Proceedings of the 2012 Winter Simulation Conference
C. Laroque, J. Himmelspach, R. Pasupathy, O. Rose, and A.M. Uhrmacher, eds

ANALYSING LTL TERMINAL PERFORMANCE BY COMBINING SIMULATION AND STATISTICS

Sonja Kuhnt
Viktoria Sander

TU Dortmund University,
Institute of Mathematical Statistics with Industrial Applications
Vogelpothsweg 87
D-44227 Dortmund, GERMANY

Uwe Clausen
Jan Kaffka, Larissa Mest

TU Dortmund University,
Institute of Transport Logistics
Leonhard-Euler-Str. 2
D-44227 Dortmund, GERMANY

ABSTRACT

Forwarding agencies dealing with LTL (less than truckload) transportation services arrange the collection of advised piece goods at the consignor and deliver the shipments to the indicated consignee in requested time and quality. The agency itself can be run according to different strategies, e.g. assignment of vehicles and fork-lift-tasks. However, the effect of individual choices is not immediately obvious due to a complex interdependence structure between inner and outer processes. With the simulation suite ED Transport and its library TransSim-Node a discrete event simulation has been developed by which effects of long term and operational strategies can be explored. Based on a limited number of well-chosen simulations according to a statistical design of experiment we analyse the waiting time of shipments as a key performance characteristic. Results are used to evaluate conjectures on the performance of the system and to derive a deeper insight into the complex interactions between strategies.

1 LOGISTIC BACKGROUND

Forwarding agencies deliver their shipments by using own or shared networks, facing a strong pressure of competition due to a fragmented and dynamic market which results into small profit margins of around 1 to 3 percent. Due to this, it is quite important for the terminal operator to identify the right mix of operational and tactical strategies, which leads to low costs and at the same time offers a high service level to the customers. The decisions affect the operation processes in the terminal and the usage of involved resources (fork lifts, workers). Besides, decisions address number and kind of resources involved (conveying equipment, staff) as well as their temporal distribution (shift schedule) and responsibilities (firm allocation of personnel to certain areas, certain or similar activities). Altogether there is an abundance of criteria and factors, which affect the decisions of dispatching. All those strategies affect the performance and therefore the efficiency of the terminal (Clausen et al., 2011).
So far, decisions are made manually or based on the experience of the dispatcher, which are feasible and yield to the demanded performance (throughput). A systematic analysis of the effect of different operational strategies usually is not possible within the real system. For this reason a large potential to reduce costs and / or to increase the service level can be assumed.
With the help of the simulation suite ED Transport (Clausen et al., 2011) we analysed a LTL terminal and focused on tactical and operational strategies. Hence, three major segments of operational strategies are identified: strategies for unloading vehicles (vehicles to doors, staff to vehicles), strategies for loading vehicles (vehicles to doors, staff to vehicles) and internal transport strategies (forklift to shipments, shipments to forklifts).
Based on this 25 different single strategies four main tasks can be identified for the operational analysis of a LTL terminal. These tasks concern the assignment of unloading vehicles to doors and operators (AU), the assignment of loading vehicles to operators (AL), Forklift-Task-Assignment (AF) and Forklift-Task-

978-1-4673-4781-5/12/$31.00 ©2012 IEEE

Assignment (PS). Even when not considering combining strategies from the same task, 8 x 4 x 5 x 8 = 1280 different strategy combinations are possible. In addition, the strategy portfolio has to be doubled due to the fact that a LTL terminal is operated in two different phases (inbound and outbound) with their distinct characteristics and therefore probably different strategy bundles.

2 STATISTICS

The effect of individual strategies as well as their combination on the performance of the forwarding agency is analyzed with a focus on the waiting time of shipments as performance measure. For a first exploration of the effects a design with only 24 runs, at least three runs for each strategy, is chosen which firstly is generated as a D-optimal experimental design (Myers et al., 2009). Then it slightly is adjusted to balance the number of occurrences of each strategy.
With the help of bar charts of the simulation results the main differences can be identified in the tail regions so that the further analysis deals particularly with the first and the third quartiles of the waiting times.
Figure 1 shows the first quartiles, hence the point below which 25 percent of the waiting times are, for the four varied tasks. In each individual plot the value of each of the 24 simulations is depicted at the respective strategy. The plot suggests that the influence of PS is most important as points for each strategy are close together and vary obviously between strategies. For the other tasks no strong systematic differences between strategies can be detected except possibly concerning AU for a low value for strategy 5 and a high value for strategy 6.

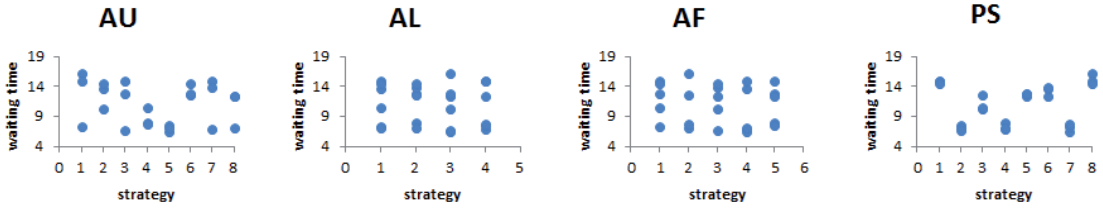

Figure 3: First quartiles of the waiting times ordered by the chosen strategy for each task

3 CONCLUSION

Overall the chosen approach of a statistical design and analysis led to valuable insight in the effects of the tasks and strategies on the key performance indicator. Next, the analysis needs to be extended to further performance measures, e.g. the waiting time of the trucks. As a further step more extensive simulation should be conducted in order to fit and analyze statistical prediction models.

REFERENCES

Clausen, U., I. Goedicke, L. Mest and J. Kaffka, 2011 *Layout Planning of Less Than Truckload Terminals*, In: Balsamo, S; Marin, A.(Hrsg.): Proceedings of the 9th Industrial Simulation Conference 2011, S. 204-208.

Myers, R.H., D.C. Montgomery and C.M. Anderson-Cook. 2009. *Response surface methodology: Process and product optimization using designed experiments.* Wiley, 3rd ed., New Jersey.