

A three echelon supply system: a discrete event simulation

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Abstract. Due to new needs of supply systems, new solutions must be developed and evaluated. One of the important tools is discrete 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. In this paper, we consider multi objective functions and integrated inventory. Also, regarding other states such as opening warehouses for some of plants and designing a three echelon supply chain will be performed. We survey the new model and will be compared with the previous method of same authors[1].

Keywords: Discrete simulation, Logistics, Supply systems, Multi objective function

1. Introduction

Due to new needs of supply systems, new solutions must be developed and evaluated. Supply chains are developed to increase the public satisfaction by maximizing goals such as benefits or service level or minimizing cost or delays. In this paper, one echelon as warehouses is added to our basic model. Also the impact of applying integrated inventory-distribution strategy is investigated.

Simulation is a modelling tool widely used in operational research (OR), where computer models are deployed to understand and experiment with a system [2]. 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[3-4], but very little communication existed between these fields[5-6]. This is, however, changing with more DES and SD academics and practitioners showing an interest in the others' world[7]. 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 [8-9], 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[10].

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 timestamp first. However computers are naturally susceptible to this approach[11].

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 [12-13].

2. A three echelon supply system: a discrete event simulation study

In this case, according to the basic case [1], plants are divided to two separate area. Area 1 is contained of plant 1, 2 and 3. Plant 4 and 5 are located in area 2. The main idea for dividing the plants into two groups, is adding an echelon to mentioned supply system. Therefore, for each area, a warehouse is regarded. Warehouse 1 is located in area 1 to serve plants 1, 2 and 3. Warehouse 2 is located in area 2 to serve plants 4 and 5. After loading, trucks 1 and 2 transmit products from corporation to warehouse 1 and 2. So, trucks do not have any transmitting between corporation and plants. Every warehouse has two vans to deliver the products to relative plants. Dividing the main area into two smaller areas is considered as a new scenario for our problem to deliver products in a shorter time and less supply system daily cost in comparison with the main state. To implement the new scenario, the main problem breaks into two similar problems. Problem 1 is delivering the products to warehouses from corporation, considering no shortage. Problem 2 is delivering the products from warehouses to plants in each area. Shortage is unacceptable. So, two problems are similar to each other. The event diagrams for each problem is similar to another problem and the main problem.

Time data is collected from samples as blow:

1. Loading times in corporation and warehouses are variables with normal distribution function. The mean and variance of loading times are respectively 30 and 5 minutes for corporation and 20 and 5 for warehouses.
2. The time of beginning traveling is a triangle fuzzy number, (2, 5, 8) minutes for corporation and (1, 3, 5) for warehouses.
3. The time of traveling for distribution is an exponential variable. The mean of traveling time for distribution is 35 minutes for corporation and 15 minutes for warehouses.
4. Unloading time is a variable with normal distribution function. The mean and variance of unloading time are respectively 15 and 3 minutes for warehouses and 8 and 2 minutes for plants.
5. The time of traveling for loading at corporation and warehouses is an exponential variable. The mean of traveling time for loading is about 20 minutes for corporation and 10 minutes for warehouses.

Unloading cost is dependent on the time of unloading in each plant and warehouse. Loading cost is dependent on the time of loading at corporation and warehouses too. Another cost is the cost of waiting in queues for trucks. Also it is considered that the cost of beginning traveling is constant and equal to 500 thousand rials for corporation and 40 thousand rials for each warehouse. Cost of opening warehouses is equal to 1000 thousand rials.

3. Simulation of the system

Table 1 shows the cost parameters for traveling between facilities, corporation, warehouses and plants.

Table1. Cost parameters for traveling (thousand rials)

Facilities	Corporation	Plan1	Plan2	Plan3	Plan4	Plan5	Warehouse 1	Warehouse 2
Corporation	0	0	0	0	0	0	1500	1900
Plant 1	0	0	700	1000	1200	1500	0	0
Plant 2	0	600	0	900	1150	1000	0	0
Plant 3	0	900	1000	0	750	900	0	0
Plant 4	0	1000	1050	750	0	170	0	0
Plant 5	0	1200	1100	800	1700	0	0	0
Warehouse 1	700	400	420	350	0	0	0	1500
Warehouse 2	850	0	0	0	600	550	1500	0

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.

Table2. Comparison of model results and sample data

	Sample	Mean of 100 simulation runs	Deviation (%)
Mean of waiting in queue j=1	3	2.8 (min)	- 6.6
Mean of τ in queue j=2	0.9	1	11.1
Mean of waiting in queue j=3	1	0.95	- 5
Mean of waiting in queue j=4	0.5	0.55	10

Mean of waiting in queue $j=5$	3	3.1	3.3
Mean of waiting in queue in warehouse 1	5	5.1	2
Mean of waiting in queue in warehouse 1	4	4.05	0.3
Mean of waiting (loading)	9.5	9.7	2.1
Total working daily time	7.3	7.35 (hour)	0.6

The best state for the model among the 100 runs which has the less cost is to serve plants 1, 2 and 3 for van 1 in area 1 and 3, 2 and 1 for van 2 in area, Plants 4 and 5 for van 3 in area 2 and plants 5 and 4 for van 4 in area 2, warehouse 1 and 2 for truck 1 and warehouse 2 and 1 for truck 2. the total daily cost estimated as 5900 thousand rials.

4. Conclusion

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

The obtained daily cost in the new scenario is less than the cost of main problem. So, using of warehouses and even developing them is recommended. It can be concluded in this case that indirect distribution is more economical rather than direct distribution.

For the future researches, considering multi objective functions can be recommended. Also, other strategies such as inventory control in warehouses, regarding distribution risks and vehicles failure can be considered.

5. References

- [1] Kazemi, S.M.M. and P. Taki, A DISCRETE EVENT SIMULATION OF PACKED GROCERIES LOGISTICS SUPPLY SYSTEM, in 4th International Conference on Computer modeling and simulation. 2011, ASME.
- [2] Pidd, M., Computer simulation in management science. 1998: John Wiley & Sons, Inc.
- [3] Wolstenholme, E.F., System Enquiry: A System Dynamic Approach. 1990: John Wiley.
- [4] Robinson, S., Soft with a hard centre: discrete-event simulation in facilitation. Journal of the Operational Research Society, 2001: p. 905-915.
- [5] Lane, D.C., You Just Don't Understand Me: Models of Failure and Success in the Discourse between System Dynamics and Discrete-Event Simulation. 2000: London School of Economics and Political Sciences.
- [6] Brailsford, S. and N. Hilton, A comparison of discrete event simulation and system dynamics for modelling health care systems. 2001.
- [7] Morecroft, J. and S. Robinson. Explaining puzzling dynamics: comparing the use of system dynamics and discrete-event simulation. 2005.
- [8] Banks, J. and J.S. Carson, Discrete event system simulation. 1984.
- [9] Banks, J., et al., Discrete-event simulation. 1999: Prentice-Hall.
- [10] Tako, A.A. and S. Robinson, Model development in discrete-event simulation and system dynamics: An empirical study of expert modellers. European Journal of Operational Research, 2010. 207(2): p. 784-794.
- [11] Tropper, C., Parallel and distributed discrete event simulation. Vol. 62. 2002: Nova Science Publishers.
- [12] Misra, J., Distributed discrete-event simulation. ACM Computing Surveys (CSUR), 1986. 18(1): p. 39-65.
- [13] Fujimoto, R.M. Parallel and distributed simulation. 1999: ACM.

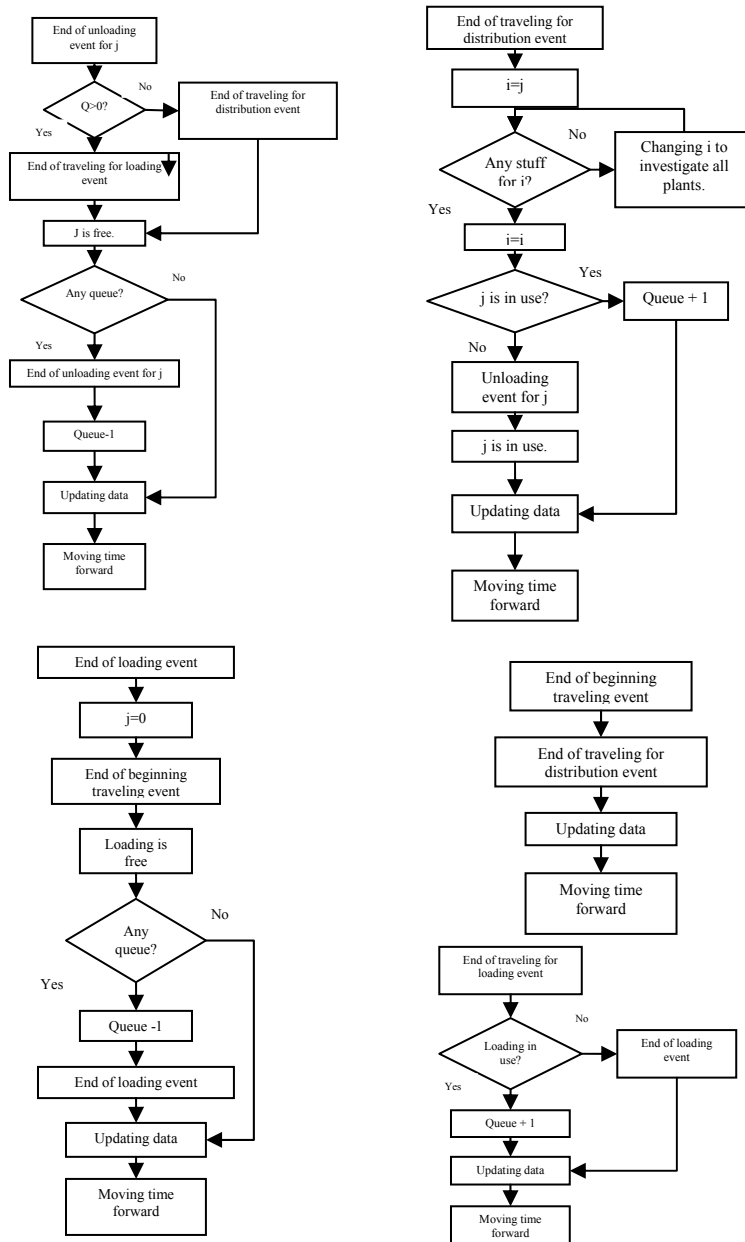


Fig.1 Flowchart of the simulation model