WORLD MANUFACTURING FOUNDATION

BACK TO THE FUTURE

MANUFACTURING BEYOND COVID-19

SOURCING AND PROCUREMENT OF SUPPLIES DURING DISRUPTIONS

Group Leader
Martin Sanne
Executive Manager, CSIR

CONTRIBUTORS

Marié Botha
Senior Manager, CSIR

Riaan Coetzee
Research Group Leader, CSIR

Shawn Cunningham
Partner, Mesopartners

Ajith Gopal
Center Manager, CSIR

Andrea Munari
Lean Production Manager, La Termoplastic F.B.M.

Giorgia Munari
Marketing Manager, La Termoplastic F.B.M.

Guido Schwartz
Manager, Airbus Defence and Space

Harry Teifel
Owner, Progressus Digital

Pieter van Beekhuizen
Owner, Bexperiece

Ezequiel Zylberberg
Partner, Bio Pharmaceuticals

INTRODUCTION

This chapter examines the impact of sourcing and production during times of disruption. With a view of the full production value chain and using the examples of medical devices, food and some manufactured products, the impact of the disruption of supply from raw materials to finished products is explored.

The benefits and need for digitalization of processes (Digital Transformation) for risk reduction and new improved ways of supply chain planning are discussed.

The chapter also looks at a specific case study of manufacturing of ventilators in South Africa to underline the trend to reshoring and local manufacturing.

CONTEXT

Particularly during early 2020, COVID-19 disrupted the sourcing and procurement of supplies across the world with a potentially long lasting effect on supply chains.

As per AT-Kearney (2017)[1], it is important to define the elements of production and to understand that production is a process which is more than manufacturing. Thus the production of a product starts with Design, the next step is to Source the materials, then Manufacture parts or elements, these are then Assembled into a final product which can be Distributed. The product then goes to the Consumer, where it may require Service and ultimately would reach end of life where it goes to Waste or to Re-use (recycling).

The ever evolving production and manufacturing landscape also provide opportunities for new business models along the production value chain. Physical manufacturing is now at the centre of a much wider production value chain, which can generate new revenue.

Value chains are increasingly global, bringing significant opportunities for companies of all sizes to integrate into chains with international partners. Digital technology is the key to opening this door. In this new interconnected digital world, consumers and business customers increasingly demand a complete package of products and services. The distinction between product and service markets is a thing of the past, with business-related services often playing a decisive role in making products attractive to consumers, even generating most of the added value in growth and employment. Value creation and innovation increasingly take place together, and customers are becoming deeply involved in the supply chain with products being customised on a mass scale. Companies are developing closer and closer relationships with their end customers who drive demand.

These new sources of revenue and value creation range from provision of services with products linked to data gathering at all stages of the production life cycle.

A high degree of disruption has been anticipated in the Production Value Chain of the future, but no-one anticipated the type and level of disruption which has taken place in 2020. At the latest since the first quarter of 2020, very few countries in the world have not been affected by COVID-19. Much of the non-medical discussion has been about trying to make sense of the impact that COVID-19 has had on the economies of countries and thereby on the global economy. Supply chains have been disrupted and slowed by the extreme reactions of governments and private companies to the perceived and real threat of the COVID-19 disease. Borders were closed to travellers, trade was restricted and life as we knew it before 2020 changed overnight.

It is a well known fact that China implemented the first massive quarantine and preventive measures in response to COVID-19. With the spread of the virus to Europe and the rest of Asia, many countries followed the hard lock down approach. Local and global economic effects were immediately apparent from the supply of raw materials, food and extending to technology. Products were suddenly in short supply or not available at all. Particularly specific medical products were in short supply as countries who had manufacturing capacity restricted exports and kept supplies for the local use. Overall, manufacturing lead times increased dramatically and prices jumped by double digit and sometimes triple digit amounts. In China[2], for example, food supply chains were disrupted, witnessing 116% price jumps in the prices of pork, 17.1% price jumps in vegetables[3].

Due to freight blockages, production decreased by about 50%. Labor shortages due to lock-downs also meant that spring planting activities in the Northern Hemisphere were delayed. The above mentioned precautionary measures of limiting or halting international trading activities were compounded by limitation of all travel ranging from tourism to business travel. In addition, border closures and travel restrictions reduced the flow of not only seasonal workers but also skilled workers involved in technology transfer.

Particularly the impact of China's hard lock down strategy has been felt across the world. Since 2018, China has become the world's factory accounting for 18.67% of the world's GDP. COVID-19 and the impact to the Chinese production capacity and its economy set the stage for the shocks that the world would experience for a long time.

Taking food as a case study of the impact of disruptions of supply chains,

Zhang and Jan[4] discuss how COVID-19 has forced businesses to look to digital means to not only sell their products to end consumers, but also to set up and optimize the logistics and fulfilment services required for example to distribute food during COVID-19 disruptions.

Farmers with basic online marketing skills and simple food products could sell their products directly to consumers. Importantly, the digitization of the food supply chain has also provided a means for farmers to receive direct feedback loops about food prices, provide information about food safety, origin of production which are essential elements of an effective food supply chain. With restaurant dine-in traffic down 100% in most major US cities, data suggests that over 35% of restaurants have closed down and many more will soon follow in its wake. In order for restaurants to survive, they have to find new ways to defray costs incurred in the process of acquiring their fresh produce. In this respect, China has paved the way through revolutionizing the idea of consumer group buying within the agriculture sector. Companies such as Pinduoduo utilizes Artificial Intelligence (AI) to understand consumer behaviors and make bulk purchases directly from suppliers, leverage scale economies, coordinate logistics and deliver fresh products to their customers at an affordable price. Such automation of the food supply chain may in future provide restaurateurs the much needed economical edge in surviving through disruptions such as the COVID-19 pandemic.

Technical innovation by way of digitalization is a key for the way forward for industry. For manufacturers, the digital transformation in terms of implementing the Fourth Industrial Revolution 4IR (aka Industrie 4.0) was moving ahead well before COVID-19. Manufacturers drew on the promise of connected plants to deliver unprecedented efficiencies, real-time supply chain visibility and customer-driven product development.

The pandemic has brought a new sense of urgency to the 4IR. Agility is essential for survival as manufacturers navigate new workplace safety requirements (driven by the need to protect workers from the spread of the highly infectious COVID-19 disease), unpredictable market dynamics and major supply chain disruptions.

Some of the most significant shifts in market share occur when coming out of downturns, when leading companies can balance resilience (Peter Herweck[5]). Digital will be a key enabler.

Many questions have to be answered for individuals and companies such as operating remotely when facility access and travel is limited or restricted?

Where should systems be adjusted or changed to reduce downtime and optimize efficiency? What can be done to become more flexible and resilient to global disruptions in the future?

A key to improving supply chains will be the need for more information and data for fast, informed decision making which is the basis digital transformation. More and more industrial companies are being forced to successfully implement digital transformation initiatives with tangible value. The COVID-19 crisis has accelerated the need for production processes to go digital, and success largely depends on manufacturers' ability to provide employees with the tools they need to make fast and informed decisions. Cloud based digital tools are facilitating this. This ranges from video conferencing calling to factory workers being able to monitor processes and receive notifications at home after work hours by being connected to the manufacturing plant

remotely. Efficiencies are improved and minor issues occurring in the manufacturing plants or in the production supply chain can be addressed immediately and directly in a closed loop fashion.

There is a need to build more resilient and sustainable supply chains moving forward. Organizations needed to embrace new business models to cope with sustainable supply during disruptive events such as the COVID-19 pandemic. These can be adopted into the future and there is a need to:

- Find a balance between what worked previously and what will be needed in the future
- Not going back to the way things were, even after lockdowns end
- The need to lock in and accelerate the changes brought about by COVID-19.

Particularly, when looking for an example of robustness and resilience, there are examples of globally distributed companies which are able to leverage their distributed locations to ensure a continued supply of goods[6]. These companies have qualified local materials suppliers and are also able to shift production capacity between the plants in different locations world wide.

In the pre-COVID-19 world, companies utilized just-in-time (JIT) supply chains, offshoring to low-cost countries and using local production to manage costs. In the future, organizations need to re-think their supply chains to a distributed approach to reduce risks and improve sustainability in the face of disruptions. This may become a key competitive advantage.

New technology such as cloud-based IoT and IoT technologies can help organizations gain the transparency they need across the supply chain to solidify these new approaches for the long term. The new digital technologies, allow an organization to remain in contact with customers and suppliers, facilitate collaboration among staff who are working remotely and help the organization to optimize operational and maintenance planning during the disrupted phase (lock down). Digital transformation is the basis for achieving this necessary change.

OPPORTUNITIES & RECOMMENDATIONS

Recommendation 1

COVID-19 accelerated some effects that were already underway. Companies need to find a balance between embracing the new order and preserving aspects of the old order which have worked. Some things will return to the previous status quo. The onset of the pandemic has necessitated manufacturers to implement disruptive changes in all areas, including supply chains. These drastic measures implemented as a direct result of the COVID-19 pandemic has accelerated the optimization of the already declining manufacturing industry worldwide.

Recommendation 2

Localization (reshoring) of manufacturing will increase and is viewed as a key to ensure continuity of supply during disruptions. Manufacturers have been required to source locally due to severe disruptions and uncertainty in international supply chains. This has resulted in increased localization within a country's borders, or within a region. The increased local content provided maximum local economic activity as well as alternative supply sources. Post pandemic, it is envisaged that manufacturers will source locally, rather than importing as a rule.

Recommendation 3

A distributed approach to manufacturing across multiple countries helps safeguard supply chains for global manufacturers and business continuity. This distributed geographic model assists in mitigating the risk on supply chains, by ensuring that there are several sources rather than a dependency on a single supplier. It is however imperative that multiple and alternative sources of raw materials must be pre-qualified, to maintain quality and potentially comply to all certification requirements.

Recommendation 4

Depending on the degree and locality of a disruption, regional and country level supply chain planning needs to have a higher priority in future. The pandemic has illustrated the importance of establishing strategic plans on regional and country level to respond in a coordinated manner to severe supply chain disruptions.

Recommendation 5

Key requirements may need to be managed at government level e.g. Food, medical supplies. As countries started retaining own production for their own use, other countries need to establish own supply chains to gain independence. Government level interventions and coordination will ensure access to all necessary supplies to ensure the safety and survival of its citizens. This is illustrated by the example of the South African government's response to the shortage of ventilators, which resulted in the local design, manufacture and certification of ventilators.

Recommendation 6

Global players need to manage technology transfer and quality control. These become more difficult when people movement is restricted. This affects productivity, efficiency and ability to supply if not planned carefully. If not managed appropriately, it will have an impact on the quality and certification of the end product. New technologies need to be used to bring expert knowledge to where it is needed.

Recommendation 7

Digital transformation is the basis for achieving this necessary change. The COVID-19 pandemic has resulted in an accelerated implementation of digital process across supply chains. This digital transformation needs to be maintained. This transformation is not limited to the manufacturing process itself, but also to the cumbersome administrative processes, which has had a direct effect on increased productivity. Procurement processes have been streamlined to ensure quick, paperless responses, and larger manufacturers have managed payment cycles to its supplier basis, especially assisting SMMEs.

Recommendation 8

A rethink of paradigms is necessary. Just in time planning meant low buffers in stock and thus long lead times. Light goods are easy to move. Heavier bulky goods more difficult and supply chain disruptions are more noticeable. OEMs can no longer push the risk to the supply chains, as this will severely impact the survival of the supply chains, especially SMMEs. Collective planning of the entire supply chain is imperative.

Recommendation 9

The impact of the disruptions in supply chains as a result of the global pandemic was severely experienced by SMMEs. Dedicated action is required within supply chains to assist smaller contributors not only on a technology development basis, but also administratively in terms of reduced payment cycle runs to improve cash flow and ultimately SMME survival.

CONCLUSIONS

Production is more than manufacturing. The impact of the disruption of supply at any part of the production value chain - from raw materials to finished products – needs to be continually investigated, as well as the duration of the impact.

As part of the full production value chain improvement, the benefits and need for digital transformation of companies, R&D and production processes for risk reduction and new improved ways of supply chain planning are key to sustainability.

As shown by a specific case study of manufacturing of CPAP ventilators in South Africa (Annexure) there will be a need and trend to reshoring and local manufacturing especially during times of disruption.

ANNEX

Localisation of Production:
Ventilators as a case study

Medical equipment, particularly ventilators, became key in the fight against the COVID-19 pandemic across the world.

Worldwide, a critical health sector need has been identified around medical devices, Personal Protective Equipment (PPE), sanitizer devices and their accessories.

Specific medical devices are used to provide ventilation and ventilatory support to patients with respiratory failure or respiratory insufficiency.

Particularly, the COVID-19 disease, which occurs as a result of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) virus and which results in an impairment on the ability of people to breathe, ultimately results in pneumonia in ±6% of cases.

South Africa and the Region at large was heavily affected because of lack of capacity to manufacture these locally and thus being dependent on imports.

The South African (SA) health system initially only had ±6,000 ventilator units, of which ±4,000 units were in the private sector. There was an identified need to radically scale up the availability of suitable breathing devices, with a specific focus on the public health sector.

An increase in the COVID19 positive cases drove the need for more ventilators and related PPE. Importing such equipment from global sources became a challenge due to closed borders owing to lock downs and export restrictions that impact global supply chain. The local organizations responses to the COVID19 pandemic equipment needs had to consider the development and manufacturing of for example a Continuous Positive Airway Pressure (CPAP) non-invasive ventilators to aid in the preparation of the healthcare ecosystem for the sharp rise in cases.

These types of ventilators can of course be used in diverse scenarios ranging from a health care facility or at home or during transport in an ambulance.

The development of such a CPAP ventilator needed to address the regulatory compliance, system engineering, value chain enablement, test, measurement and evaluation as part of the manufacturing preparation.

The case for development and local production of Non-Invasive CPAP Ventilators was motivated as follows:

With a high attack rate of the population, South Africa could expect a high peak in COVID-19 infections, of which a significant portion would require some form non-invasive ventilation.

This called for the development and local production of a rapidly manufactured low cost CPAP ventilator which could be manufactured at scale.

From the initial decision to manufacturing start took 3 months. After production ramp-up, the first units were distributed to various hospitals across South Africa within 1 month. This includes full documentation and training videos accompanied by online training sessions. This short time period from production start included all emergency procurement of material and components and ramp up of localized supply of elements which were in short supply world wide. It should be noted that the industry benchmark to design, industrialize and produce a medical product lies in the region of 18+ months. In this case the first fully certified systems were delivered to hospitals in just over 4 months from the start of product development.

The overall procurement of all the material and components for the initial ten thousand systems (incl. two patient circuits per system) had been secured within 3 weeks. The team focused on the managing and improving the logistics of bringing together the over 30 elements in the bill of materials for a complete system from nearly 15 partners and suppliers to the final ISO13485 certified final assembly at a medical device production facility in Cape Town.

The further procurement of parts and materials for additional devices and patient circuits was started in parallel.

Production and delivery ramp up consisted of over 30+ dedicated staff and another over 60 staff at the production partners and suppliers – all fully committed to achieve the required production rate.

The following aspects are worth noting:

- Production and delivery output was initially slower than expected due to a high attention to and no compromise on final product quality. Due to the nature of the device, some quality issues only emerged in the final assembly and testing phase where for example final leakage tests were performed. Leakage affects the ultimate overall performance of the systems and no compromise is possible. Tracing quality faults proved time consuming and individual components and their manufacturing processes needed to be analyzed for root causes. Improvements in the manufacturing of individual components needed to be trialed and tested. Examples of components which have been most impacted are: setting dials in the CPAP/Venturi which are machined from very hard material; the Fixed and Variable PEEP valves which are injection moulded where part fit tolerances and springs needed to be modified and adjusted; filter inserts made from high performance nano fibres.
- A key success factor of the project was the need for localization of the production of a number of components where insufficient local production capacity existed to date e.g. Oxygen hoses, PEEP valves, Filter housings and inserts, Masks and of course the CPAP/Venturi itself.
- International supply chains were overwhelmed by the COVID-19 pandemic and even at the later stage into the pandemic there was still a world wide shortage of ventilators. Production capacities for key elements (masks, PEEP valves etc) are still oversubscribed leading to long lead times in production and delivery (sometimes up to 12 weeks).
- Delays experienced for sourcing parts and materials in the early phases of the process have shown that the transport side of the supply chain was also significantly disrupted resulting in unreliable air freight and courier lead times on components with commitments being changed daily. Shipments were dropped from flights without notice and material would lie in transit waiting for a flight for up to two weeks.
    - In an effort to mitigate the supply chain issues and to make local production sustainable, local designers and manufacturers were included into the project early on in the production planning. Nevertheless, these companies have had to set up special manufacturing processes in a very short space of time after production start using specialized machinery and production processes (e.g. nano fibre filter material and inserts with ultra sonic fibre welding processes; injection moulding tooling requiring special hardening and fine tuning etc). As can be expected, some setup and teething problems have been encountered and this has contributed to delayed repeatable volume production. Particularly unfortunate tooling and machine failures at times resulted in the need for slower manual processes to be used in the production ramp up. CNC machining of components which is slower and machine intensive was used initially but to achieve the target of highly scalable production, injection moulding of the components was introduced where possible.
- Critical to the success of the project, was the design for certification and the involvement of the certification body from the onset. This contributed to the success of the project by minimizing time required for certification.
- The CPAP ventilator was designed and manufacturing utilizing a suit of Product Lifecycle Management (PLM) software which ensure a digitized design and production.

ENDNOTES

[1]AT-Kearney collaboration with the World Economic Forum. (2017, March 30). Shaping the future of production. Retrieved from: *https://www.weforum.org/organizations/kearney-inc*

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World Manufacturing Foundation
Via Pantano, 9 - 20122 Milano, Italy

info@worldmanufacturing.org
worldmanufacturing.org