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# Dynamics of Multi Agent Supply Chain under the Threat of Disruption

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**Abstract**—This research deals with a dynamic hybrid modeling approach of multi agent supply chain. The integration of system dynamics (SD) and agent based modeling concept is a potential effective combination of methods in order to consider flexibility and complexity of the model. In this paper, this approach in a two-level supply chain is presented. In the proposed model, three types of disruption risks is considered, and an experiment for which the integrated simulation solution is applied are described.

**Keywords**- Supplier selection; disruption; supply chain; agent based; system dynamics

## I. INTRODUCTION

In the global competitive business environment, companies are seeking the best way to get high efficiency of their supply chain in order to gain competitive advantages. In regard to this issue, suppliers play a major role in reducing costs, increasing profit margins, and ensuring timely delivery [1]. When number of suppliers are limited, companies run into the risk of insufficient raw materials to supply their uncertain demand [1]. As an example, Ericsson cell phone company lost \$400 million in sales due to shut down of its single supplier of microchips [2]. This risk may be as a result of natural disaster or man-made activities. Regardless of the source of risk, it can go through whole supply chain and cause huge amount of costs.

There is an extensive literatures which show the development of mathematical models to answer these basic questions when supply chain is under risk: which supplier to choose, and what the optimal ordering policy is [3-6]. The main disadvantage of mathematical models is their weakness in dealing with complex and nonlinear systems. In this situation, simulating methods can be a better tool of analyzing the behavior of system components and supporting decision making processes.

In this research, SD as a well-known simulation and modeling tool is applied.

SD is a modeling perspective based on feedback theory concept which is used in a complex systems that linear cause-and-effect reasoning cannot explain the behavior of the system well [7]. Also, SD is a widely used modeling and simulation tool in supply chain management. Due to the chain's inherent feedback loops and delays, this tool is applied in several issues at strategic, operational, and tactical level [8]. Despite the wide use of SD in supply chain management, SD may miss the dynamic of the system at detailed level because of different individual agents' behavior [9]. Whereby, in this research, SD modeling with coordination of agent based modeling concept is used to describe the suppliers' and customers' behavior under the disruption in a supply chain. Multi agent system is composed of multiple agents where agent is a component of the system that has independency in its actions, and has ability to interact with other agents in the system through some patterns like cooperation, coordination, and negotiation [10]. Agent based models are based on actions of individual agents and their interactions with other agents. In other words, agents should be able to make independent decisions and interact with other agents in a multi agent system according to the objectives of model [10].

The remainder of this paper is as follow: in section 2 the whole SD model with the agent based modeling approach is depicted. Experimental result based on scenarios is shown in a sample SD model in section 3. In last section, the conclusion of this research with some advices for future research is discussed.