COVID-19 shows the need to weigh efficiency against resilience in supply networks
Since the outbreak of the virus in December 2019, the COVID-19 disease developed into an epidemic in China in January 2020 and subsequently spread as a global pandemic. The overall impact of the COVID-19 pandemic is not yet certain. In addition to serious health impacts, the corona virus is also leading to a not anticipated global economic crisis because national governments around the world have restricted public life as well as economic activities, trying to prevent the collapse of health systems and providing aid packages for population and economy. The economic effects of the corona crisis become particularly apparent when one considers not only individual companies but the entire supply chain. According to some early industry surveys, nearly 85% of companies reported negative or very negative impact of COVID-19 on their supply chain and an equal number reported they were not prepared or only somewhat prepared for the kind of disruption it caused. A difficult challenge for supply chains was (and in some cases still is) the management of the sudden sharp rise in demand for certain products. In the following, we will take the toilet paper industry as an example to explain some of the short and mid-to-long-term consequences of the sudden increase in demand.
Facing the current pandemic, some supply chains are reaching their limits, being confronted with an unexpectedly high demand, caused by a change of people’s lifestyle and buying behaviour. Although many different companies, states and individuals are working together to develop solutions to the current shortages, the crisis has already shown that many companies were not prepared for the current situation. A reason for concern is that all of this could be a result of good business practices and academic recommendations aimed at reducing sourcing lead times and variability in supply or demand. Normally, these practices allow firms to operate very efficiently with minimal safety stocks and production capacity, but when they experience a sudden shock, like the one we are seeing now, there is very little extra capacity within the supply chains to adequately respond in the short-term.

The example everyone heard about was the extremely high demand for toilet paper. The turnover generated by toilet paper in Italy, for example, was 140% higher in March 2020 than in the same month of the previous year. Why did demand for this product, which is widely produced and does not in any way protect people from respiratory diseases (such as COVID-19), spike so high that the stores around the world experienced shortages for days and weeks? Images of empty shelves and even fights over packs of toilet paper quickly spread through social media and the attention was quickly directed towards hoarders as irrational decision-makers responsible for the shortages. However, the origins of this behaviour could be much more rational than one would expect. To visualize this, we can use the following causal diagram, which depicts this situation as an interplay of three different feedback loops.

We will see that the problem is more complicated than just hoarders buying things they do not need. Yes, there is a certain emotional element to all of this. People may increase their estimated needs to irrational levels and buy much more than they really need. However, we cannot ignore the impact of highly efficient supply chains being exposed to a substantial increase in demand because of an external shock.
The “stay-in-home” orders (or strong recommendation) implemented by governments around the world caused a steep increase in estimated need for toilet paper. Knowing that the members of a household would be spending more time at home, it is perfectly rational to increase your estimated need for toilet paper and try to satisfy this need by buying more. This product is normally only subject to very slight fluctuations in demand, which is why production capacity is typically very highly utilized (up to 95%). An unexpected increase in demand can therefore quickly lead to the unavailability of this product for end customers, which leads to even higher demand thereafter (the blue feedback loop R1). During times of stable demand, the red production loop (B1) can balance the system and supply the stores with sufficient amounts of the product in time so that the final customers never experience shortages. However, this balancing production loop is not as quick as the buying loop. It takes time to adjust the production capacity and make the product available. While the manufacturers adjust their capacity to meet the new demand, the shelves get more and more depleted creating a perception of shortage. This is possibly further amplified through the media heavily reporting on empty shelves and creating a perception of severe shortages. This loop, shown in green (R2), further increases the estimated need for the toilet paper and the demand. In effect, while the industry is catching up to the initial increase in demand, the demand is already increasing further because of the widespread perception of shortage, which puts even more pressure on the manufacturers.
Even if the sudden surge in demand and the resulting empty shelves already had some immediate negative effects in themselves (from dissatisfied customers to fights over toilet paper), serious consequences due to this initial spike in demand are likely to be felt along the entire supply chain for some time to come. Thereby, the strong increase in demand for toilet paper provides an ideal starting point for a phenomenon known as the bullwhip effect. This effect is characterized by an increase in order variability as one moves upstream the supply chain, i.e. the demand signal becomes more and more distorted. Among others, the bullwhip effect causes excessive inventories, low capacity utilization, and poor customer service along the supply and hence, high costs. To understand how the effect and its consequences could occur in the toilet paper industry, it is useful to imagine the toilet paper supply chain in a very simplified form, consisting of two retailers, a wholesaler and a toilet paper manufacturer as depicted below.

Due to the sudden surge in demand for toilet paper from end customers, retailers quickly ran out of stock and had to replenish their inventories from the wholesaler. The wholesaler faced the same problem and reordered toilet paper from the manufacturer who ramped up production. However, it is likely that the demand signal received by the manufacturer did not correspond to the demand signal of the end customer. What we often see in supply chains is comparable to the famous children’s game called Chinese whispers or telephone where the first person in a row comes up with a message which is whispered into the ear of the second person in line. This goes on till the last person announces the message they heard to the entire group. Most often, this message has almost nothing to do with the original message. Obviously, in a supply chain, decision makers do not whisper to each other’s ears. Nevertheless and despite digitalized business processes, the original information (customer demand) is often distorted by each supply chain partner and the demand variance becomes amplified. This can happen for a variety of reasons that can be attributed to uncertainty, misaligned incentives and inappropriate cognition of the situation which are all facilitated by characteristics of the structure of the system.
The next logical question is what we can do in order to handle these shortages during this crisis and in the future. Communicating to the public that shortages are only temporary and that there is no need to panic is certainly the first step. If that does not help, more strict rationing measures can be helpful. We have seen stores implement these measures on their own by preventing the customers from buying more than one or two packs at a time until enough supply was established. When necessary, the rationing measures should extend to the entire supply chain. For example, it would be possible for manufacturers to base delivery quantities on a customer’s past order quantities and not react to excessive order quantities. In the mid-to-long-term, the companies should be aware that, not only could the demand return to previous numbers, but that the same mechanisms could now lead to the completely opposite effect. As companies ramp up their production to meet increased demand, the perception of shortage will decrease, which could lead to a substantial decrease in estimated household demand. Companies should be aware of this and avoid overreacting to a drop in demand, otherwise they could initiate another demand cycle driven by the green panic loop (R2).

We have relied on predictable and stable demand patterns to optimize our supply chains to maximum efficiency. There are many benefits for producers and customers from this, such as lower costs and less waste. Unfortunately, this has come with a cost of less resilient supply chains that are unable to quickly respond to external shocks. Worryingly, this also includes critical goods supply chains where shortages can directly cause loss of life (for example, ventilators and safety masks). Sacrificing some efficiency in supply chains producing these critical products for the ability to respond quickly in a crisis may be the safest option.
Sources

David Adam: As for the epidemiological side of the crisis, https://www.nature.com/articles/d41586-020-01003-6;
Huiling Tan: There will be a ‘massive’ shuffling of supply chains globally after coronavirus shutdowns, https://www.cnbc.com/2020/03/20/coronavirus-shocks-will-lead-to-massive-global-supply-chain-shuffle.html

Contact

University of Stuttgart
Department of Operations Management
Prof. Dr. Andreas Größler
Keplerstraße 17
70174 Stuttgart
Germany

produktion@bwi.uni-stuttgart.de
www.bwi.uni-stuttgart.de/en/dept10/
+49 711 685 83468