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A discrete event simulation of Packed groceries logistics supply system

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Abstract. Nowadays the supply chains are getting longer and we have make their logistics networks more efficient, companies have to choose the appropriate model of supply chain and should promote cooperation with partners in the supply chain.They should adopt new technologies to have better decisions. One of the powerfull tools is discrete-event simulation1 model. Companies and manufacturers can use it to perform analyses to estimate the impact of their decisions performance on the overall before they made any real system changes.

In this paper, we will look at DES techniques to study the reception area processes of packed groceries plant. Then we will model the system and analyze the system performance, and finally find the optimized cost for this model by simulation. It should be mentioned that our analysis are useful for other industries like Dairy industry.

Keywords: Discrete-event simulation, Logistics, Supply systems

1. Introduction

Nowadays the supply chains are getting longer and we have make their logistics networks more efficient, companies have to choose the appropriate model of supply chain and should promote cooperation with partners in the supply chain.They should adopt new technologies to have better decisions. One of the powerfull tools is discrete-event simulation model. Companies and manufacturers can use it to perform analyses to estimate the impact of their decisions performance on the overall before they made any real system changes.

Simulation is a modelling tool widely used in operational research (OR), where computer models are deployed to understand and experiment with a system [1]. Two of the most established simulation approaches are discrete-event simulation (DES) and system dynamics (SD). They both started and evolved almost simultaneously with the advent of computers[2-3], but very little communication existed between these fields[4-5]. This is, however, changing with more DES and SD academics and practitioners showing an interest in the others' world[6]. Unfortunately there is little assistance with this interest, since work reporting on comparisons of the two simulation approaches is limited.

A DES model is defined as one in which the state variables change only at those discrete points in time at which events occur and Simulation is the imitation of the operation of a real-world process or system over time [7-8], and we can say however DES modellers follow a more linear progression, DES modellers focus significantly more on model coding and verification & validation, whereas SD modellers on conceptual modelling[9].

Each event in DES has a time stamp associated with it when an event is processed, it's possible that new events are generated as a consequence of this processing. These new event has larger time stamp. The event in the simulation are stored in a heap and are processed in order of the lowest timstamp first. However computers are naturally suceptible to this approach[10].

1 DES

Traditional discrete-event simulations employ an inherently sequential algorithm. In practice, simulations of large systems are limited by this sequentiality, because only a modest number of events can be simulated. Distributed discrete-event simulation (carried out on a network of processors with asynchronous message-communicating capabilities) is proposed as an alternative; it may provide better performance by partitioning the simulation among the component processors [11-12].

2. The supply system of Packed groceries

The problem is a supply system for distribution of packed groceries in a relatively huge area. In this area, there are five plants that their demand is supplied by a distribution corporation. The mentioned corporation uses two tracks as the same, to transmit the demand of plants daily. At the beginning, each track loads at the distribution corporation. Then, it commence it's traveling to deliver the demand of plants. Traveling is divided to two parts. First, after loading, the beginning path and, second, travel to deliver the products to plants which has unsatisfied demand. After complete unloading of each track, if any demand has been remained, travel to loading at corporation begins. This process continues until no demand remains. Therefore, a model is designed for this case which has five events to define. They are respectively: 1. End of loading event (at Distribution Corporation), 2. End of beginning traveling for event, 3. End of traveling for distribution event, 4. End of unloading event for plant j (index of plants), and, end of traveling for loading event. Based on proposed model, an objective function is considered. The objective function is to minimize the daily cost for supply system. There are some assumptions as blow:

1. Shortage for the demand of plants is unacceptable. Therefore, an integrated scheduling-inventory problem has been solved.
2. It is considered that tracks have no breakdown during their services.
3. Delivering of products is respectively based on j from 1 to 5.
4. The start of loading of track 2 is at least 30 minutes after track 1.
5. Time data is collected from samples as below:
6. Loading time is a variable with normal distribution function. The mean and variance of loading time are respectively 30 and 5 minutes.
7. The time of beginning traveling is a triangle fuzzy number, (2, 5, 8) minutes.
8. The time of traveling for distribution is an exponential variable. The mean of traveling time for distribution is 60 minutes.
9. Unloading time is a variable with normal distribution function. The mean and variance of unloading time are respectively 15 and 3 minutes.
10. The time of traveling for loading at corporation is an exponential variable. The mean of traveling time for loading is about 30 minutes.

3. Simulation of the system

The real system data is gathered by monitoring the system in one week. The simulation program is prepared in visual basic software and the program is run for 100 times to determine the best state and minimum system cost.

Table 1 shows the cost parameters for traveling between facilities, corporation and plants. These values are obtained from the main actual system by gathering the real data.

Table1: Cost parameters for traveling (thousand Rials)

Facilities	Corporation	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5
Corporation	0	2000	2600	2800	2850	2750
Plant 1	1000	0	800	1200	1400	1600
Plant 2	1500	650	0	1000	1200	1100
Plant 3	1700	1000	1100	0	800	950
Plant 4	1900	1150	1250	800	0	250
Plant 5	1800	1250	1200	950	2100	0

Unloading cost is dependent on the time of unloading in each plant. Loading cost is dependent on the time of loading at corporation too. Another cost is the cost of waiting in queues for tracks. Also it is considered that the cost of beginning traveling is constant and equal to 500 thousand Rials.

For model validation, we use the views of experts and available data in real system. Therefore, table 2 shows the results of model in comparison with sample data. The model runs 100 times. The sample column is obtained by data gathering from the real system in one week. Then the simulation was ran for 100 times. Values are shown in table 2. Deviation is obtained from the distance between the simulated values and sample data based on the sample data.

Table2: Comparison of model results and sample data

	Sample	Mean of 100 simulation runs	Deviation (%)
Mean of waiting in queue j=1	5	4.6 (min)	- 8.0
Mean of waiting in queue j=2	1.15	1.2	4.3
Mean of waiting in queue j=3	1.05	0.95	- 9.5
Mean of waiting in queue j=4	0.5	0.55	10
Mean of waiting in queue j=5	7	7.5	7
Mean of waiting (loading)	10	10.6	6
Total working daily time	7.5	7.6 (hour)	1.3

The best state for the model among the 100 runs which has the less cost is to serve plants 5, 4, 2, 3 and 1 respectively for track 2 and, 1, 2, 5, 4 and 3 for track1. In fact, among the simulation runs with serving the plants in different permutations, best answer is determined as above. The optimized cost for this model is estimated "65000 thousand Rials ".

4. Conclusion

In this case, we consider a supply system with 5 plants and a corporation. A model designed and 100 simulating runs implemented. Then, among all of the runs, the best state which has the less cost selected.

For the future researches, considering multi objective functions can be recommended. Also, regarding other states such as opening warehouses for some of plants and designing a three echelon supply chain can be performed.

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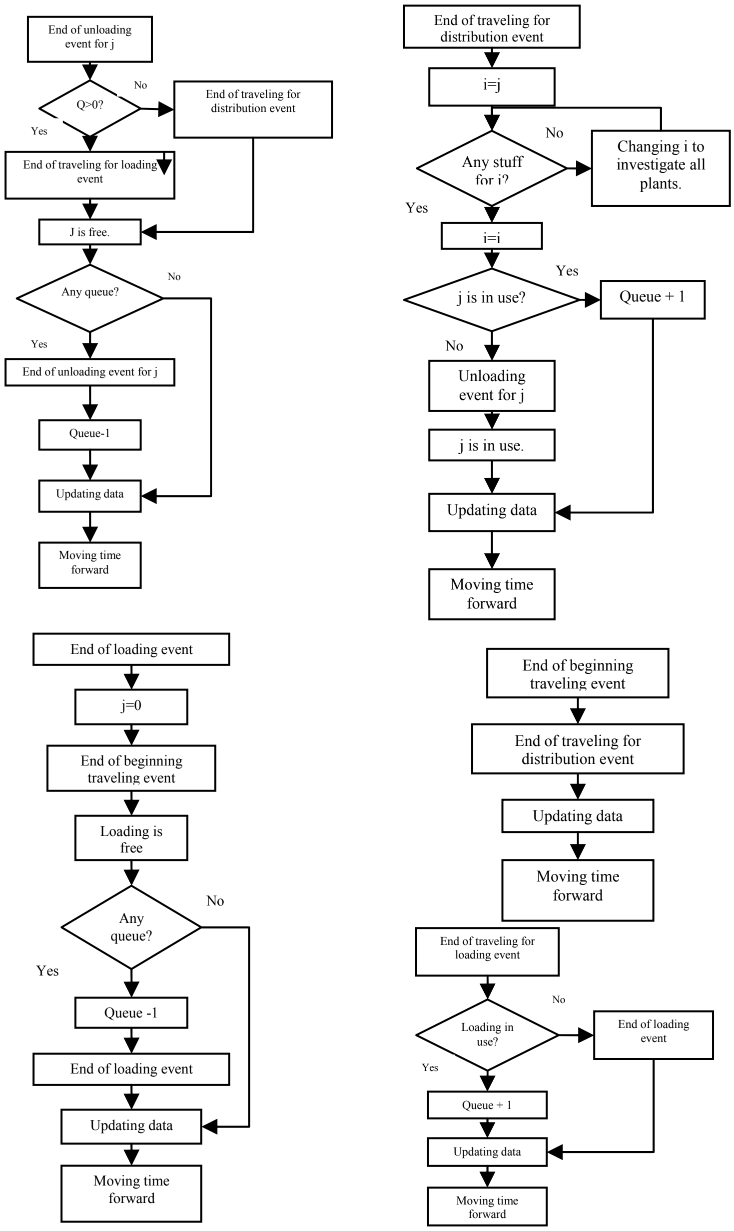

Fig.1 Flowchart of the simulation model