The Impact of Panic Buying on Inventory Logistics

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This paper investigates the impact of panic buying on consumer and organizational inventory logistics due to the limited body of research in organizational behavior and logistics. Goldratt's Theory of Constraints is the primary theoretical model and is coalesced with organizational psychology exploring the link to panic buying and decision making. A new statistical model examining the relationship between participants' feelings of nervousness about product shortages and panic buying was established and tested. The purpose of this new statistical model was to explore these implicit phenomena from an organizational psychology lens where few statistical models exist. Findings include panic buying during uncertain times as an unrealized constraint in operations management.

Keywords: Theory of Constraints, panic buying, inventory logistics, consumer logistics

INTRODUCTION

The COVID-19 pandemic had a tremendous impact on consumer buying and retail inventory behavior. Common inventory items (e.g., canned goods, paper goods, food stocks) found in major retail stores were at and in many instances remain at dramatically low levels compared to pre-pandemic levels (Mao, 2020). One primary reason for this inventory drop includes consumer behavior evolving such that hoarding, personal inventory loading, and fear of shortages dominated the shopping landscape (Wang et al, 2020). It is a common reaction to times of uncertainty (Sterman & Dogan, 2015) including hurricanes and other natural disasters (Zwieback, 1995). Moreover, this often leads to consistent consumer goods shortages whenever there is a man-made or natural disaster (Nguyen et al., 2019). Thus, a deeper understanding of consumers' psychological reasoning and internal cost-benefit analyses during uncertain times remains an area critical to a greater exploration of disaster logistics. One such approach to this exploration is the application of Goldratt's Theory of Constraint (TOC) to panic buying. The TOC is a process improvement methodology that people and companies use to identify and eliminate constraints (Akdeniz, 2016) - "Anything that limits a system from achieving higher performance versus its goal" (Goldratt, 1990). Typically, TOC is used to identify bottlenecks that are directly connected to manufacturing processes. For example, lack of labor is considered a capacity constraint (Akdeniz, 2016). However, it appears that TOC

can be applied to the consumer side of buying and inventory decision-making to detect and prevent bottlenecks for consumers which lead to bottlenecks for manufacturers. When applying TOC to consumers, panic buying becomes yet another bottleneck as defined by TOC and includes consumers' perceptions and feelings brought on by perceived or real production defects. Linking TOC directly suggests that by not detecting potential constraints may negatively impact consumer's individual inventories, and thus, negatively impacts companies' ability to forecast and meet demand.

LITERATURE REVIEW

Panic buying often suggests a pejorative behavior linked to control or addiction when it is common across all facets of consumer and industry decision-making (Bentall et al, 2021): Consumers increased their purchasing modestly and many bought disproportionate quantities (Bentall et al., 2021). According to Hendrix & Brinkman (2013), especially during times of uncertainty, people tend to panic buy - "panic buying also has been linked with perceived feelings of insecurity and instability in certain situations" (Hendrix & Brinkman, 2013). In this paper, panic buying is defined as having an inner need to buy higher quantities of goods than what is needed that may be expressed in various ways, as described later in our model (Arafat, Kar & Kabir, 2021).

According to existing literature concerning this panic buying, people engage in panic buying for multiple different reasons: **1)** The first one is due to the illusion of control, meaning that, whenever people engage in panic buying, they overestimate their ability to control events around them. They buy more as a coping mechanism to feel under control when things around them are uncertain and challenging to grasp. Consumer behavior theories argue that individuals attempt to use product acquisition and panic buying to regain a sense of control during times of uncertainty. (Ballantine et al., 2013). **2)** Another reason people engage in panic buying is because of something named groupthink, also defined as herd mentality (Loxton et al., 2020). It describes the tendency to align one's thoughts and behavior with what others are doing (Kameda & Hastie, 2015, p.2), regardless of how individuals think about the issue. According to Meyer, groupthink may cause panic when disasters occur (2020). For example, if it is perceived that friends or other nearby groups are stocking up on essentials, one is more likely to do it because the rest of the people are doing it. According to Paul Marsden, it appears that stress restrains people's reasoning, causing people to observe others' behavior and to thus, engage in stockpiling when others do (Taylor, 2020). **3)** Another cause for people to engage in panic buying is the perception of scarcity. When something is perceived as scarce regardless of real scarcity or just perceived scarcity, it is more desirable. As its perceived attractiveness to consumers increases, people are more likely to hoard or pursue in-store hiding. External stimuli, including Limited Quantity Scarcity (LQS) and Limited Time Scarcity (LTS), impact people's emotional arousal, and thus, may affect the impulsive and obsessive buying behaviors of consumers (Islam et al., 2021).

There is exploratory research indicating some of the possible explanations and psychological reasons behind panic buying (Kaur & Malik, 2020; Taylor, 2020). Nevertheless, such research has not been directly linked to theories that analyze supply chain limitations, e.g., TOC, making panic buying an unrealized phenomenon.

The TOC can be described as a process improvement methodology (Akdeniz, 2016) or as a management philosophy (Nave, 2002), focusing on the improvement of a series of independent processes (Nave, 2002). According to Akdeniz, systems have multiple activities or processes linked to each other, whereby the weakest is considered a constraint (2016). Constraints appear to be able to be divided into four categories: physical, policy, paradigm, and market (Akdeniz, 2016). Some examples of such constraints may include but are not limited to labor and raw material, union policies, habits regarding task procedure within a company and output exceeding demand (Akdeniz, 2016). It appears valuable to extend the given constraint categories by behavioral constraints to consider humans' decision-making processes and resulting behavior, such as panic buying, as constraints in the TOC.

When applying TOC to look at inventory management, it appears that people tend to look at current constraints that hinder higher performance and potential future constraints that may interrupt the supply

chain and thus, negatively impact the output. As seen during the COVID-19 pandemic, when disasters, such as pandemics occur, supply chains are frequently disrupted (Kovács, 2021). To better understand, forecast, and avoid bottlenecks in times of uncertainty, one not only has to forecast potential disruptions in the supply chain, but also has to consider the impact that uncertainty has on humans' decision-making processes.

RESEARCH METHODOLOGY

The purpose of this study was to look at how customers and their decision-making process regarding purchasing and supply chain and logistics could impact inventory management. We assumed that people's decisions could generate constraints for their personal inventory management. To gather data, we administered an online survey exploring grocery and retail consumers' feelings and behavior during the COVID-19 pandemic regarding availability of products at stores and at home. The survey was developed and adapted in English and Spanish to avoid language barriers for people with Spanish as their first language. Native speakers translated the survey from English to Spanish to ensure clarity and understanding. The survey was live for three weeks during June 2021 through Google forms and shared through various online platforms (e.g., Facebook, WhatsApp, LinkedIn, Instagram) and by email. A chain referral technique was used to reach as many participants as possible. Respondents participated voluntarily and needed to be eighteen or older to participate. Before participating in the study, participants were informed about the study's purpose and gave consent to participate. The study was anonymous to ensure open responses.

The questionnaire investigated the influence of panic buying and consumer's inventory logistics. The survey consisted of 21 multiple-choice and open-ended questions, which can be categorized into feeling questions, behavior questions, socio-demographic questions, and COVID-19 fear. The 19 multiple choice questions consisted of 10 Likert scale questions reaching from [what is our Likert scale] and [number] applies/does not apply questions. The feelings, and behavior questions covered themes such as feelings regarding lack of product availability, perception of the present and the future, and adjusted shopping logistics and inventory strategies since the beginning of the COVID-19 pandemic. Socio-demographic questions included citizenship, gender, household income, and impact of COVID-19 on household income. The survey ended by asking participants to describe their fear of COVID-19 and its consequences on a scale from 1 to 5, 1 being the lowest and 5 being the highest level of fear. A total of 136 answers were collected. T-tests and regression analysis was applied to the data.

In our survey, the Likert scale reached from one to four, whereby one was "Not concerned at all" and four was "Very concerned". As one and two implied that the person was not concerned, we grouped those two responses together and gave them the same value; three and four implied that the person was concerned and therefore were grouped and received the same value. We translated people's responses on demographics to better understand the nature of the participants of our survey.

MODEL

Panic buying is defined as the simple act of having an inner need to buy more quantity than is needed of a good, given a perceived or a real threat, that a variety of thoughts and feelings can trigger. This feeling of panic buying might be expressed in various ways, as described in this model. Given this definition, we created a model to define and describe panic buying (P) as a function of feelings (F).

$$P = f(F) \tag{1}$$

Since panic buying is a combination of different behaviors, it is a combination of various dependent variables, and one could describe panic buying as a multivariable dependent variable. Given the complexity of the dependent variable, this model includes a formula to determine the panic buying score for individuals. Such a panic buying score is used as the dependent variable in the following regressions.

The panic buying score can be calculated by adding all dependent variables that demonstrate the complexity of panic buying, and dividing this number by the number of variables included in the panic buying combination, so that

$$P = \frac{x_1 + x_2 + \cdots + x_n}{n} \tag{2}$$

This model uses the following five variables as dependent variables that together combine as panic buying: (1) Buying more products to ensure one has enough at home, (2) Changing times to go to the grocery store to make sure one gets everything one needs, (3) using various suppliers to ensure having a particular product at home, even if it is not from one's usual brand, (4) Buying brands one is not familiar with because typically used brands are unavailable, and (5) Arranging at home a bigger space for storage. Those variables were chosen because they demonstrate panic buying in the most direct way and illustrate the complexity and diversity of panic buying. The first variable - buying more products to ensure one has enough at home - appears to be the most crucial, and describes panic buying in the most direct way. Thus, this model takes the first variable twice to calculate the panic buying score, changing equation 2 to

$$P = \frac{(2 * x_1) + x_2 + \cdots + x_n}{n+1} \tag{3}$$

The following four variables are the independent variables in this model: (1) concern when items run out of stock in store or online, (2) unease when running out of products at home, (3) worry about essentials running out at stores, and (4) nervousness when not getting all products needed. Those four variables were chosen because they demonstrated the most significant p-values in the t-tests and seemingly presented lower multicollinearity than other independent variables.

$$\hat{P} = \hat{\beta}_0 + \hat{\beta}_1(A) + \hat{\beta}_2(B) + \hat{\beta}_3(C) + \hat{\beta}_4(D) \tag{4}$$

Putting equation 3 and equation 4 in equation 1, we get

$$P = \frac{(2 * x_1) + x_2 + \cdots + x_n}{n+1} = \hat{\beta}_0 + \hat{\beta}_1(A) + \hat{\beta}_2(B) + \hat{\beta}_3(C) + \hat{\beta}_4(D) \tag{5}$$

Equation 5 is the final equation that includes all necessary adjustments to understand which feelings significantly cause panic buying. Analyzing the result of regressions on this equation allows us to predict to a certain degree whether people panic buy or not.

FINDINGS

Figure 1 shows that most of our participants were located mainly in Colombia, Germany, or the United States, except for very few in other countries (Canada, Eswatini, Hong Kong, Spain). Figure 2 shows how the income of our participants was impacted as a consequence of the pandemic. Although most of our participants reported no change in their income, there was still an important percentage corresponding to 31% of participants that indicated their income got impacted due to the pandemic. Figure 3 shows gender distribution for our participants, clearly demonstrating that we had more than double the number of females participating in our survey. Figure 4 looks at the income distribution of our participants for those who disclosed it; the most representative groups were surprisingly the opposite of the spectrum, meaning that we had 26% of our participants earning less than $20.000 and 30% of participants earning $100.000 or more.

FIGURE 1
CITIZENSHIP OF PARTICIPANTS
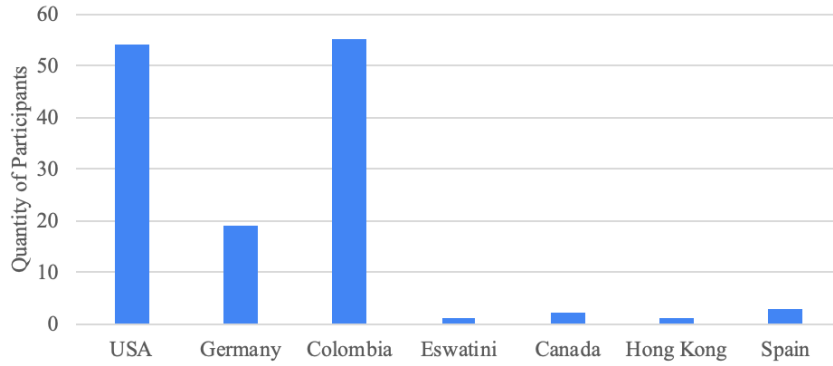
FIGURE 2
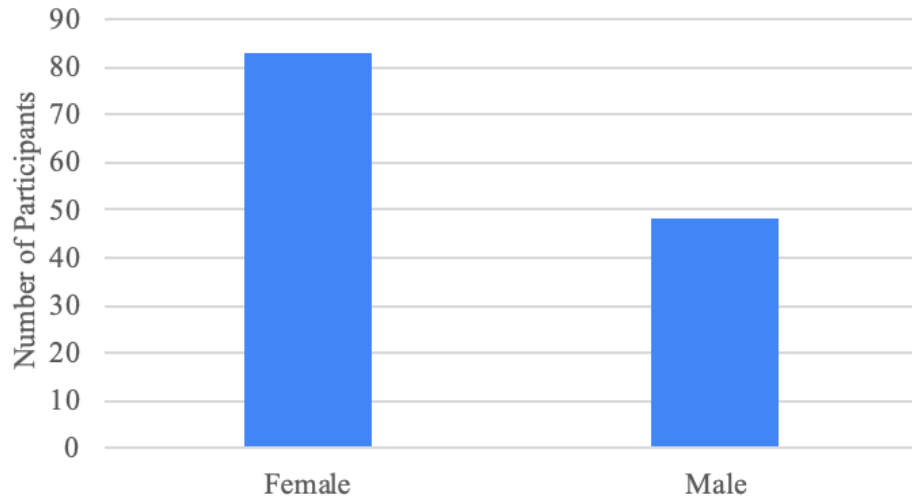**GENDER DISTRIBUTION OF PARTICIPANTS**

FIGURE 3
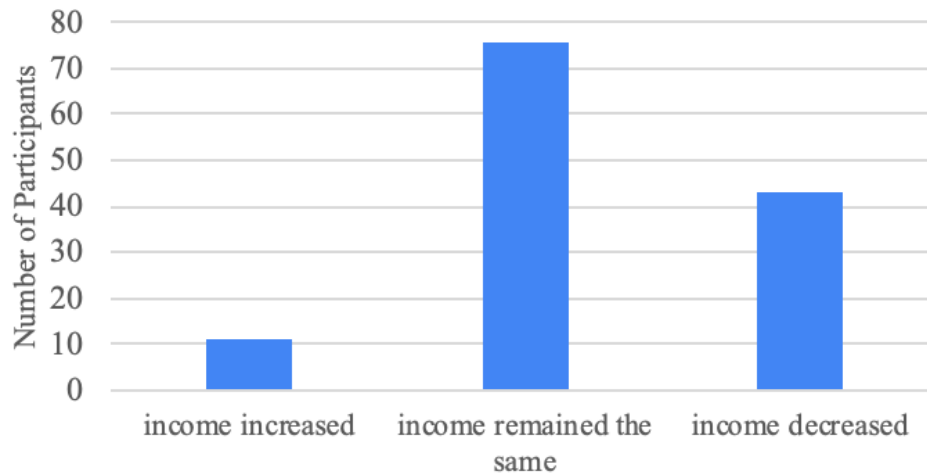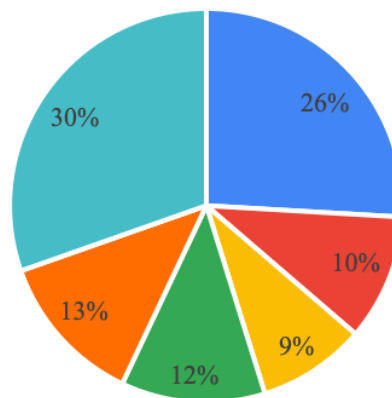**CHANGE IN HOUSEHOLD INCOME SINCE THE BEGINNING OF THE COVID-19
PANDEMIC FOR PARTICIPANTS**

FIGURE 4
INCOME DISTRIBUTION OF PARTICIPANTS

To find significant differences in behaviors and feelings regarding panic buying during the pandemic, we ran a t-test for all of our questions. All t-tests demonstrated significance with p-values ranging from *7,2^-34* to *0,0079.* Such results led us to create a model that helped us understand the relation that existed between feelings and behavior questions. Table 1 shows that our model presented a linear relationship with an R-value equal to 0.175 among feelings of panic and panic buying behavior. In other words, it implies that our model was able to predict the relationship between feelings of panic and the actual behavior - panic buying as defined in this paper.

TABLE 1
ANOVA TABLE

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.4185
R Square	0.1751
Adjusted R Square	0.1497
Standard Error	0.2882
Observations	135

ANOVA

	df	SS	MS	F	Significance F
Regression	4	2.2926	0.5732	6.8991	0.0000
Residual	130	10.8000	0.0831		
Total	134	13.0926			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.3487	0.0408	8.5421	0.0000	0.2679	0.4294
Concern when products run out of stock in store or online	0.0570	0.0584	0.9751	0.3313	-0.0586	0.1726
Unease when running out of products at home	-0.0645	0.0578	-1.1162	0.2664	-0.1790	0.0499
Worry about essentials running out at stores	0.1431	0.0638	2.2431	0.0266	0.0169	0.2693
Nervousness when not getting all products needed	0.1689	0.0604	2.7950	0.0060	0.0493	0.2884

As for the specific feelings evaluated in our model, in Table 1, we can see that two questions appeared significant when taking a significance level of 0.05 in predicting the behavior; those questions were: 1) To what extent do you worry or have worried about essentials running out at stores? (described as "Worry about essentials running out at stores" in Table 1) (p-value = 0.0266) And 2) To what extent do you get nervous or have gotten nervous when you haven't gotten all the products you need? (described as "Nervousness when not getting all products needed" in Table 1) (p-value = 0.0060). As seen in Table 1, both variables have a positive coefficient. According to this research, worrying about essentials running out of stores increases the panic buying score on average by 0.1431; feeling nervousness when not getting all products needed increases the panic buying score by 0.1689. Thus, when having either of those feelings, a person is reaching a higher level of panic buying on average.

Having clarity over what triggers panic buying is critical to prevent and manage future bottlenecks. These two questions might indicate that essentials are the ones that trigger the most panic. Therefore, the companies in the essentials industry might be the most impacted when faced with uncertainty. Additionally, not getting all products when going to the store seems to determine how much a customer would buy in the future and their likelihood to engage in panic buying.

As seen in Table 5, the variable "Concern when products run out of stock in store or online" has a p-value of 0.3313 and is thus, not statistically significant. Therefore, we cannot infer from this study that if people feel such concern, their panic buying score increases on average by the given coefficient of 0.0570.

To conclude, something we found particularly interesting was the question: To what extent do you feel or have felt uneasy when you were running out of products at home? This question presented a negative coefficient that was counterintuitive to what we would have thought for our model. A negative coefficient means that as the unease increased for this specific item, the likelihood of engaging in panic buying decreased. We believe two aspects can explain this. First, those who might be close to running out of products at home might not be concerned about the availability of products in stores, even if running out of

the store at home generates discomfort. Second, running out of products at home can be directly linked to income-related issues and therefore might not be a choice, which would explain why buying more quantity than is needed of a good, might not even be an option. However, further research would be necessary to determine the real cause of this opposite relation between unease when running out of products at home and panic buying.

CONCLUSION

Overall, we believe this study begins to address a gap in the literature on specific insights into panic buying. Determining that nervousness when not getting all products needed and worries of essentials running out of stores were the most important predictors of panic buying could impact policy decisions at the public and private level. For example, strategic policy that is in place in advance of a pandemic related to restrictive purchases, and randomized surveys to monitor consumer satisfaction regarding product availability could benefit all consumers. Additionally, awareness campaigns regarding alternatives to panic buying or shortages could mitigate these situations.

LIMITATIONS AND FUTURE RESEARCH

The limitations of this study correspond to a limited sample size; further research should include an extended, more diverse, and heterogeneous sample. Additionally, forthcoming studies should also control for the current stage of COVID-19 in the countries evaluated, alternatives sources of food different from stores, and investigate income and gender as possible predictors of panic buying.

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