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published in

ISCRAM 2021 - Proceedings
2021

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Boersma, K., & Larruina, R. (2021). Restoring the medical supply chain from below. The role of social entrepreneurship in the production of face masks during the COVID-19 crisis. In A. Adrot, R. Grace, K. Moore, & C. W. Zobel (Eds.), *ISCRAM 2021 - Proceedings: 18th International Conference on Information Systems for Crisis Response and Management* (pp. 260-269). (Proceedings of the International ISCRAM Conference; Vol. 2021-May). Information Systems for Crisis Response and Management, ISCRAM.

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Restoring the medical supply chain from below.

The role of social entrepreneurship in the production of face masks during the COVID-19 crisis.

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ABSTRACT

The COVID-19 pandemic affected societies worldwide, compromising socio-technical systems across geographical, judicial, and administrative borders. It therefore a cross-border, transboundary crisis. It also exposed the global medical supply chain's vulnerability. Authorities' inability to restore it quickly caused serious problems in crisis response, but private initiatives provided unexpected bottom-up solutions. How social entrepreneurs respond to a crisis alongside the formal crisis governance system and generate resources related to product development and logistics deserves more attention. We therefore present a case study about a Dutch social enterprise (Refugee Company) engaged with the cross-border dimension of the COVID-19 crisis. We show it is possible to establish a supply chain and domestically produce personal protection equipment using a bottom-up approach. Policy and crisis governance should not overlook the potential of entrepreneurial activities to strengthen supply chains during crises, as they make supply chains more sustainable and crisis-resilient.

Keywords

COVID-19 crisis response, supply chain, personal protection equipment, face masks, social entrepreneurship.

INTRODUCTION

The COVID-19 crisis, which the World Health Organization (WHO) officially declared a pandemic on 11 March 2020 (Cucinotta and Vanelli, 2020), has deeply affected societies around the world. From a crisis management viewpoint, it can be considered a slow-burning, creeping crisis, implying that it causes “a threat to widely shared societal values or life-sustaining systems that evolves over time and space, is foreshadowed by precursor events, subject to varying degrees of political and societal attention, and impartially or insufficiently addressed by authorities” (Boin et al., 2020, p. 7). Indeed, the COVID-19 crisis had a long incubation time, and unlike a fast-burning crisis, it has no clear beginning or end, which means that it will remain undefined for a long time. It is also a cross-border, transboundary crisis: societies worldwide have been affected, and the crisis has compromised complex socio-technical systems that stretch across geographical, judicial, and administrative borders (Boin and Rhinard, 2014).

The cross-border, transboundary dimension of the crisis became visible in many ways. The harm it did to people and communities had a severe impact on supply chains, production lines, and manufacturing in various economic sectors (Burger, 2020; De Sousa Jabbour et al., 2020). It also revealed the vulnerability of the global medical supply chain, especially for testing materials and personal protection equipment (PPE) (Gereffi, 2020; Illahi and Mir, 2021; Ivanov and Dolgui, 2020; Mollenkopf et al., 2020). The supply chain clearly lacked resilience, as it had become too dependent on a small number of PPE producers (from China). Because of its lean and mean nature, the chain lacked buffers (i.e., stockpiled PPE), which are crucial for responding to a sudden increase in

demand during a crisis situation (Esper, 2021; Iyengar et al., 2020; Kovács and Falagara Sigala, 2021; Rowan and Laffey, 2020). However, unexpected alliances and independent entrepreneurs successfully produced respiratory ventilators, face masks, and hand sanitizers domestically through companies that did not traditionally belong to the field of medical equipment producers. For example, individual designers used 3D printing to provide critical medical supplies to fight the pandemic (Attaran, 2020; Vordos et al., 2020). DSM, a plastics and nutritional products manufacturer, and Auping, a mattress manufacturer, collaborated to produce face masks, combining their expertise on materials and production lines (Hoekstra and Leeflang, 2020). Such entrepreneurial initiatives took place in various parts of the world.

This paper aims to focus attention to the value of bottom-up generated initiatives in restoring the broken supply chain during the cross-border, transboundary COVID-19 crisis. Our case study on the Dutch Refugee Company's "Mondmaskerfabriek" (Face mask factory) provides important lessons on how such initiatives have contributed to the crisis response. It also shows how companies that are willing to respond to a crisis alongside the formal crisis governance system create general processes regarding product development, logistics, and collaborations with stakeholders, and how general bottom-up approaches to crowdsourcing tasks are created under (time) pressure and with scarce resources. In presenting social entrepreneurial behavior and innovative activities (Christensen et al., 2015) in the production of PPE, particularly face masks, this paper highlights the role that bottom-up generated activities, including production, trading, and distribution (logistics), play in the complex cross-border ecosystem of PPE. It thus contributes to the growing attention on the private sector's role in harnessing resources in response to crises (Horwitz, 2009, 2020). Indeed, the case illustrates the role of civil society's and private organizations' initiatives and the potential of cross-border, networked organizational responses to the COVID-19 crisis (Boersma et al., 2020). Our main research question is: *How did Refugee Company engage with the cross-border dimension of the COVID-19 crisis to set up its own supply, operation, and (domestic) production of PPE to restore the broken supply chain from below?*

To answer that question, we first present our methodological approach to collect data. We then elaborate on the broken (medical) supply chain and the formal authorities' struggle to repair it. Next, we describe the formal COVID-19 crisis management structure in the Netherlands in order to understand the context in which Refugee Company was operating. We then explain how Refugee Company set up its production line and provide details on the type of mask it produced, the materials it used, and the challenges it overcame to obtain the necessary certifications. We end by discussing the broader implications of this research.

METHODS: A GROUNDED APPROACH

Our research used a grounded theory approach. This methodology, which is widely used in qualitative research, applies inductive reasoning, a method of reasoning where statements/premises are considered as evidence of, but not a total guarantee of, the conclusion's veracity (Bryman, 2012; Rainbolt and Dwyer, 2014). Research using grounded theory usually starts with a broad research question. In this paper, the research question presented in the introduction provided the initial focus. We then collected data (including primary and secondary sources) (Eisenhardt, 1989). Following the grounded theory research perspective, data collection and analysis took place simultaneously to structure the findings and decide what kind of data should be collected next (Suddaby, 2006). To combine different data collection methods and adapt to the dynamic situation studied, we adopted a case-study approach. This perspective allowed for continuous description and comparison of data and theory and the generation of new theoretical perspectives. By zooming in on Refugee Company's practices in setting up a production line for the manufacturing of PPE, we were able to recognize the role of entrepreneurship (especially in restoring the medical supply chain) in times of crisis. This paper thus builds on the notion of societal resilience as it recognizes the potential for adaptation and transformation of systems and society and the self-organizing principles of emergent response networks. Using the lens of societal resilience emphasizes the strengthening capabilities of local organizations and communities in response to crises (Aldrich, 2002; Comfort et al., 2010).

For this case study, we utilized qualitative research methods such as interviews, primary data collection, and analysis of documents (Mason, 2017). These methods were used to deconstruct and reconstruct important moments and events in Refugee Company's response to the COVID-19 crisis. We interviewed six key actors in the setup and running of the factory. Three were from external stakeholders that played a vital role in transporting the first machines and materials (KLM Royal Dutch Airlines), financing the factory (Philips Foundation), and installing and monitoring the machines (Qing Engineering and Consultancy). Of the other three respondents, two were professionals working *ad honorem*. One was an expert in food production, and the other had formerly managed "inward/outward" logistics for Bol.com, the largest Dutch online store. The third was the Refugee Company (and Mondmaskerfabriek) director.

Semistructured interviews were used to deconstruct and reconstruct the case study, allowing relevant themes to surface, and to take advantage of unique opportunities that might occur during an interview. Document analysis

involved the study of press releases and publicly available material (social media, media appearances, public and confidential material), providing data to complement the interviews' findings (Bryman, 2012). We analyzed the data to create a narrative about Refugee Company's initiative. This narrative details Refugee Company's contribution to restoring the PPE supply chain from below. It also reveals how the company managed to establish a production line and successfully produce face masks.

SETTING THE SCENE: THE BROKEN SUPPLY CHAIN

In April 2020, EU countries started to report PPE shortages; China, the main producer of PPE, had drastically decreased its exports of such materials (Campbell and Doshi, 2020). This situation became problematic in various member states, including Italy, Spain, France, and the Netherlands, countries with very high numbers of patients in intensive care units. In response, the EU Commission launched joint public procurements through which its member states hoped to address their PPE shortages. These initiatives aimed to procure a range of essential items from masks to laboratory equipment to medical ventilators and other respiratory equipment. However, the EU Commission struggled to utilize its potential as a crisis manager (Boin et al., 2013) and to take a coordinating role. Individual member states began purchasing equipment and making bilateral agreements with suppliers. Furthermore, the EU commissioner for the internal markets reported that national purchasers were facing immense pressure to guarantee PPE availability. The commissioner advised member states to do most of the EU law and being flexible when possible. Similarly, guidelines for manufacturers were established to accelerate the production of PPE, hand sanitizers and 3D-printed medical products.

The diffuse nature and inherent complexity of the COVID-19 crisis meant that coordination and decision-making had to cut across various governance arrangements, sectors (or "organizational fields" in organization theory terms) and working processes (Boersma and Wolbers, 2021; Wolbers and Boersma, 2018). However, restoring the supply chain as part of the crisis response was not just a matter of integrated actions coordinated by a central authority; it also involved many innovative actions from below. The COVID-19 crisis (and previous crises and disasters for that matter) revealed that potential or latent capacities to contribute to crisis response have not been used to their full potential (Van Fenema and Romme, 2020).

THE FORMAL COVID-19 CRISIS MANAGEMENT STRUCTURE IN THE NETHERLANDS

In the Netherlands, the National Institute for Public Health and the Environment (RIVM) has played a significant role in the country's response to COVID-19 (particularly infectious disease experts but also behavioral experts to a lesser extent) and in the development of knowledge on infectious diseases and the effectiveness of measures. The role division between the scientists (infectious disease experts) and the policy advice provided to the government is organized as follows (Ten Dam, 2018). In the event of a nationwide infectious disease outbreak, the RIVM's Center for the Control of Infectious Disease plays a coordinating role in controlling that disease. In addition, the RIVM convenes an Outbreak Management Team (OMT). Throughout the COVID-19 crisis, for example, specialists and experts with different backgrounds and knowledge about the disease and its control have been invited to the OMT to discuss how to respond to the outbreak based on current information, professional knowledge, and scientific literature. The OMT advises the Dutch government through the Administrative Consultative Committee (BAO). The BAO assesses the advice on the basis of administrative feasibility and implementation and ultimately determines the control policy. However, neither the OMT nor the BAO actually makes decisions; the Dutch government (the state) makes the formal decisions.

In the current COVID-19 crisis, the member association GGD/GHOR (Municipal Public Health Service/ Medical Response Organization in the Region) and the ROAZ (Regional Network Healthcare Crisis Response) have been in charge of the response operation. Whereas the OMT advises the government, which decides what measures to take, the 25 GGD regions are responsible for executing the policy and the actual response. The nature of the COVID-19 crisis legitimated a change in this area: the role of the mayor (who, in local crisis situations, is the "commander in chief of an emergency operation" within their municipality) was taken over temporarily by the "Veiligheidsberaad" (Safety Council), which consists of the mayors of the main cities in the 25 Safety Regions (the public bodies whose task is to facilitate regional cooperation between response organizations in dealing with crises), in order to get countrywide consistency in the implementation of measures. On 12 March 2020, after the prime minister's press conference, the Safety Council decided to seriously "scale up" their crisis management organizations (Van Duin et al., 2020).

To deal with the increasing demands of the Safety Regions' operational capacity, the National Operational Team Corona; LOT-C was set up on 20 March as an ad hoc, temporary organization (Burke and Morley, 2016) responsible for coordinating the operational aspects of the crisis response and executing the complex crisis response tasks. The LOT-C was embedded in the 25 Safety Regions, which, by Dutch law, play an important role in emergency response and crisis management. It was organized via various units, including Healthcare;

Continuity and PPEs; Scenarios, planning, and behavioral protocols; Policy and Stakeholder collaboration; Societal Resilience; Civil–Military collaboration; and Information and Communication.

Because of face mask shortages in the Netherlands, the Ministry of Health, Welfare and Sport founded the Landelijk Coördinatiecentrum Hulpmiddelen (National Consortium for Medical Supplies; LCH) in collaboration with the healthcare sector (hospitals, academic centers) and suppliers and manufacturers of medical aids. The LCH was set up for the joint procurement of medical supplies in danger of running out. The LCH purchased medical supplies jointly, on a nonprofit basis, in the national interest. It also started to monitor the national daily need for medical supplies and to make arrangements regarding distribution.

REFUGEE COMPANY IN ACTION

Refugee Company is a private, social enterprise that began in 2015 and became part of the Dutch organizational crisis response ecosystem supporting refugees during the “refugee crisis” of 2015–2017. Its origins are intrinsically related to the organizational dynamics that occurred when local and national governments, as well as established response organizations, were unable to deal with the cross-border crisis – the high numbers of refugees arriving in the Netherlands (Boersma et al., 2019; Larruina et al., 2019) – and bottom-up initiatives emerged. Since then, Refugee Company has adapted its mission to assist both asylum seekers in reception centers and status holders with their socioeconomic inclusion. Status holders are asylum seekers who have obtained the legal status to remain in the country. Refugee Company’s social mission is to enable refugees to move toward social and economic independence via the organization’s commercial subsidiaries, making the organization economically independent and sustainable.

Before March 2020, Refugee Company had two subsidiaries: Makerspace (clothing design and production) and Beautiful Mess (restaurants in three different locations). Starting that March, however, their activities were severely impacted by the pandemic. The protective measures established in the Netherlands (physical distancing, working from home, etc.) meant that they – like so many other enterprises – had to develop online activities or temporarily cancel their operations. Thus, in February 2020, with the impending outbreak of COVID-19 in the Netherlands, the management team began to consider the possibility of producing masks.

Responding to a crisis situation and seeing business opportunities at the same time is at the heart of Refugee Company. The following quote from their blog suggests some of the early steps taken and the maneuvering of social capital that was needed to make the factory a reality (translated from Dutch; <https://www.mondmaskerfabriek.nl/updates/klm-last-minute/>):

I am thinking along with Naz Kawan (co-initiator), who, along with the atelier team, develops face mask samples. Different models are being tried out, and we are looking into whether they can be certified in conjunction with Waag¹.

One month after the lockdown began in the Netherlands, Refugee Company announced the beginning of operations in their new mask factory in the Dutch city of Arnhem. They aimed to produce certified surgical masks locally in a factory operated mainly by status holders living in that municipality. The press release shared with 250 media outlets read: “Status holders are working hard to reduce the face mask shortage in the Netherlands” (translated from Dutch). Thus, since the end of April 2020, Refugee Company has been running a third subsidiary: de Mondmaskerfabriek (MMFactory).

Refugee Company’s social entrepreneurs considered de Mondmaskerfabriek as an initiative to create disruptive innovation through the production of face masks. It was supported by the Philips Foundation² (financial support) and Qredits (micro financing; financial support). The Ministry of Economic Affairs and Climate Policy and the Ministry of Health, Welfare, and Sport also played a massive role in providing financial support and in creating the market/distribution. The LCH, responsible for coordinating the distribution of PPE in the Netherlands, guaranteed the purchase of 1 million face masks per week. Another important governmental partner was the Municipality of Arnhem,³ with whom Refugee Company collaborated in creating jobs for refugees/status holders (in combination with language lessons).

¹ A knowledge institute in Amsterdam operating at the intersection of science, technology, and the arts, focusing on technology as an instrument of social change and guided by the values of fairness, openness, and inclusivity: <https://waag.org/en>.

² <https://www.philips-foundation.com/a-w/articles/mouth-mask-factory.html>

³ <https://www.omroep gelderland.nl/nieuws/2447006/100-000-mondkapjes-per-dag-Arnhemse-fabriek-kan-los>

SETTING UP THE PRODUCTION LINE

After establishing MMFactory, the next step was acquiring, installing, and correcting the functioning of the relevant equipment. Because setting up a production line for fabricating face masks was complicated and outside the scope and expertise of Refugee Company, Qing Engineering and Consultancy collaborated with the company, offering engineers who could advise them on how to set up and operate the production line.

We are an engineering company. And what we do is we help companies optimize their production facilities [...] because the machines, when they arrived here from China, they did not comply with European regulations regarding safety. Not on any level [...] It was just, it was a hazard. So, the first thing we had to do was modify the machines to make them comply with European regulations. (Respondent from Qing Engineering and Consultancy)

Refugee Company had to build the production line from scratch. With help from the company founder's sister who works as a KLM pilot, they were able to import the production machines from China in cargo space offered by the airline (See Figure 1 and 2).



Figure 1. Machines being loaded onto the KLM cargo flight from Shanghai⁴



Figure 2. Mondmaskerfabriek's face mask production line

At the beginning of its operation, MMFactory employed 20 status holders living within Arnhem, enabling the factory to expand its working hours and production. To be considered for this position, status holders had to have completed their Dutch residence exam or be in the later stages of preparation. Thus, this social initiative brought together the production of certified masks and the recruitment of status holders, who gained experience and learned essential skills for their socioeconomic inclusion in Dutch society. The following statements from press releases agree:

We are proud that we can contribute to a social enterprise that can make a difference in these times. Our form of social credit is a perfect fit for social initiatives such as these, which also create work experience places for refugees in the Netherlands. (Commercial director of Qredits)

⁴ Captions are from the video blog, with authorization from KLM's Communication and Marketing department.

It is great that there will be a factory in Arnhem where face masks are produced. [...] Thanks to the good collaboration between our municipality and Refugee Company, they were able to switch quickly and they managed to achieve this in a very short time. It is great that in this way, inhabitants of Arnhem with a refugee background can contribute to fighting the corona crisis. (Alderman for the Municipality of Arnhem)

CREATING THE MASKS

As important as setting up the production line was the question of which type of mask to make and what was needed to make it. From the beginning, MMFactory focused on making certified 3-layer surgical masks, type IIR, which are suitable for regular hospital care, elderly care in nursing homes, home care, and oral care (Mondmaskerfabriek, 2020; Philips, 2020). This type of PPE was chosen because it has a relatively easy certification process and it is widely used in public transport, private venues, and the streets. Its wide use also provided more chances to find potential buyers and guarantee a more sustainable business model. It is important to note that the contract with the ministry of health was not completed until July (three months after starting operations and deciding which type of mask to produce).

So, the initial thought with Refugee Company was to produce FFP2 and FFP3 masks, which are high-grade masks where you need a lot of certification, a lot of audits. [...] So, we said, do not do that. Go through what we call surgical masks. They are less regulated. And these will always be needed because, guys, you're also both sitting in Amsterdam. If you go to the tramways or the subways, you have to wear a face mask. That need will always be there. [...] Everybody is wearing the surgical mask. So, if you want to have a sustainable business model, also a part of COVID-19, you have to have a product portfolio which is lasting beyond that. (Respondent from the Philips Foundation)

However, setting up a face mask production line from scratch was not easy. Medical masks have a sophisticated fabrication process. Their filtering and protecting capacity rely mainly on multilayered structures made of *non-woven fabric*. The standard material used is polypropylene, which is “melt-blown” to form fibers that can catch small particles in the air that passes through, possibly thanks to electrical charges (electret treatment) (Chellamani et al., 2013). Refugee Company's concern, therefore, was to obtain good quality raw material:

And then I called Jaap⁵, who's my shareholder, also here in the restaurant. And I know he used to live in China. And I called him and I said, well can't we arrange something from China that we get the right filter material so they can at least work with the right materials here. (MMFactory director)

Refugee Company appeared in the PPE production ecosystem with the motto “To reduce dependency on factories on the other side of the world” (MMFactory press release) and to respond to the shortage of medical face masks in the Netherlands. They were one of the first factories to produce PPE in the Netherlands. Production began with filter material obtained from Philips intermediates.

The Philips Foundation has been involved from the start. It is great to see how we can use the knowledge in intermediates of Philips and convert it to filter material crucial for ensuring the quality of these medical face masks. (Respondent from the Philips Foundation)

However, obtaining high-quality material was difficult, not only to start but also to maintain a steady production of masks. The main challenge was finding reliable and stable suppliers, which at that time, were not available in Europe.

What you saw during the COVID-19 crisis is that you saw a lot of fake suppliers coming into the markets. Companies who never produced PPE before, all of them had millions available at horrendous pricing without the right certification [...] an interesting Wild West business today. (Respondent from the Philips Foundation)

The MMFactory logistics manager described the difficulty of obtaining raw material for the masks and the lack of European suppliers in the following:

We don't have a fixed supplier, so we buy what we can buy. But it's pretty ad hoc, pretty chaotic. We work sometimes with companies that don't speak English. So, Jaap's wife, she is Chinese. She then does the communication. I, myself, I'm not able to communicate yet with the parties involved. So that makes it a bit difficult to structure this in a way I would

⁵ Independent entrepreneur who co-founded MMFactory

like too. But that's the reality of where we are at the moment, is that there's a big scarcity and we buy what we can get our hands on [...] But there's a big risk that this whole venture could run out of supply if we cannot secure a more structured supply, supplier for our base, base materials.

Once the obstacles to obtain materials were temporarily fixed, the question became how to transport those materials to the Netherlands.

We have quickly come to realize that the necessary raw materials are not easy to obtain. [...] My sister is a pilot for KLM and flies the 747 airplanes. She is coincidentally flying to Shanghai today to pick up respiratory equipment for the Ministry. I will call her to ask if she can bring back a roll of cloth. I will explain to her what it is for. I will also call Jaap, as he is always willing to think along. He lived in China for 5 years, and together with his wife Ling, he spent some hours calling around and close to Shanghai. They found a factory that can supply 25 kilos non-woven melt-blown, which is good for 25,000 masks. (MMFactory director)

CERTIFYING THE MASKS: THE LAST HURDLE

Despite setting up its production line, knowing which type of product they wanted to make, and having the material they needed to make it in May 2020, MMFactory could not start producing fully certified PPE until October 2020. The six-month delay was due to the certification process – the preparation, application, and final approval of the relevant certification necessary to sell their product to the Ministry of Health.

Every machine needs to be certified. Every packaging you do needs to be certified. Every fabric you work with needs a specific certification. So, if you change a supplier to another one, you need to certify this whole product again. (MMFactory director)

The product needs to be tested on several parameters and that needs to be done at an accredited test lab, which is not available in the Netherlands. (MMFactory production manager)

This delay was aggravated because certification of medical products no longer takes place in the Netherlands. Furthermore, because of the pandemic, there were long queues at laboratories and test centers all over Europe. Some of these places were declining to certify more products due to their huge backlogs. Moreover, certification is a long process that can take up to two years. To get the quality of their masks approved, Refugee Company sent batches of the masks to accreditation institutes in Austria and Spain.

We were working with Austria because there is no certification in the Netherlands possible, the knowledge is not here. [...] So, we have sent it in now to Austria and to Spain. And in Spain it takes 12 working days. And in Austria, they said 10 working days, but they're already 20 working days busy with our products. So that takes a longer time. And they also told us, yeah, the whole world wants this now [certification of PPE]. So, yeah, you just have to wait. And the thing is, now we've sent in things, we don't have the fabric anymore of that supplier. So, Monday we will maybe get something back, but then we need to start all over again because it's a different supplier. (MMFactory director)

But all the other labs in Europe are filled up. So, they will not pick up the phone. Or when they pick up the phone, they will tell you we are not taking in any other test material for the next four weeks because we don't have the capacity. So, that's an issue. (MMFactory production manager)

The MMFactory director also reported that “after tests, it turned out that something was still not 100 percent in order”. This was a shock. The factory had applied strict quality control requirements since the beginning of its operations because it aimed to produce PPE suitable for hospitals and other clinical care. The failure to pass the first round of tests was mainly due to small dust particles found in some of the masks. This issue was corrected by setting up a *white room* (a type of clean room). Once certification was obtained, the MMFactory was ready to produce and deliver masks to the LCH, honoring its contract with the Dutch Ministry of Health for 50 million masks. “It is great that it worked out [the whole venture]. Everything we make now, we will deliver to healthcare” (MMFactory director, quoted in Heller, 2020).

DISCUSSION AND CONCLUSION

Since October 2020, Refugee Company has been part of the PPE supply chain in the Netherlands. Their production of face masks helps restore the broken supply chain. The company produces 350,000–500,000 masks weekly, all of which are delivered to the LCH. They are one of the few enterprises directly providing PPE to the Dutch government. The factory's current government contract ends in the summer of 2021, making its future uncertain, especially because China is increasing its production of PPE and offering competitive prices. Still, the factory has many potential customers, mostly healthcare providers and organizations willing to buy masks for their staff, who have already inquired about possible supply contracts. Furthermore, the Dutch government has expressed the desire to have face masks permanently produced domestically to avoid the vulnerability of global, transborder PPE supply chains during future crises.

This paper addressed the vulnerability of the global supply chain for medical equipment and PPE during the COVID-19 pandemic, a cross-border, transboundary crisis. It therefore contributes to the discussion on the promising role of social entrepreneurs and enterprises in response to such crises. Our case study on the Dutch Refugee Company's face mask factory contains important lessons on how such initiatives contribute to crisis response. It shows how social enterprises can respond to a crisis alongside the formal crisis governance system to generate processes for product development, logistics, and stakeholder collaborations and how bottom-up approaches to crowdsourcing tasks are generated under (time) pressure and with scarce resources.

The challenges in maintaining the global supply of PPE during the COVID-19 crisis have shown that building more resilient supply chains and diversified resource channels is crucial. Given the cross-border and cross-boundary nature of current crises related to global risks and challenges, including climate change, rapid urbanization, poverty and vulnerability, (forced) migration, mass tourism, animal welfare, and loss of biodiversity, global supply chains will likely be under constant pressure in the future. Refugee Company's entrepreneurial initiative to develop a supply chain, set up a production line, and begin the production of face masks during the COVID-19 crisis shows what an important asset bottom-up generated initiatives can be. The main lesson for policy makers is that social entrepreneurial activities from below can play a valuable role in strengthening supply chains to make them more sustainable and resilient to crises.

ACKNOWLEDGMENTS

This article is part of the H2020 project HERoS, Health Emergency Response in Interconnected Systems, which received funding from an EU Horizon 2020 grant (No. 101003606).

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