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A MILITARY FOOD SUPPLY CHAIN IN A HOSTILE ENVIRONMENT: A CASE STUDY

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ABSTRACT

History teaches us that commercial-supply chains (SCs) emerged and developed from military-SCs. However, the interest of researchers and practitioners has focused mainly on the former, thus creating a significant gap in the literature. Although several factors can be mentioned for this prevalent inattention and consequent lack of detailed studies upon military-SCs, the main reason for this gap relates to the access to reliable sources of information on how this type of SC operates in practice. Additionally, from the logistics point of view, the battle/operational situations are very attractive for doing risk analysis since none commercial-SC faces the level of challenges and dangers that a conventional military-SC tackles on a daily basis.

Taking into account the above, in this article we develop a case study analysis based on a real-world supply chain of military food (SCMF) operating in a risky environment. This military-SC specializes in the production of 'ready-to-eat' food (or combat rations, CRs) for a medium-sized army (< 280,000 troop members). In order to accomplish this task, the SCMF has to complete a detailed production process—military-SCs are usually public organizations operated by the government—that involves twelve main operations including the selection and evaluation of suppliers; the preparation and shipping of raw materials to warehouses; the receipt, verification and storage of raw materials; the transportation and delivery of raw materials; the pre-assembly of energetic products for CRs; the assembly of CRs; the quality control and shipping of CRs; the transportation and delivery of CRs to stocking points; the receipt, classification and storage of CRs; the transportation and delivery of CRs to distribution points; the receipt and delivery of CRs to cross-docking points; and, the transportation and delivery of CRs to customers (troops).

Regarding the risky environment, the SCMF under study deals with the stepwise occurrence of nine risks grouped in three categories—operational risks; natural disasters and intentional attacks; and, black swan events. The risks in the first category include the occurrence of breakdowns in machines or workstations, delays in contracting with suppliers, shortages of raw material and components, and quality problems. The risks in the second category comprises natural phenomena that may cause serious damages to the SCMF facilities such as earthquakes, storms, floods, fires, power cuts, attacks on the lines-of-communication, attacks on forward logistics support units, and contingent demand. Lastly, this analysis also consider the occurrence of 'black swan events' in the form of surprising and premeditated airstrikes launched by air forces of any neighbor country. For each one of these risks, the case study describes underlying causes, foreseeable effects on the SC, probability distribution associated, distributional parameters, and modeling assumptions.

To conduct this analysis, we use as methodology discrete-event simulation (DES) in the form of the software *Simulink* [v.R2019a] by MATLAB®. Thus, the primary objective of this study is thereby to observe the long-term performance—'level of service' = cycle time minus lead time—of the SCMF when the frequency of the three categories of risk considered are individually increased. The importance of this

key performance indicator is given by its meaning for the SCMF: A low level of service in the SC could be associated with a low performance of the troops on the battlefield, or even a large number of wounded or killed troops in combat. In this sense, although it seems pretty intuitive that, ceteris paribus, an increase in the frequency of each category of risk considered will adversely affect the level of service of the SCMF; for the simulation study is worth to know in advance the impact of each risk on each process and how the initial configuration of the SCMF could affect its final performance.

To this end, this article presents an in-depth characterization of the SCMF subject of study, including the identification of raw materials used, the determination of effective and theoretical assembly capacity, the operations needed for the assembly of combat rations, the identification and characterization of the three categories of risk that might affect the SCMF, as well as the mechanisms for its verification and validation. Regarding the simulation model, the analysis also incorporates an efficient simulation experiment, one for each category of risk considered. The final result: a thorough and robust non-terminal DES model for the SCMF subject of study.