomes relevant. Rated capacity is the theoretical maximum capacity (e.g., maximum number of units that can be produced under perfect conditions). Usable capacity is the actual capacity after factoring random variables that diminish the maximum (e.g., breakdowns, quality of inputs) (Exhibit 2) In Challenge 2 it was also observed that, as investment increases, capacity increases and variability decreases. Capacity does not increase or decrease linearly with investment. Capacity is NOT balanced across the three stations, and bottleneck will be moving around due to variability, also because of the explicit variability and interconnection among the three stations, there are many potential results. Notably, optimal profitability does not derive from a unique combination of investment options; it is possible to get the same results with different combinations of investments.(exhibit 3) The impact of variability will always get the profit down and that is exactly what we saw happening from Challenge 1 ($825) to Challenge 2 ($685). The reduction in Profitability for the optimal allocation of Challenge 2 relative to the optimal allocation of Challenge 1 ($690 versus $825) is due to the inefficiencies created by the variability. This is a very important learning. Variability represents a “cost” for every system and that is why we need to understand its impact.
In the presence of variability, there is a trade-off between high throughput rates and low manufacturing (i.e., car wash) lead times. This trade-off becomes more severe as process variability increases. In the presence of variability, queue time can become many times larger than processing time as utilization approaches 100%.
Implication of Variability: As the variability in a process becomes more severe, it becomes more and more difficult to achieve high utilization (i.e., higher throughput) and low WIP inventory (i.e., cars waiting in the different stations) simultaneously. The specific solutions to deal with process and demand variability in the simulation are –
A) **Process Variability –**
1.Lean Manufacturing techniques: Implementing Lean techniques like 5S, SMED, TPM, and Six Sigma to reduce waste and improve process efficiency.
2.Statistical Process Control: Utilizing statistical tools like control charts and process capability analysis to monitor and control process variability.
3.Process standardization: Establishing standard operating procedures, visual management systems, and work instructions to minimize human error and improve consistency.
B) **Demand Variability**
1.Demand forecasting: Using statistical models, machine learning algorithms, and sales data to make informed predictions of future demand.
2.Inventory management: Implementing inventory strategies like Just-In-Time, Economic Order Quantity, and safety stock to balance demand and supply.
3.Capacity planning: Developing strategies for adjusting production capacity to meet changes in demand, such as flexible scheduling, outsourcing, and outsourcing.
4. Sales and operations Planning – Collaborating between sales, marketing, and production teams to align demand and supply.
Conclusion - Variability across the stations eliminates a continuous movement of cars through the system, and the resulting irregular build-up of WIP can create different throughputs and therefore varying profitability. capacity, inventory, and variability have an explicit trade-off. Reducing Variability is equivalent to reducing investment in Capacity and reduction in WIP inventory. Variability is therefore always a “cost” to the system.

	Run	Variability	Spending on Vacuum	Spending on Wash	Spending on Dry	Cars Washed	Total Profit
	Run 1	Yes	$1,300,000.00	$562,000.00	$1,138,000.00	272	$685.00
	Run 2	Yes	$1,300,000.00	$550,000.00	$1,150,000.00	272	$685.00
	Run 3	Yes	$1,250,000.00	$590,000.00	$1,160,000.00	272	$685.00
	Run 4	Yes	$1,275,000.00	$550,000.00	$1,175,000.00	272	$685.00
	Run 5	Yes	$1.400.000.00	$600.000.00	$1.000.000.00	269	$670.00

Exhibit – 1

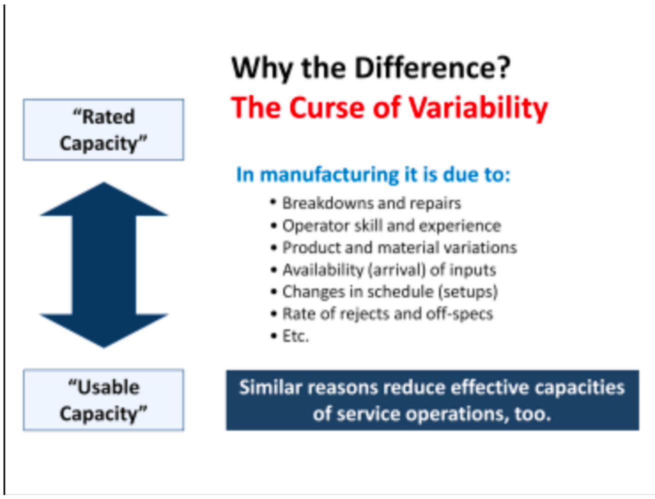

Exhibit -2

Compare Saved Runs:

	Run	Variability	Spending on Vacuum	Spending on Wash	Spending on Dry	Cars Washed	Total Profit
☑	Run 5	Yes	$1,400,000.00	$600,000.00	$1,000,000.00	269	$670.00
☐	Run 4	Yes	$1,275,000.00	$550,000.00	$1,175,000.00	272	$685.00
☐	Run 3	Yes	$1,250,000.00	$590,000.00	$1,160,000.00	272	$685.00
☑	Run 2	Yes	$1,300,000.00	$550,000.00	$1,150,000.00	272	$685.00

Showing 1 to 6 of 6 entries

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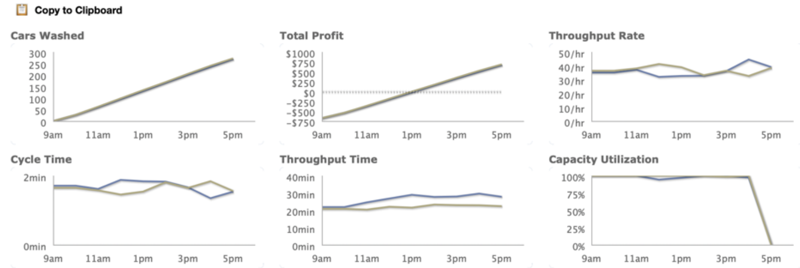

Exhibit – 3 (comparing run 2 and run 5)