

# 博士論文 (要約)

## Development of consumer panic buying model and managing its impact on supply chain during a disaster

(災害時における消費者のパニック購買行動モデルの開発とそのサプライチェーンに与える影響の管理)

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Disasters, nowadays, are far from rare events, causing extensive damage to life and property. The number of natural disasters has been increasing by the year, with growing intensity and amount of damage occurring to life and property. A disaster affects every aspect of human life, from the daily activities of an individual to the economic activities of the community or the country overall. While the opportunities have immensely improved with globalization, the risks posed to the businesses and supply chains has increased proportionally. The supply chains are often susceptible to many disruptions due to various reasons such as natural calamities, terrorism. Given the importance of supply chain performance in any business, there is a lot of research in the field of supply chain risk management, which works towards the reduction of these disruptions. But, one major reason for the disruption, which is often ignored, is the change in consumer behavior in uncertain situations such as large scale natural disasters, emergencies, etc.

Consumer behavior is also of utmost importance for business success. This behavior is altered in a disaster scenario. Disasters create a sense of fear, anxiety, and people tend to take precautionary actions of survival, to mitigate future risks. One such survival action is the stockpiling of essentials to mitigate the risk of a possible stockout. People can be seen panic buying on essentials like water, instant foods, fuel, etc., before or immediately after almost every disaster. However, the recent COVID19 pandemic has shown that this behavior can be seen in all uncertain situations. People were hoarding on available goods irrespective of the necessity. Masks, sanitizers are products that were and are still difficult to be obtained even by some governments. But, goods such as toilet paper, groceries, which are low priority goods during a pandemic, were also flying off the shelves. This resulted in stores implementing sales restrictions all over the world.

Panic buying leads to a sudden increase in demand, which has the potential to disrupt the supply chain. The disruption leads to more panic buying forming a vicious circle. Research on understanding consumer panic buying is conducted by sociologists and psychologists but is mostly limited to statistical analysis. With a focus on the causes, effects, and mitigation of the disruptions, a substantial amount of literature is available on supply chain disturbances by the specialists, mostly ignoring the effect of consumer behavior. Hence, there is a requirement to bridge the gap between consumer behavior and supply chain management for better functionality. To address this issue, we have developed a simulation tool which will quantitatively analyze the transformation of consumer purchase behavior in a disaster and evaluate the consumer panic purchase intention; analyze the impact of consumer panic buying on the supply chain and tests the mitigation measures to reduce the impact

using an agent-based model. The product used for the current model is bottled water, as it is one of the most essential commodities in any disaster.

The simulation proposes a combination of consumer behavior and supply chain. The supply chain model deals with the various activities the members or the organizations involved in a supply chain need to undertake on a regular basis to sustain their businesses. A simple 3-tiered hierarchical supply chain has been considered. The model has 5 types of agents which include manufacturers, distributors, individual retailers, chain head, and chain stores. The supply chain agents produce and distribute the product until it reaches the final consumer. The consumers can interact and buy the product from the retail stores only.

The consumer model is the decision-making process that involves how individuals make decisions to spend their available resources such as time, money, effort on the consumption of products. In general, consumer decision-making is influenced by factors, such as lifestyle, family, motivation, price, brand, etc. However, in a disaster scenario, the products sought out are mostly essential commodities. Hence, the key factors to affect are family, motivations, psychological factors, and importantly, the situational consequences of a disaster over other factors such as price and marketing. These factors are segregated into different categories - Personal, Psychological, Individual, Social, and Situational. The consumer agent in the current model is a household.

The model evaluates the purchase intention probability of a consumer, given the personal and situational factors. The model is developed based on a logistic transformation function, built using a multiple regression analysis of a questionnaire survey. The survey has been conducted to understand the significant factors which influence the decision making of the purchase of essential commodities during disasters. The survey was conducted with 300 participants in the Tokyo metropolitan area, between the age groups of 19-70 years. The survey focuses on the personal characteristics, psychological attributes, purchase habits, past experience, along with the situational occurrences after a disaster, such as sales restrictions in stores, media reports regarding stockouts or panic buying, rumors about the shortages of products or panic buying and the panic purchase behavior of their reference groups and how the above situations would influence their purchase behaviors. The above model is implemented by the agent through the decision-making process involving six stages, viz., need recognition, information search and processing, factor valuation, purchase decision, purchase, and purchase evaluation.

The simulation was conducted with 2000 agents with four stores for the consumers to purchase the product. The stores are restocked at the end of every interval. The personal attributes for each agent

are randomly generated, but distributed according to the survey data. The simulations are executed for 60 intervals in various scenarios, where the disaster occurs in the 30th interval and the strategy is implemented in the subsequent interval.

Consumer behavior, along with its impact on the supply chain, has been studied in cases of disaster and the implementation of strategies of sale restrictions and rationing system. The changes in consumer behavior due to the situational factors can also be analyzed with this model. While sale limitation is a very popular strategy, rationing is a rather strict measure used for scarce goods or essential commodities. The simulation results have offered to provide an understanding of the impact of both the strategies on the consumers and the supply chain. The disaster compels the consumers to panic buy, which in turn has a negative effect on the supply chain, creating a disruption. The strategies have been found useful in supporting the system in crisis times; however, one was found to be more effective.

The sale restrictions strategy shows improvement in the supply chain by avoiding the crash, but minor disruptions could not be prevented. This strategy was found to improve the purchase situation and helped in increasing consumer satisfaction from the disaster scenario. But, the rationing system was very effective from the point of employment in curtailing the disturbance from moving up the hierarchy and in increasing the number of highly satisfied consumers, minimizing the consumers with zero satisfaction. Hence, this strategy can be implemented in crisis situations to properly regulate the sale and distribution of scarce goods or basic essentials. The application of the developed model has been demonstrated by varying the amounts of situational elements. It was found that the strategy when employed uniformly is most effective. While reducing the media reports and rumors by 50% could significantly reduce the demand.

Such research helps in providing an insight into the behavioral changes of the consumer induced due to panic situations. There is an increasing need for more researchers to work on panic buying to understand better and improve the situations in the future. Such tools would help the government to identify the people resorting to excessive buying and work on reducing panic buying among the people and are quite useful for the industrial sector to take measures to mitigate future disaster scenarios.