Proceedings of the 8th North American International Conference on Industrial Engineering and Operations Management, Houston, Texas, USA, June 13-16, 2023

Loading-Unloading Simulation Model for System of Manufacturing

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Abstract

In manufacturing systems, real-time is a cost feature. Theoretically, the more time a product takes in system, the more value will be added; therefore, production units need to feasibly utilize manufacturing resources in terms of optimal system utilization. For typical manufacturing systems, loading and unloading processes need to operate synchronously with the other system processes. In this applied research work, simulation model for the loading and unloading has been developed for a local manufacturing company to optimize the time and capacity utilization of the system. Real-world data from the system has been collected and used for the modeling. This paper' research approach has been based on developing simulation model for the current loading and unloading processes, and then; after the validation, analyzing the compatibility of the entire system in terms of loading and unloading processes with the manufacturing system capacity. Rockwall software platforms ARENA, Input Analyzer, and Output Analyzer have been used for simulation and analysis. The results show the powerful of the simulation to model this critical process, minimum time and maximum production units are possible optimizing the loading and unloading processes with the manufacturing system.

1. Introduction

Loading process of a manufacturing system is when the system takes required jobs to work in terms of no process is in starvation state will be recognize and unloading process when the system sinks completed jobs in terms of no process is in blocked state. Loading and unloading processes are leading the total performance of systems, and key of the improvement analysis. Simulation approach has been applied to variety of industrial systems and projects as a tool of improvement for the operational capacity and the net profit projects. Many authors used ARENA with other simulation platforms to investigate the effect of conveyor breakdowns on the performance of enterprise operational processes including loading and unloading processes such as fabric handling, delivery, and transportation (Al-Saleh 2011). Graphical representation tools and animation associated with many software platforms provide options to manage involvements of decision-making process (Azadeh, et al., 2013). Deshpande et al. (2007) used ARENA to model truckload terminal operations and analyze alternative dock assignment scenarios. Greasley (2003) used simulation model approach in the manufacturing sector to provide an accurate estimation for system processes utilization. In this research work, a valid simulation model for the loading and unloading processes has been developed using ARENA to find effective number of resources and operation time for the processes. The simulation model used to analyze different scenarios for a local company system's loading-unloading to improve the current system.

2. Simulation Modeling

Figure (1) shows an overview of simulation methodology that has been applied to develop the model of the real-world system. In this illustration figure, system processes are demonstrated as a warehouse of parts arriving, assembling, storing complete products, and other management processes. Four main phases have been followed to develop the model in addition to experimentation phase for the analysis.

Figure 1: Simulation Modeling Methodology

Two simulation models have been developed to represent the loading and unloading processes that are simultaneously operate at the ends of the system as illustrated in Figure (2). The loading process model in demonstration (a) consists of delivering of unassembled parts that arrive at different time interval, parts assembling process, and sorting complete products, and then a loading vehicle transfers complete products to the system as per demands. The model represents vehicle arrival operation, followed by six operations in addition to registration operation used to record the count of vehicles going through the process. The process is sinked using dispose process pointed as truck out. It illustrates that the loading process starts at shipping and receiving station that signs up the system orders and then operates the process as follows: packing process, checking process, sealing process, guaranteeing process, loading products, registration, and sinking out process. Demonstration (b) shows the unloading process logic, it illustrates that the unloading process starts at checking of the final products which arrive on a vehicle that lies the products down for checking, unloading process, registration process, and then arranging and sorting processes by moving the products to the dedicated areas of shipment operations.

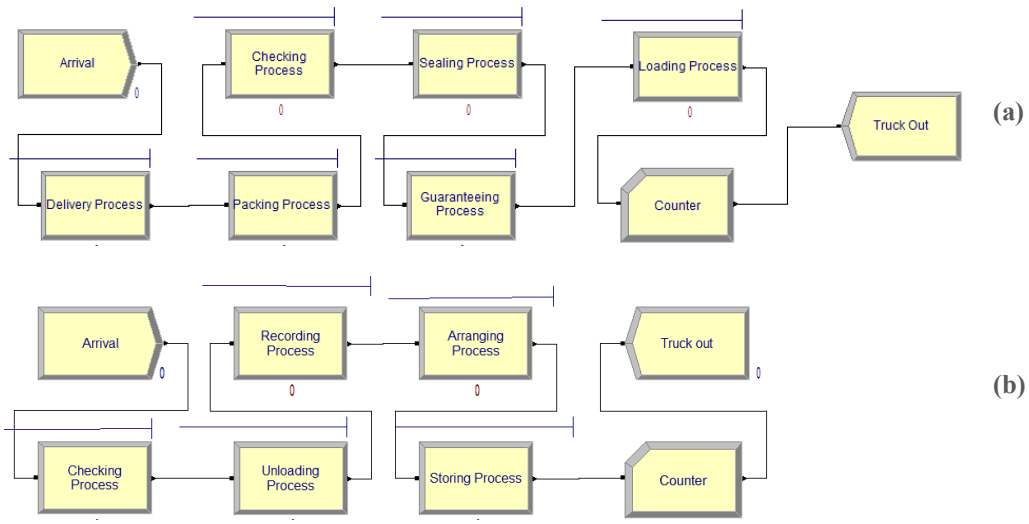


Figure 2: (a) Loading Process Logic and (b) Unloading Process Logic

3. Data Analysis and Results

Table (1) illustrates statistical expressions that have fitted to model variability distribution of each loading operation for the loading process data collection using Rockwall' Input Analyzer. Similar distribution results of unloading process have been analyzed for modeling the process characteristic.

Table 1: Statistical Distributions and Expressions of Loading Process

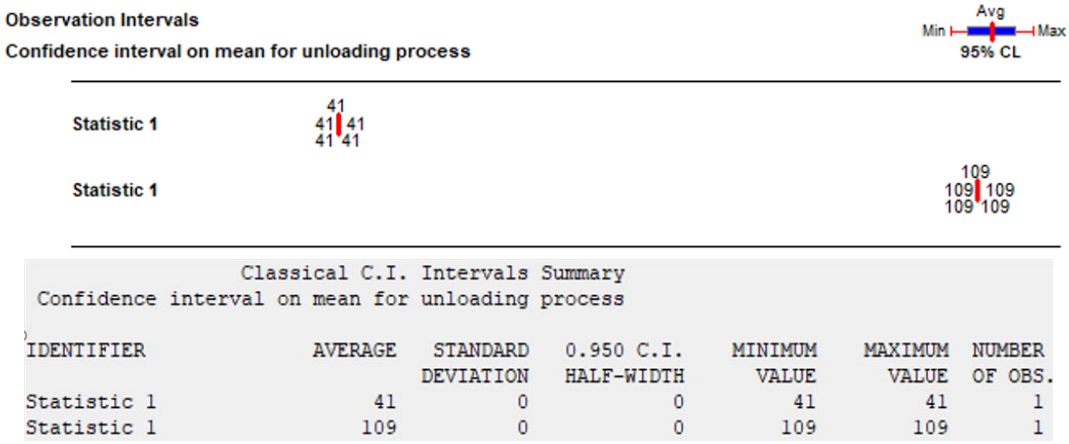
Process	Distribution	Expression
Delivery process	Triangular	TRIA(89.5, 110, 116)
Packing Process	Poisson	POIS(78.9)
Sealing Process	Beta	15.5 + 10 × BETA(0.914, 1.07)
Checking Process	Beta	44.5 + 15 × BETA(1.07, 0.846)
Guaranteeing	Beta	11.5 + 6 × BETA(1.78, 1.3)
Loading time	Beta	7.5 + 8 × BETA(1.01, 0.844)
Truck arrival	Beta	120 + 21 × BETA(0.894, 0.686)

Results analysis and experimentation of running the simulation model show that to improve the unloading process, increasing the resources from one vehicle capacity to two vehicles. This improvement needs that shipping and receiving section needs to expand the number of workers from one to two resulting in duplicating the capacity to four vehicles can operate at a time. Table (2) shows simulation results of experimenting unloading process model for this plan of improvement.

Table 2. Improvement Results of Unloading process Simulation Model

Entity	Average waiting time	Average Total time	Number of vehicles in	Number of vehicles out	Total number seized
Worker 1	0	192.34	110	109	547
Worker 2					547

Results analysis of unloading process also shows that as number of vehicles get in are 110 whereas only 41 vehicles in the system can respond to the entire unloading load which means significant error involved in making feasible decision. This negatively affects the profit and demand responsiveness. However, after increasing the resource, the system can reach maximum unloading process in terms of the number of the vehicles. With increasing the resource number of vehicles in to 109 can finish the entire unloading process which improves the whole performance. The result obviously shows that this improvement saves cost from unloading process without consuming many resources that can be utilized for other production requirement. Figure (3) shows the comparison between the real-world data of unloading process and improved scenario using Rockwall' OutputAnalyzer. It obviously states that adding the vehicles in 110 and 109 can complete the unloading which will save cost in unloading process without utilizing more capacity can be allocated to other resources and meet production requirement on time.



Classical C.I. Intervals Summary
Confidence interval on mean for unloading process

IDENTIFIER	AVERAGE	STANDARD DEVIATION	0.950 C.I. HALF-WIDTH	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBS.
Statistic 1	41	0	0	41	41	1
Statistic 1	109	0	0	109	109	1

Figure 3: Confidence Interval Analysis Unloading Process

4. References

Azadeh, A., Allahverdiloo, M. and Nazari Shirkouhi, S. (2012) 'A computer simulation model for analysing performance of inventory policy in multi-product mode in two-echelon supply chain', International Journal of Logistics Systems and Management, Vol. 8, No. 1, pp.66–85.

Al-Saleh, K.S. (2011) 'Productivity improvement of a motor vehicle inspection station using motion and time study techniques', *Journal of King Saud University – Engineering Sciences*, Vol. 23, No. 1, pp.33–41.

Deshpande, P.J., Yalcin, A., Zayas-Castro, J. and Herrera, L.E. (2007) 'Simulating less-than-truckload terminal operations', *Benchmarking: An International Journal*, Vol. 14, No. 1, pp.92–101.

Greasley, A. (2003) 'A simulation of a workflow management system', *Work Study*, Vol. 52, No. 5, pp.256–261.